Ganga Ram Regmi
Falk Huettmann *Editors*

Hindu Kush-Himalaya Watersheds Downhill: Landscape Ecology and Conservation Perspectives

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Editors
Ganga Ram Regmi
Third Pole Conservancy
Kathmandu, Nepal

Falk Huettmann
-EWHALE Lab- Institute of Arctic Biology,
Biology & Wildlife Department
University of Alaska Fairbanks
Fairbanks, AK, USA

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Foreword by the Editors

Writing a book on the Hindu Kush Himalaya (HKH) region remains a global task. It means so many things to so many people. For me, FH, the HKH regions comes loaded with exotic concepts; it's a vast and deep landscape of global relevance reaching far beyond 'just' Asia. It features over two billion people, and already the spiritual aspects are too vast to catch and to understand for us westerners. As a child, I heard about this region and subsequently read about it, but details remained 'foggy' to me, and neither our education system would virtually present it to us nor our media! We got left in the dark. Turning later into a professional landscape ecologist, I was intrigued for years by this landscape, its mountains and people, and finally – but way too late one may submit – I was able to learn more through its wildlife and biodiversity about this region, its mountains, its water systems and the world and the universe we live in!

But the HKH region is more than just that. For GR, it's home, where he lived and grew up and makes a living. HKH is not 'a museum for western people'; instead, it's part of the real life and reflects all global processes. As a Nepali scholar gone abroad, GR can present on such experiences first hand.

Considering the Anthropocene of seven billion people and with many more to come soon, one simply cannot express all aspects of HKH well. HKH means many things to many people. Books – or science – are not good platforms to present that, and so we still can only start to grasp the complexities and to remain in awe. Instead of the western world describing such a vast reality in its narrow and limited, experiment-driven mind, we find the HKH region can instead inform, and improve, aspects how the world overall acts and describes things. The HKH region has much to offer on those grounds still, but many of its pristine and diverse elements are put in decay by ruthless global trends and efforts!

Here, we tried to start this process of deep appreciation, and – while incomplete – we express and document what we know and saw, thus far, in the HKH region. This book is for people who move and who look beyond the horizon at the mountain peaks and in the remote valleys to capture what Mother Earth – our universe – really is about! We kindly invite the reader to engage into our chapters and in a good debate to forward the subject of sustainability and for all what the HKH region has to offer, which will easily reach beyond a lifetime and have global repercussions!

Third Pole Conservancy
Kathmandu, Nepal
Ganga Ram Regmi

-EWHALE Lab- Institute of Arctic Biology,
Biology & Wildlife Department
University of Alaska Fairbanks
Fairbanks, AK, USA
Falk Huettmann

1 July 2019

Preface: The Third Pole – Lessons for 'Barbarians' Everywhere?

I try to live a low-carbon life. I travel little, bike much. I invest in photovoltaic and wind power. I use a plug-in electric hybrid automobile. To some extent, I attempt to compensate for a long career of mandated and invited air travel, although my partner can confirm that we lived nearly 10 years in the UK and Switzerland without a car. Co-workers will attest to my persistent (often inconvenient) preference, as resident of Europe, for train travel. The appellation "armchair traveller" suits me. I welcome opportunities to read books about distant regions.

During the International Polar Year 2007–2008, we gave lip service to the ice and snow region addressed in this book – the Hindu Kush-Himalaya (HKH) – while research and media attention focused instead on the Arctic and on Antarctica. I traveled to "gateway" cities both north and south, often to events organized by local promoters hoping to enhance commercial success of their particular access services. I traveled to central India and south-central China but never close to this HKH region. I unknowingly joined downstream users of HKH-derived water. Now, Drs. Ganga Regmi and Falk Huettmann and colleagues have compiled an interesting guide to this "third pole" location.

I start this exploration with curiosity and caution – curiosity about mountain regions, particularly about difficult, challenging, remote mountain regions. I resonate with James Scott's depiction, in his recent book *Against the Grain*, of "barbarians." Although defamed by central authorities (who, not incidentally, also introduced the earliest written histories), Scott's barbarians lived outside of tax and legal systems. Those barbarians sustained diverse food sources and habits; stimulated exchanges of material, ideas, and genes; and very likely recognized the need for constant innovation. Scott argues that, for much of its early development, civilization depended as much or more on barbarians than on cities. Excluded by force or choice from deltaic wetland grain-producing regions, those so-called 'barbarians' often occupied remote mountainous regions. My curiosity follows that spirit: challenging the status quo, looking for innovation, finding solace and inspiration in high mountains, and preserving the wild against the commercial demands of civilization. What might I discover about modern mountain barbarians in this book focused on the HKH?

My caution arises because I suspect (phrases like "serious problems" and "business as usual" in the book's section headings tend to heighten suspicion) that – expecting Shangri-La – I might instead confront exploitation, commercial excess, and, as a consequence of the very remoteness I admire, grotesque carbon footprints. When, as director of the World Climate Research Programme, I suggested that we consider carbon expenditures in planning administrative and advisory meetings, participants – confident of global importance of their activities – would not hear such caution. If we fail to set good examples in prominent endeavors, what might we discover in out-of-the-way locations?

The book offers geophysical and ecological landscape descriptions to get us oriented (strange word "oriented" in this context). It introduces us to cultures, languages, and religions because those have played and continue to play surprisingly strong – often but not exclusively positive – roles in environmental protection and conservation. The book devotes the majority of its chapters, text, and figures to biodiversity and conservation ecology – the essential inseparable essence of the HKH region from local as well as global perspective. A theme of water, from high-altitude snow and ice to literally millions of downstream users, pervades the text. Two final sections, one focused on challenges and problems followed by a second describing current good examples and practices, tend to leave the reader in a cautious and concerned mode.

The book assembles contributions from ten countries, with more than 50% of chapter authors from Nepal; more than 30% from the USA; a few each from China, Pakistan, and the UK; and one each from Australia, Germany, Norway, and Switzerland. Readers will encounter influence of Drs. Regmi and Huettmann in many of these chapters: Falk wrote 15 of 45 chapters himself, and he and Ganga serve as coauthor on many others. But why not? Their work and the book itself promote Nepalese authors and research. I, for one, always enjoy reading their activities, ideas, and viewpoints. Falk and I share a very strong commitment to full open access of all information and tools, a persistent theme in this book with many good examples.

I recommend the book to conservation ecologists, water managers, and curious armchair tourists. Yes, it conveys primarily a Nepalese viewpoint, but those Nepalese researchers know their region and its issues. Their curiosity and energy stimulate our own. They also address larger issues with undoubted global impact. As the reader explores these narratives, I call her or his attention to three issues.

The HKH region has sustained and continues to sustain *remarkable biodiversity*. Nepal alone has warm wet lowlands, moist (often forested) midlands, and cold dry highlands home to everything from elephants to snow leopards. Large migration pathways and flyways cross the region. The book often describes flora and fauna reflecting Palearctic (northern) or oriental (southern) regimes. Readers will join me in recognizing that the intersection of those source influences combined with awesome elevation ranges and historically limited access has stimulated and supported remarkable biodiversity. Here, one will discover (for themselves, no disclosures from me) the gharial, the langur, the Pallas cat, and the Sarus crane. In cases itemized here, natural area reserves associated with religious compounds and cultural/religious veneration of specific animals often play a positive role in conservation. HKH biodiversity faces extreme threats, with many facets of those threats itemized here in chapter after chapter. But, without question, one started with, and many of these authors work to preserve, a valuable globally distinct ecological resource.

The HKH region undergoes severe disruptive destructive change. It appears that we subject this remarkable region to even more remarkable exploitation. One senses a "Wild West" mentality? Mining, "rampant" dams, commercial forestry and agriculture, heavy-handed tourism – one detects the worst of humanity's excessive consumption and construction habits rapidly at work here. Without diminishing the collective negative impact of all these forces, *climate change*, particularly through its very disruptive impact on water in the form of snow and ice, already disrupts even the disruptions? Readers will confirm that most of these 45 chapters call out climate change as the largest, often most difficult to quantify, forcing function for the present and future. Even admitting known global-scale climate impacts on sea level, storm tracks (including monsoons), diseases, etc., one gets a clear sense of a seriously negative climate future for a region already facing its own peculiar challenges.

In one of Falk's personal chapters, he raises this interesting question: Do the mountainous regions of HKH represent a *source* of remarkable animals *or* a *refuge* to which animals from a wider region have now retreated? This question echoes my thoughts above, stimulated by James Scott, of mountains as homes but also refuges for barbarians – refuges, in other words, for diversity, innovation, fresh ideas, and new approaches. I do not anticipate an "either/or" answer to the source versus refuge question. One can find, especially in this book, examples of both. In some ways, however, a mixed answer, part source part refuge, implies even greater impact and importance of such regions. In native prairies (where we can find them) and in tropical rainforests, we find (and hopefully preserve) a wealth of biodiversity, stimulated and supported in those cases by relatively constant environmental conditions. In contrast, perhaps uniquely in HKH, an authentically cold snow and ice environment far from the geographic polar regions, we find a biodiversity hot spot stimulated not by constancy but by interfaces and gradients. Does HKH represent a highly stressed but perhaps hopeful example for conservationists? Can modern barbarians find cause for optimism?

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Contents

About the Editors

Ganga Ram Regmi Ganga has 15 years' experiences in wildlife survey, monitoring and conservation in one of the most difficult terrains of the world, the Hindu Kush-Himalaya region. He is the founder and long-term director of 'Global Primate Network' (now 'Third Pole Conservancy'), a small NGO actively engaged in wildlife research and conservation activities in Nepal. He graduated in Zoology and Primate Conservation from Nepal and Oxford Brookes University, UK. He is also a manager for the Nepal Snow Leopard Project funded by the Snow Leopard Conservancy, USA. Over the years, he has received many grants and prestigious awards from the international community for his work on wildlife and biodiversity conservation in Nepal.

Falk Huettmann Falk spent over 10 years doing field work and research analysis – including a sabbatical – at the Third Pole: the Hindu Kush Himalaya region. He is a 'digital naturalist' linking computing, open-access data and the Internet with natural history research for global conservation and sustainability. Working as a professor for Wildlife Ecology with the University of Alaska Fairbanks (UAF), he and many international students run the EWHALE lab, where he pursues biodiversity, land- and seascape approaches, the atmosphere, global governance, ecological economics, diseases and new approaches to global sustainability on a pixel scale in a transparent and repeatable way. Most of his over

220 publications and 8 books are centred on open access and open source, geographic information systems (GIS) software, metadata and data mining/machine learning, pushing real-world conservation questions forward.

Contributors

Shakeel Ahmad Hagler Bailly Pakistan, Islamabad, Pakistan

Purna Bahadur Ale Third Pole Conservancy, Kathmandu, Nepal

Sagar Aryal Central Department of Microbiology, Tribhuvan University, Kirtipur, Kathmandu, Nepal

Muhammad Naeem Awan Earth Day Network, Islamabad, Pakistan

Hem Sagar Baral Zoological Society of London Nepal Office, Kathmandu, Nepal

School of Environmental Sciences, Charles Sturt University, Albury-Wodonga, Australia

Fritz Berger Transhumana, Bern, Switzerland

Anita Bhattarai Animal Research Laboratory, Faculty of Science, Nepal Academy of Science and Technology (NAST), Lalitpur, Nepal

Daya Ram Bhusal Central Department of Zoology, Institute of Science and Technology, Tribhuvan University, Kirtipur, Kathmandu, Nepal

Michael Buckley Independent Researcher, Vancouver, BC, Canada

Rabita Duwal Third Pole Conservancy, Kathmandu, Nepal

Rajive Ganguli Department of Mining Engineering, University of Utah, Salt Lake City, UT, USA

Tashi Rapte Ghale Third Pole Conservancy, Kathmandu, Nepal

Tirth Raj Ghimire Animal Research Laboratory, Faculty of Science, Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur, Nepal

Yumin Guo College of Nature Conservation, Beijing Forestry University, Beijing, China

Xuesong Han College of Nature Conservation, Beijing Forestry University, Beijing, China

Lindsay Hansen Department of Environmental Science, Policy and Management, University of California, Berkeley, CA, USA

Falk Huettmann -EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA

Carol Inskipp Patron, Himalayan Nature, Stanhope, Bishop Auckland, Durham, UK

Rohit Raj Jha Institute of Forestry, Tribhuvan University, Pokhara, Nepal

Sakar Jha Institute of Forestry, Tribhuvan University, Pokhara, Nepal

Aashish Kumar Joshi Institute of Forestry, Tribhuvan University, Pokhara, Nepal

Muhammad Kabir Department of Forestry & Wildlife Management, University of Haripur, Haripur, Pakistan

Apsana Kafle Institute of Forestry, Tribhuvan University, Pokhara, Nepal

Kamal Kandel Third Pole Conservancy, Kathmandu, Nepal

Dikpal Krishna Karmacharya Bhaktapur Multiple Campus, Tribhuvan University, Doodhpati-1, Bhaktapur, Nepal

Third Pole Conservancy, Kathmandu, Nepal

Arjun Kurmi Green Youth of Lumbini, Rupandehi, Nepal

Rinzin Phunjok Lama Third Pole Conservancy, Kathmandu, Nepal

Yuanbo Liu Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing, China

Chunrong Mi College of Nature Conservation, Beijing Forestry University, Beijing, China

Harisharan Nepali Institute of Forestry, Tribhuvan University, Pokhara, Nepal

Sandhya Neupane Ministry of Agriculture and Livestock Development, Singhadurbar, Kathmandu, Nepal

Nirju Ojha School of Environmental Science and Management (SchEMS), Pokhara University, Kathmandu, Nepal

Pitamber Pant Tri-Chandra Multiple Campus, Tribhuvan University, Kathmandu, Nepal

Laxman Prasad Poudyal Department of National Parks and Wildlife Conservation, Ministry of Forests and Environment, Government of Nepal, Kathmandu, Nepal

Jamuna Prajapati Third Pole Conservancy, Kathmandu, Nepal

Ganesh Puri Department of Forests, Government of Nepal, Kathmandu, Nepal

Ganga Ram Regmi Third Pole Conservancy, Kathmandu, Nepal

Kabindra Shahi Institute of Forestry, Tribhuvan University, Pokhara, Nepal

Mina Shrestha Third Pole Conservancy, Kathmandu, Nepal

Thakur Silwal Institute of Forestry, Tribhuvan University, Pokhara, Nepal

Madan Krishna Suwal Department of Geography, University of Bergen, Bergen, Norway

Yajna Prasad Timilsina Institute of Forestry, Tribhuvan University, Pokhara, Nepal

Guiping Wu Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing, China

Santosh Kumar Yadav Green Youth of Lumbini, Lumbini Cultural Municipality, Rupandehi, Nepal

Grace M. Yoxon International Otter Survival Fund, Broadford, UK

Part I
Landscapes

Chapter 1
Mountain Landscapes and Watersheds of the Hindu Kush-Himalaya (HKH) and Their Biogeography: A Descriptive Overview and Introduction for 18 Nations in the Anthropocene

Falk Huettmann and Ganga Ram Regmi

Just approximately 30% of the globe consists of terrestrial ecosystems (Miller and Spoolman 2011; Lomolino et al. 2016); the rest is ocean, primarily made up of saltwater but fueled by a freshwater inflow. Those oceans essentially cover the majority of the earth. Like most of the universe, and like all mountains of the globe, the earth's sea-floor – as the biggest habitat type in the world (Wei et al. 2011) -is primarily covered by 'mud' (=wet sand & dust) and rocks which are exposed to the earth's weather and the direct forces from outer space. It's 'raw' and part of the wider universe we are all exposed to. This type of primordial landscape features the deepest trenches at app. 11 km below sea level (Mariana Trench), whereas the highest area on earth is Mt. Everest,[1] located c. 8848 meters above sea level. Needless to say that the mountain ranges of Everest show us exposed marine sediments from the past (Burga et al. 2004; Miller and Spoolman 2011)! The geology of the earth, and its movements and evolution, makes for a major player in this discussion either way. Plate tectonics and resulting forces shaped the topography of the earth in dramatic ways. Although of great importance for global well-being and subsequent politics, ice, glaciers and snow just play a small role in the cover percentage of the globe (Huettmann 2012; Goel et al. 2018 for the three poles).

[1] Everest is just a recent western name -promoted by the English-speaking world- but in Nepali it is called Sagarmāthā, and in Tibetan it carries the name Chomolungma.

F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

G. R. Regmi
Third Pole Conservancy, Kathmandu, Nepal

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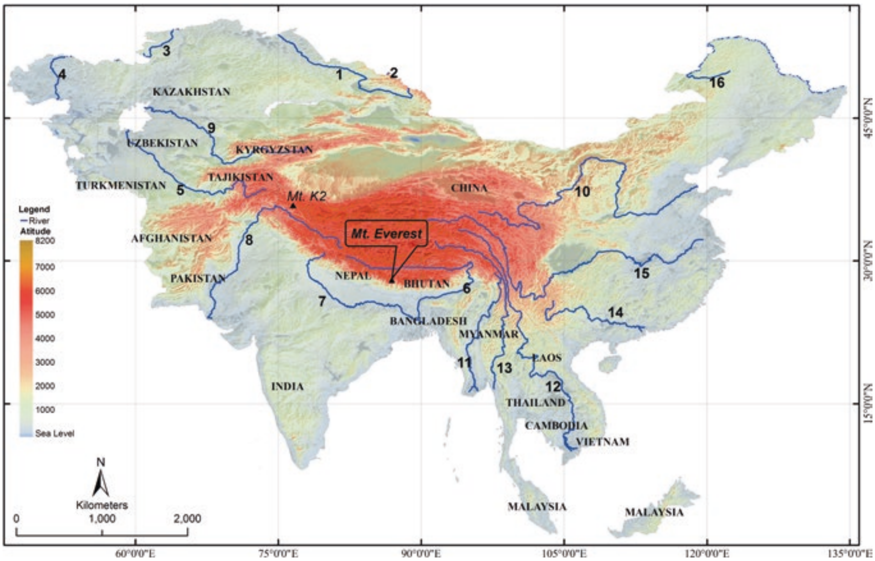

Fig. 1.1 Study area of the Hindu Kush-Himalaya region, its geography and nations

The deepest trenches of the earth and the highest peaks are part of the outer crust of the globe. Both of these extreme ends – c. 11 km below the water level as well as c. 9 km above- happen to be located in Asia and are part of the 'ring of fire' in the wider Pacific Rim. Not surprising that this area is probably the world's most geologically active one, too. Also this situation leaves humans, and any life as we know it, within just a narrow belt of overall app. 20 km wide to live on, with most live just found around sea level, at the coast centered around estuaries. The biggest diversity of the biological live is located along the elevational gradient found in Asia, with the Hindu Kush-Himalaya (HKH) region as a main player (for locations above sea level, the area around Kunming, China (eastern Tibet) is considered to be among the most diverse biodiversity gradients in the world (see also Yu et al. 2018); Figs. 1.1 and 1.2 shows similar extremes for the country of Nepal for instance).

To the best of our knowledge, this 20 km strip of life on the outer earth's crust is actually the only layer in the entire wide universe where live really can be found anywhere. And within that layer, most life is primarily located just in coastal zones (where subsequently app. 50% of mankind lives) and in the low altitudes where water accumulates (wetlands are good examples of that and they are widely seen as human cradles with rivers as the dispersing channels; virtually all centers of civilization show such a set up; Diamond 1997). Clearly, humans and water are linked (ICIMOD 2018)! Whereas, high mountain areas tend to be somewhat toxic to human life and its wider society (Messner 1999; Bonington 2016); already the alpine climate niche is rather hostile for most people (Burga et al. 2004; Barry 2008). Still, the photic-zone – as directly affected by the sun – remains the main center of life, and specifically near water. Most of the world's fishing – as a major source for human food- only occurs in the top layer of the ocean and

Fig. 1.2 Mountains, clouds and steep slopes; a typical view in the Hindu Kush-Himalayas. Note that the mountains are reaching above the clouds even

Fig. 1.3 Effective farming at c. 3,500 m is usually at its upper limit (as shown here in the Annapurna range of Nepal; perhaps a few hundred meters higher are possible if good soil and warm aspects with water are found)

that's for a good reason. Effective farming, as the other major source of human food, can barely reach higher than 3500 meters (see Fig. 1.3). Still, an important endemic and biodiversity peak can actually be found in the mid-hill ranges, e.g. Yang et al. (2012 for medical plants), Yu et al. (2018 for the Qinghai-Tibet plateau). These mid-hill mountain ranges provide a lot of unique resources to sustain human life in the valleys, including freshwater flowing downhill.

Above 3,500 m is where the higher mountain zone 'tends to start' and where life – as we know it – 'starts to end' (Barry 2008; Wester et al. 2019; see for instance Chaudhary et al. 2007 for a Manang example in Annapurna, Hindu Kush-Himalaya region). Considering that mankind grew to c.7 billion people by now, and that all of them are to fit in that narrow 'belt of life', namely valleys, it is easy to comprehend that the ecological niche of mankind getting rather crowded and widely overused. In such a magnitude, mankind had never witnessed such a 'crowded' situation on earth, and thus a global experiment is to unfold! How many people can Mother Earth really sustain, and to what effects and costs? By now, many uncritical efforts are made by people, their governments and agencies to extend that niche in any direction, e.g. deep-sea explorations (Halfar and Fujita 2007), high altitude farming (Kumar and Bhatt 2006) to expand economies 'anywhere and anyhow' (Sachs 2008), and even flying to other planets (just a very recent phenomenon, fueled by ideology; with just 550 people or so ever undertaken such a 'space' journey, it even makes for much less people than the ones who climbed Everest: c. 5500 individuals; see also http://www.himalayan database.com/).

With few exceptions, the universe, and even earth, tends to be quite barren, e.g. Figure 1.4 for an example in the HKH region. Vegetation, and with diverse hotspots, does not present the majority of the globe's area, it's hardly common but heavily fought about. In the epic pursuit to ever widen the extend of the human niche many water tables are now drained and exploited to record depths (a classic modern example is found in the Ogala watershed in the U.S. For Asia, an increasing list of aquifers that are getting

Fig. 1.4 A typical view of higher altitudes without snow: Rock and sand dominate the scenery as a dry high-altitude desert. (For snow- and glacier-covered altitudes, see for instance Ohmori 1994; Huettmann 2012; Goel et al. 2018)

depleted is found here http://www.nationalgeographic.com/ magazine/2016/08/vanishing-aquifer-interactive-map/). The pressures of humans to leave and to extend their initial ecological niche is growing; it's part of their evolution. And people who achieve it – e.g. explorers- are awarded peer recognition and society esteem (Diamond 1997). In a way, the internet is part of those efforts too because it helps to make a wider and sometimes more efficient use of the existing niche, but it also promotes new niches (e.g. websites on mountain climbing, diving or exploration of the universe speak to that effect nicely); and the peers do notice and award it. But while many even think the internet is a human niche of its own – with the world's economy to be grown within (Paul Romer for such a nobel prize, e.g. Rivera-Batiz and Romer 1991, and nobel prize winner William Nordhaus for stating agriculture just accounts for 3% of the national output) – this is obviously a serious fallacy and error because any technical constructs have no life of their own really, are not sustainable and are just built on natural resources (for those counterviews see Daly and Farley 2010; Czech 2018). Only the earth is, and will remain, the 'container' of natural resources for mankind and defines the carrying capacity, with water at its core. Gravity plays a driving force for water distribution: It starts in the atmosphere and then it rains and flows down to the ocean. It affects human society and global wealth and well-being!

By now, the initial landscapes – natural resources worldwide- are in a poor shape (Mace et al. 2010). They got transformed from a pristine and virgin state into the 'Anthropocene' (Smith and Zeder 2013, also referred to as the 'Capitalocene' due to its global governance allowing for such transfers of wilderness). Another way to describe it is that mankind and its 'modern civilization' has transformed, within just 40 years really, Mother Earth into 'brutalism' (http://www.sosbrutalism. org/cms/15802395#): buildings and earth surface was constructed so badly and in disrespect of human needs, the earth and sustainability that they look 'brutal' and are to be torn down again, further destroying processes and habitats that otherwise occurred and evolved there fine for millennia. These human-made buildings do not only have a vast water foot print, but they also wasted and used up water, carbon and many other resources and keep spoiling them. Thus, "*the gods are angry*", and why would they not be angry by now?

The state of most landscapes these days is all but pristine, beautiful or good habitat for most of the initially endemic and wilderness species and ecological processes. This is true throughout most of the world, for most landscapes by now. Usually, only remote or difficult to access landscapes remained less impacted. One of such an area difficult to access are remote mountain landscapes. They lag behind in that 'modern' development and industrialization. Thus, they offer mankind still relatively pristime landscapes; a certain 'heaven' (see Hilton 1933 for the infamous Shangri La). Ohmori (1994) provides stunning evidence about those landscapes, their snow, ice and glaciers feeding surrounding rivers and over 2 billion people downstream! As stated by ICIMOD (2017) those mountain areas occupy c. 24% of the world's land surface, mountains are home to 12% of the global population and provide a wide range of goods and services to one-fifth of humanity. The Hindu Kush-Himalaya (HKH) is among the largest and most assorted mountain settings in the world. It covers c. 4.3 million square kilometers, stretching from Afghanistan in the west to Myanmar in the east including over 18 nations (see

Fig. 1.5 "*Hey Mista…*". People, and specifically the new generation to come, are a main focus for the well-being of HKH. (Wester et al. 2019)

Shrestha et al. 2012; Miehe et al. 2017 for a brief description, Fig. 1.1 for overview; Kandel et al. 2015 for an ecological application of that concept). The HKH landscape needs to be seen as a holistic entity, as it always was! It's this landscape that runs the water source for the world, and for over 3 billion people that are directly affected in its watersheds downhill (ICIMOD 2018).

But what has dramatically changed in nature since the last ~60 years is that the human influence index is further on the rise. But also a few 'strictly' protected areas have increased. Corridors are planned to connect the last remaining areas to a network (http://www.icimod.org/?q=3854). Humans take over habitats and play a major role to focus on (Fig. 1.5; it's the Anthropocene at last). However, as the tiger habitats show, a vast amount of the initial habitat is gone (Fig. 1.6) and is unlikely to come back any time soon while wild tiger and other DNA is widely diminished and lost forever due to human impact and mis-management. Future generations will simply pay the bill; they have no choice (Barnett and Adger 2007; Huettmann 2012; Marsden 2019).

It comes without saying that such dramatic changes in landscape use and associated culture result in dramatic conflicts, usually warfare and a different society and governance paradigm. Those warfares are not only found on the landscape overall, and even in global governance, e,g. colonialism and local re-take of colonies (see India or China; Elvin 2004; Harris 2008), but also they are seen locally (see for instance Yue and Mensah 2017) and within the actual national set up (see Whelpton 2005 and Vanaik 2008 for Nepal and the Maoist insurgency); other classic examples are found in Afghanistan as well as Pakistan, Bangladesh and Vietnam.

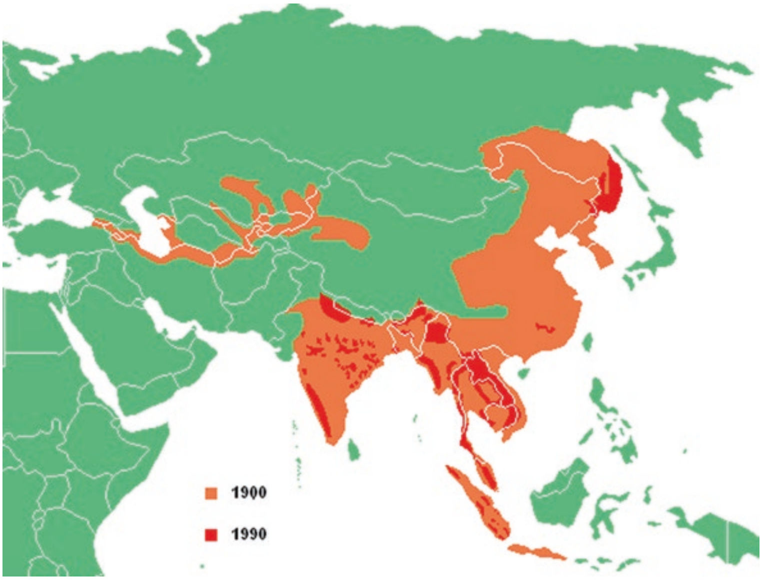

Fig. 1.6 Tigers lost in Asia over time. (Original map source: WIKIPEDIA https://en.wikipedia.org/wiki/Tiger)

Like with the ocean, the atmosphere has initially not received much attention in that concept of a human ecological niche requirement (Flannery 2007); or even in times of the Anthropocene. Accordingly, it was marginalized in the global governance and simply used as the sewer of industrialization and for billions of people long-term (see Daly and Farley 2010). Just now that this sewer is full – and the atmosphere eventually beats back – this topic received more attention. So by now, it's very clear that the atmosphere is an essential part of the human ecological niche and is to be treated with care and managed well. It affects all global processes, including the water cycle. Tim Flannery (2007) expressed that well in his writings (Fig. 1.2 shows some of those atmospheric aspects and global processes linked with an initially vast wilderness).

The Hindu Kush-Himalaya landscape is an inherent part in all of these global concepts (Wester et al. 2019). It easily ranks among the major landscapes of the world (Table 1.1). It's well-known and reaches major popularity in virtually all age groups and audiences, e.g. Braun (2018). This region makes for a base requirement for human existence locally as well as globally and across ecosystems. Life – as we know it – is either not possible without the Hindu Kush-Himalaya and it affects billions of people locally and beyond (ICIMOD 2017; Wester et al. 2019; see Hossain et al. 2018 for a real-world example of global repercussions).

This unique landscape of the Hind Kush-Himalayas is not short of world records. According to its role, it is simply named 'the roof of the world'. And how can one life without a roof? But beyond that, one may easily summarize it as a mighty landscape that

Table 1.1 A selection of landscapes of global relevance in addition to HKH

Landscape	Brief description	Citation	Conservation status	Uniqueness
Amazonia	An ancient river basin covered with tropical rainforest, savannas	Hemming (2009)	Highest deforestation rates in the world, tense conservation disputes and land claims by industry vs indigenous populations	Endemism, co-evolution, cradle for several species of commercial interest
Central African rainforest	An ancient river basin covered with rainforest		Mining and related warfare impacts	Ancient vegetation
Eurasian Steppe	Vast grassland wilderness		Farming transition	A cradle of civilization, linked with North America
Boreal Forest	The largest forest ecosystem in the world		Heavily cut in Canada with very short rotation periods	Forest wilderness, wetlands, permafrost
Southeast Asian Coral Reef triangle	Largest reef ecosystem in the world		Heavily overfished	Marine biodiversity
Antarctica	Largest ice and glacier area in the world	Huettmann (2012)	A climate change hotspot	An engine for global ocean currents
Arctic	North Pole	Huettmann (2012)	Summer sea ice disappears dramatically	A global climate chamber
Mediterranean	A cradle of western civilization		Heavily overused, lack of forests	Resource center for many civilizations of global relevance, e.g. ancient egypt, ancient greece, romans, Arabs etc.
Caribbean	A marine biodiversity cradle	Huettmann (2015)	Heavily affected by warfare, drug trafficking and poverty	Tropical rainforest and reefs
Siberia	Cradle of (Arctic) civilization		Industrial oil and gas development	Boreal forest and subarctic
Russian Far East	Sea of Okhostk as an ocean wilderness area	Huettmann (2008)	Unique ocean, wetlands and forests	Fisheries, wilderness
Northwest Pacific Rainforest	Largest temperate rainforest and old-growth forest		Salmon and endemic species decdline	Water cycle
Australian Outback	Human history for over 60,000 years	Flannery (2002, 2007)	Endemic species decline	Fire cycles and human society

(continued)

Table 1.1 (continued)

Landscape	Brief description	Citation	Conservation status	Uniqueness
Patagonia	A unique fjord ecosystem		Affected by salmon farming	Fisheries
Andes	A large corridor across South America		Heavily used area, e.g. mining	Watertower for South America
North American Prairies	Steppe of North America	Graves (2002), Johnsgaard (2005)	Farming transition	Bison ecosystem and affiliated human culture
Rocky Mountains	A large corridor across North America		Strong tourism and development	Watertower for North America
Great Lakes region	A unique string of waterbodies in North America		Heavy watershed development and pollution	Shipping lane, freshwater resource

Table 1.2 A selection of landscape types found in the HKH region; many of them with a global recognition in their own right

Landscape type	Famous features	Conservation status	Conservation outlook
Tibetan Plateau	High altitude herder	Dramatic and traumatice industrial development ongoing	Trend ongoing
Eastern Himalaya	Mt Everest and adjacent 8000 m peaks	Climate change impacts, tourism and development	Trend increasing
Western Himalaya	Lower dry lands	Slowly moving into western development	Trend increasing
Hindu Kush	Passes between India and Pakistan	Conflict zone	Unclear
Kashmir	India/Pakistan boundary	Conflict zone	Unclear
Kailash Sacred Landscape	Includes the remote, south western portion of China's Tibet Autonomous Region (TAR), adjacent districts in Nepal's far western region, and the north eastern flank of the state of Uttarakhand in India.	biologically and culturally diverse, it is also environmentally fragile	Regional transboundary cooperation has been started for the sustainable management

affects billions of people and their view and understanding of the globe (Ueda 2013; Buckley 2014). HKH affects world governance in many ways and it is easily among the most impressive, and most relevant landscapes in the world (Table 1.2; compare with other nations in Table 1.3).

Table 1.3 Amount of wilderness in nations of the HKH (=Amount of land having very low human impact; source: http://www.nationmaster.com/ country-info/stats/Environment/Wildness. This source uses 1990 metrics and thus represents an underestimate of human impacts by now; arguably, the last 40 years have been especially devastating to earth)

Nation	Wilderness area in the nation	Comment
India	1.94%	Largest nation in the world
China	31.49%	Second largest nation in the world
Pakistan	2.51%	Very high population densities, water irrigation
Nepal	2.62%	High altitude areas mostly located in marginal boundary zones
Bhutan	1.76%	A low number despite the high amount of newly protected areas (~60%)
Afghanistan	NA	Not listed in the source for details. Nation with ongoing warfare for decades
Bangladesh	0.06%	One of the densest populated nations in the world
Mongolia	69.99%	Vast impact by cattle browsing but little official roads
Kazakhstan	39.50%	This country joined capitalism and its metric widely declined.
Uzbekistan	34.40%	This country joined capitalism and its metric widely declined.
Tajikistan	25.63%	This country joined capitalism and its metric widely declined.
Turkmenistan	22.28%	This country joined capitalism and its metric widely declined.
Laos	6.21%	
Burma	15.66%	Surprisingly high wilderness, located in the wider HKH watershed region

The HKH region is dominated one way or another by the cluster of the world's highest mountains. It does not only provide for the fame of HKH (Bonington 2016), but also has a real-world impact. The 14 peaks over 8,000 m are shown in Table 1.4; they are among the highest in the world. These peaks are more or less a naturally connected areas, e.g. by geology, culture, ecosystem type, snow and ice. Another reason why those peaks matter globally is that they are the water towers, providing 'life' to all people living downhill from them (ICIMOD 2018; see also Marsden 2019). Many landscapes and oceans are consequently directly driven by those mountains. While this concept is simple to understand (but still not well addressed, governed and implemented in 'nation states', in the current global governance and property schemes, nor with the legal systems), its real-world implications are serious. It affects billions of people, eventually over 30 nations and a lot of the global culture and politics including global warfare (e.g. Afghanistan, many other border disputes etc).

The overall catchment area of the Himalayan rivers serves directly as a home to app. 3 billion people (nearly 50% of the population of the world; ICIMOD 2017, 2018). It covers the 18 nations of Bangladesh, Afghanistan, People's Republic of China, Bhutan, Nepal, India, Cambodia, Burma, Uzbekistan, Tajikistan, Kazakhstan, Turkmenistan, Thailand, Kyrgyzstan, Vietnam, Laos, Pakistan, and Malaysia. The financial impacts of the Hindu Kush-Himalaya and it glaciers affects c. 30% of the world GDP (ICIMOD

Table 1.4 List of 14 mountains over 8000 m high in the HKH region

Mountain peak	Environmental description	Comment
Kangchenjunga	Nepal near India, surrounded by tropical ecosystems	Lower areas are famous for its tea (Illam and Darjeeling)
Mt Everest	Located on a high glacier plateau	World's highest mountain
Lhotse	Located next to Mt. Everest	
Makalu	Part of the Mt. Everest area	
Cho Oyu	Next to Mt. Everest	
Manaslu	Nepal, near China	Features ridges and glaciers
Annapurna I	Entirely located in Nepal, Annapurna Conservation Area; surrounded by tropical ecosystems	Several Annapurna peaks exist. Ranked as a dangerous peak.
Dhaulagiri	Entirely located in Nepal. Kali Gandaki River nearby	
K2	Boundary zone between Pakistan and China	One of the most dangerous mountains, thus far.
Nanga Parbat	Pakistan	Also one of the most dangerous mountains (death rate of ~77%).
Gasherbrum I	Pakistan/China region	
Gasherbrum II	Pakistan/China region	
Broad Peak	Pakistan/China region	Carries its name due to its wide shape
Shishapangma	China	

2017; the World's GDP is app. $88,081 bilion)! As stated by these authors, the goods and services provided include water, hydroelectricity, timber, medicine, a wide variety of bio-resources, and opportunities for recreation and spiritual renewal. The region is well known for its widely-acclaimed geo-hydrological, biological, cultural, and aesthetic value (see for instance Palin 2004; Braun 2018 for children focus). The services provided by mountains contribute enormously to the region's economic growth and are key to sustaining the livelihoods of the more than 200 million people living in the mountains themselves and the approximately 1.3 billion people in the downstream river basins, as well as all the ones of the wider communities and benefiting the global community overall.

Due to one of the biggest agglomerations of snow and ice (usually ranked third globally, after Antarctica and Arctic; Huettmann 2012; Wester et al. 2019), there are over 11 major rivers (see Table 1.5). Those rivers will receive more attention in subsequent chapters, but the basic metrics are provided here for an introduction. For any modern reviewer it will easily be clear that those river systems and watersheds are now under threat and widely stressed, beyond the pure irrigation and extreme water use found worldwide, e.g. use of river gravel and sand as a global trade commodity (for sand mining see here: https://www.theguardian.com/world/2017/dec/30/india-sand-mining-conflict-deaths-building-boom-environmental-damage; Fig. 1.7 for a real-world detail in the HKH region) (Fig. 1.8).

Table 1.5 List of major rivers that are coming down from HKH region

River name	Local name	Length	Origin	End	Nations covered	Citation
Ganges	Ganga	2,525 km	The eastern Himalayas in the Indian state of Uttarakhand,	Bay of Bengal	China, India, Nepal and Bangladesh	https://en.wikipedia.org/wiki/Ganges http://www.thewaterpage.com/ganges.htm
Iriwaddy	Ayeyar-wady River)	2,210 km	Originating from the confluence of the N'mai and Mali rivers	Andaman Sea	Myanmar	https://en.wikipedia.org/wiki/Irrawaddy_River
Yellow River	Chinas Sorrow	4,845 km	The Bayan Har Mountains in Qinghai province of western China	Bohai Sea near the city of Dongying in Shandong province.	China	http://www.newworldencyclopedia.org/entry/Yellow_River
Jangtsekiang	This is the Yangtze river (see details below)					
Mekong	Lancang Jiang (Turbulent River) in China, the Mae Nam Khing in Thailand, Myanmar and Laos, Tonle Than (Great Waters) in Cambodia and Cuu Long (Nine Dragons) in Vietnam. It is also known as River of Stone, Dragon Running River, Mother River Khong, and Big Water.	4,350 km	Yangtze River	The South China Sea at the Mekong Delta in Vietnam	China, Thailand, Laos, Myanmar,Combodia, Vetnam	http://factsanddetails.com/asian/cat63/2sub6/entry-2833.html
Yarlung-Tsangpo River	Yarlung Zangbo Jiang	2,840 km	flows from or through Tsang- encompassing the Tibet west of Lhasa.	Yarlung Tsangpo Grand Canyon	China, India, Bangladesh	https://en.wikipedia.org/wiki/Yarlung_Tsangpo_River

Yangtze River	In the high Qinghai-Tibet Plateau, the Tibetans title it Dri Chu—Female Yak River. The Chinese in the area know it as Tongtian He, Travelling-Through-the-Heavens River. Where it borders Sichuan and runs through Yunnan, it is referred to as Jinsha Jiang, River of Golden Sand.	6,380 km	Originating from the Tanggula Range in Qinghai Province in western China	The East China Sea at Shanghai.	China	https://www.travelchinaguide.com/river/
Heilongyang/ Amur River	Black Dragon River	2,824 km	Junction of the Shilka River, which rises in the Russian Federation	Tatar Straits	Russia, China	https://en.wikipedia.org/wiki/Amur_River#cite_ref-2
Padma River	Lotus flower, Podda	120 km (section)	Ganges	Bay of Bengal	Bangladesh	https://en.wikipedia.org/wiki/Padma_River
Karnali	Ghaghara	1,080 km	Mapchachungo Glacier(Left tributaries-Bheri, Sarju, Kuwana, Rapti,Chhoti Gandak)	Ganges at Revelganj in Bihar (Right tributaries-Seti Dahawar, Sarda,Budhi Ganga)	China, Nepal, India	https://en.wikipedia.org/wiki/Ghaghara
Trishuli		200 km	Tibet Autonomous Region of China where it is called Kirong Tsangpo, Gosaikunda	It flows through Nepal and joins at Devghat the Narayani River, which at a lower stage flows into India and joins the Ganges.	China, Nepal	https://en.wikipedia.org/wiki/Trishuli_River

(continued)

Table 1.5 (continued)

River name	Local name	Length	Origin	End	Nations covered	Citation
Kali gandaki	Narayani in southern Nepal and the Gandak in India	630 km	Nhubine Himal Glacier at Mustang. (Tributaries- Trishuli,Budhi Gandaki River,Marshyangdi, Madi,Seti Gandaki River)	Ganges	Tibet (China), Nepal, India	https://en.wikipedia.org/wiki/Gandaki_River
Koshi	Saptakoshi (Tamur Koshi originating from the Kanchenjunga area in the east, Arun River and Sun Koshi from Tibet. The Sun Koshi's tributaries from east to west are Dudh Koshi, Bhote Koshi, Tamba Koshi and Indravati Koshi.)	720 km	Sun Kosi, Arun and Tamur form Saptakoshi	Ganges	Tibet (China), Nepal, India	https://en.wikipedia.org/wiki/Koshi_River
Marsyangdi		150 km	Two mountain rivers — Khangsar Khola and Jharsang Khola	Trishuli at Mugling	Nepal	https://en.wikipedia.org/wiki/Marshyangdi
Indus		2,880 km	Tibet	Arabian Sea	China, India, Pakistan	https://simple.wikipedia.org/wiki/Indus_River
Salween River		2815 km	Tibetan Plateau	Andaman Sea in Southeast Asia.	China, Myanmar,Thailand	https://en.wikipedia.org/wiki/Salween_River
Koshi River	Saptakoshi	720 km	Sun Koshi, Arun and Tamur form the Saptakoshi	Ganges	Tibet (China), Nepal, India	https://en.wikipedia.org/wiki/Koshi_River

Brahmaputra	Tsangpo-Brahma-putra	3,848 km	Kubi, the Angsi, and the Chemayungdung.	Ganges (Ganga) River, after which the mingled waters of the two rivers empty into the Bay of Bengal.	China, India and Bangladesh.	https://en.wikipedia.org/wiki/Brahmaputra_River
Karnali River	Ghaghara	1,080 km	Mapchachungo Glacier	Ganges at Revelganj in Bihar	China, Nepal, India	https://en.wikipedia.org/wiki/Ghaghara
Tarim River	Yarkand-Tarim river, Sita in Sanskrit	2,030 km	Karakorum and Kunlun Mountains.	Taitema Lake at southwest of Lop Nur.	China	https://en.wikipedia.org/wiki/Tarim_River#History
Amur Daya River	In Vedic Sanskrit, it is referred as Vakṣu, Ōxus in Latin, Ôxos in Greek	2,620 km	The junction of the Vakhsh and Panj rivers,	Southern remnants of the Aral Sea.	Afghanistan, Tajikistan, Turkmenistan, Uzbekistan	https://en.wikipedia.org/wiki/Amu_Darya
Onon River		817 km	The eastern slope of the Khentii Mountains	Ingoda River to produce the Shilka River	Mongolia, Russia	https://en.wikipedia.org/wiki/Onon_River

Fig. 1.7 Sand mining in a river of the Hindu Kush-Himalaya region

Fig. 1.8 Realities in the Hindu Kush-Himalayas: A sugarcane plant operating somewhere in Northern India- a commonly encountered situation

Like many landscapes and continents, the HKH region offers stunning perspectives for science, its theories and for assessments whether those theories actually hold up. In many cases, western science got enhanced and extended, simply based on experiences with HKH and what it offers, e.g. plant medicine, biology, atmospheric sciences, geology, archeology and spiritual research. The HKH is a man-made experiment allowing us a look into ancient history, wilderness and earth processes to manage earth better (see biogeography patterns in Table 1.6). The HKH region is a playground for biogeography (Lomolino et al. 2016).

Table 1.6 Known biogeography patterns that are already well-described for the HKH area

Biogeography	Impact	Example/Citation
Barrier	Separates species and sub-species	Assamese Macaque, Fish species in Ghat region
Fragmentation	Habitat loss	Forest cover
Isolation	Speciation, inbreeding	Valleys
Corridors	Connectivity, gene flow	Mountain ridges
Island Biogeography	Isolation	Endemic species, mountain peaks, remote valleys
Connectivity and Corridors	Gene flow	Proposed protected area network, river valleys
Core areas	Cradle, endemism	Snow Leopard, Pallas Cat
Undisturbed Co-evolution	e.g. fish left un-fished	Tibetan Plateau, Mongolia

These landscapes of HKH are all stunning in their own right (Table 1.3; Wester et al. 2019); but as a unifying feature it is pretty clear now that they are all changing, and they are changing fast due to 'man' (Wester et al. 2019 and citations within). The speed of change, towards destruction, happens in front of our eyes (Xuesong et al. 2017)! It's the Anthropocene (Smith and Zeder 2013). Areas in Tibet now carry an economic growth of over 300% GDP (Xuesong et al. 2017), and other areas are also set for a similar concept of development! In that process of massive man-made change to cater global consumption, all what evolved in the study area over hundreds of years, and more, and what was sustainably til then, gets by now widely destroyed; simply eaten up (Harris 2008; Buckley 2014). Entire lifestyles, languages and skills (e.g. Subedee et al. 2016 for an example), usually sustainable, got lost and became suddenly even obsolete, including sophisticated governance schemes, societies, cultures and languages. What we still can see now in the year 2018 is just a fragment, a left-over, of what was there initially and of a wider, more-close- to-the-earth concept. A way how to live well on the land is disappearing in front of our eyes and even worse: it is replaced with something much worse that has already a devastating track-record anywhere else in the world! Figure 1.9 shows how the thousand-years old flow of rivers is now ended, 'dammed' (Sachs 2008 and Poff and Olden 2017 for a discussion). Like found elsewhere now, e.g. the mighty U.S.Columbia River in Baja California Mexico, the productive estuaries and oceans are compromised in full (Fig. 1.10; this specific ocean zone in Bangladesh happens to be the home of endangered species like the Spoon-billed Sandpiper *Calidris pygmaeus*, Zoeckler et al. 2016).

An example for this extinction process already ongoing is the number of ancient languages spoken, and now almost lost in the HKH (India has by now the highest density of English-speakers anywhere in the world). This follows the global trend of conversion, neo-colonialism and loosing cultures and ethnicities world-wide. It's like the loss of species and DNA worldwide due to human-caused actions, but already ongoing since the so-called period of (western) enlightenment and modern progress! What an enlightened progress would that be, and for whom? And who is proud of it?

Fig. 1.9 End of the ancient flow? A representative view of a hydro damn of rivers in the HKH region (see also Poff and Olden 2017 for examples and details)

Fig. 1.10 Where the Hindu Kush-Himalaya rivers end? A beach in Bangladesh

Without doubt, global change – a massive change that includes global warming – stands out as the single biggest scheme in our time and that is already ongoing (e.g. Wester et al. 2019 for glaciers and watersheds drying). As judged by IPCC (www.ipcc.ch) it will become even more devastating in the next 20, 50 and 100 years from now, most likely beyond that. It will be "hell" by some accounts (Evers 2019; Wester et al. 2019 for more conservative outlooks). One may call it easily 'Global Change' because it includes processes of human growth, increased consumption as well as warming and drying, even extreme events like rainfall and flooding and so on. The melting glaciers and their subsequent drying of the rivers is just one phenomenon of many (see Armstrong 2010 and Wester et al. 2019 for the HKH region). One would prefer to call it universal change because the entire universe can witness what we currently do the planet, to the narrow strip pf live on earth, which happens to be the only one in the universe we know of. For now, we do not see how this problem is addressed and resolved in a good way for betterment. From the perspective of the HKH, this book is trying to help promoting those discussions, show facts, and help towards thinking for a better world where everybody is fully involved – equally and fair – and where well-being is shared equally and in a meaningful way for the world that is all based on a sustainable use of natural resources – from all what is left. While there is probably no good way back anymore, the future is still based on our actions centered around natural resources of mother earth (Naess 1989; Lama 2009). Better decisions are to be made. A good culture – how humans relate with the earth – remains the recipe for our future wellbeing and sustainability!

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Chapter 2
The Hindu Kush-Himalaya (HKH) Region in the Modern Global and Climate Context: Major Weather Systems, Monsoon, Asian Brown Clouds (ABCs), Digital Data/Models and Global Linkages of Telecoupling and Teleconnection all Affecting Global Human Well-Being

Falk Huettmann

"Weather" is a big issue; even without climate change. It has occupied mankind for millennia as it sets the limits humans live under. Historically, humans have attributed a lot of their weather observations to the mountains and their 'gods' located on mountain peaks (Barry 1992)! Mountains can be the 'weather engines' (Burga et al. 2004; Whiteman 2000). Mankind and human civilization are children of the weather! Humans rely on, and can make the weather (Flannery 2007). Nowadays, in the Anthropocene, 'weather' is fully embedded in the climate change question; a topic that also clearly exists in the Hindu Kush-Himalaya (HKH) region and which becomes quickly obvious to any practitioner (Shrestha et al. 2012).

Weather consists of many features and metrics, and it is explicit in space and time, all in 3-D (e.g. Barry 1992; McIlveen 1998). But it's not just a reflection of a single metric, like temperature (or precipitation, sun angle or even 'the atmosphere' itself). That's because apart from stellar constellations, sun winds and the universe, much of the local weather on earth actually is driven by…the ocean far away from land even (McIlveen 1998). That is referred to as 'coupling' (=systems are connected/coupled). Weather systems are coupled with oceans, and specifically, with polar and mountain regions (Zhu and Shukla 2016; see also Barry 1992; Whiteman 2000). That also applies strongly to Asia (see Fu 2007 for the monsoon)! But apart from the earth axis

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F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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and rotations (including non-cyclic ones like ones proposed by M. Milankovich), jet streams also play a role, as does the chemistry of climate gases, dust, sediments and vapor (=clouds). Topography and evapotranspiration need to be mentioned here as well, as well as the role of volcanoes even. While these are all many individual factors, in real live they actually act together as a complex multivariate synergy package over time. It easily challenges the human mind. In the HKH region, all of this comes together as one, and it even gets magnified there for impacts due to the steep altitude, vast terrain and synergies (Barry 1992; Whiteman 2000). It's the roof of the world afterall! Likely there are 1000 s of predictors acting in combination here; which is typical for any ecological system (Naess 1989): The weather in HKH is nothing but a reflection of truly global events. Most notably is the monsoon weather system making for a unique combination of ocean-driven land processes linked with global inputs and outputs across dimensions (see for classic research by Blanford 1884 etc). For the first time in the universe, there are now over 7 billion people on earth. Consequently, humans add a new dimension to this 'weather machine': man-made climate change makes for an inherent part of the Anthropocene (Figs. 2.1 and 2.2).

No wonder then that predictions and descriptions of weather and climates for regions like the Tibetan Plateau, or alpine glacier fields and Mt. Everest, have been notoriously difficult in climate science (such details and discussions can be tracked here: http://www.ipcc.ch/; see Moore and Semple (2004), Huettmann (2018a) for examples and errors in rugged terrains and which are ocean-coupled). The data available for this region are often incomplete, problematic, if not sometimes plain absent or 'buggy' (e.g. Singh and Thadani 2015; Huettmann 2018a). Consequently, data for such regions get frequently debated, updated and they change, with its underlying science still in flux (e.g. Duan and Wu 2006). Regions like China and remote places locked up and/or disconnected from the western world and its science and research remain equally difficult for climate work and when climate ground data are incompatible, missing or are not made openly available (see the Italian weather station -the so-called CYR Pyramid- at Everest for instance: http://www.evk2cnr.org/cms/en/evk2cnr_committee/pyramid/story; or see portable weather station and data from Moore and Semple 2004).

As shown in Fig. 2.3, the HKH region is not really short of climate data and layers, but which ones are really accurate, and how assessed, and by whom? What is the truth and what is a good benchmark? That is specifically a question for climate pixels that are poorly sampled, located on steep slopes or in complex areas and in locations with big political interest (e.g. international boundary zones). Orographic precipitation correction is a typical issue in such data sets (Singh and Kumar 1997; Bobrowski and Schickhoff 2017). Table 2.1 shows a set of widely used modern data layers for the region and with a generic quality label, based on the author's work in the region. Arguably, many opinions and pixels exist on the topic then.

Those modeled data layers can provide many metrics, nuances, of the weather at a given pixel. Over 19 metrics easily exist, temperature-based. Table 2.2 shows some of those, all based on numerical model methods and theory extrapolated from weather station data. Many more metrics can be computed. The issue here is that while many metrics can help to express weather details, none of those currently

Fig. 2.1 A mountain landscape in the HKH region indicating some weather processes

really do express a convected and highly interacting larger scale weather system in 3 dimensions, yet (see an example here https://climatedataguide.ucar.edu/). For now, the best climate models for the HKH region are either just for specific commercial, public and strategic hotspots in HKH such as Everest, a handfull (international) airports or otherwise the coarse ocean-coupled climate ones (e.g. general circulation model GCM implementations following http://www.ipcc.ch/; see for details http://www.ipcc-data.org/guidelines/pages/gcm_guide.html). I am not aware of downscaled climate models freely available for the public for the HKH region covering all of the 18 nations as one coherent landscape unit and its local interactions (as covered in this book) (Fig. 2.4).

Fig. 2.2 Claming (mussel harvest by locals) at a tropical estuarine zone in Bangladesh, a down-river outflow region of the Hindu Kush-Himalaya. Those oceans and their coastal zones can be great drivers of weather, rain and snow fall patterns in mountain regions. Monsoon is widely driven by ocean impacts, apart of other factors. Those areas are also habitat for endangered species, for instance the spoon-billed sandpipers (*Calidris pygmaea*) migrating from the Arctic, and many seabirds

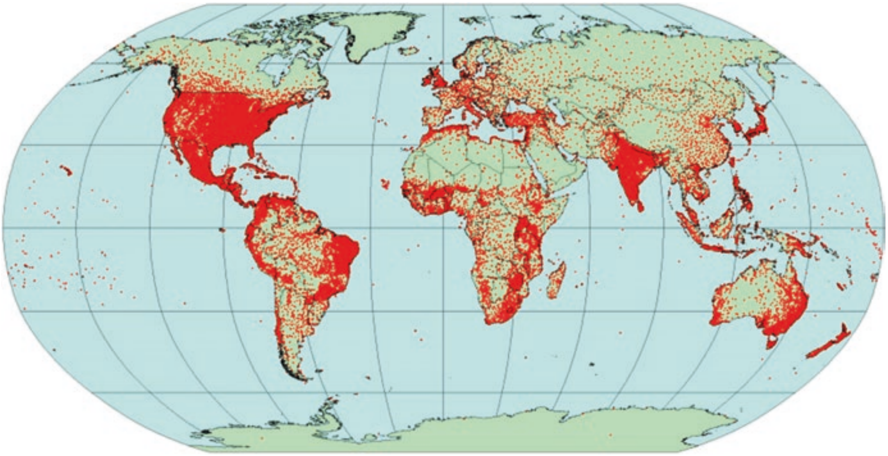

Fig. 2.3 Locations that have climate and weather records, used for climate layers and models, e.g. wordclim (http://www.worldclim.org/ methods1)

Table 2.1 A selection of data layers, pixels, rasters and data sets for the Hindu Kush Himalaya region

Dataset Name	Spatial Resolution	URL	Citation	Comment
Worldclim vers 1.4	1 km	http://www.worldclim.org/version1	Hijmans et al. (2005)	Some problematic pixels in the HKH region
Worldclim vers 2	1 km	http://worldclim.org/version2	Fick and Hijmans (2017)	Improved but not widely used/ tested yet
CHELSA	1 km	http://chelsa-climate.org/	Karger et al. (2016, 2017)	Not outperforming WorldClim
ICIMOD	1 km	http://geoportal.icimod.org/	NA (but mostly referred back to Worldclim (Hijmans et al. 2005)	There should be app 60 climate data layers for the HKH region, but we are not able to locate them online, beyond fragmented glacier and snow layers and clipped Worldclim ones.
IPPC	8 km	http://www.ipcc-data.org/	http://www.ipcc.ch	Coarse and some

There are many weather systems in the world and for large landscapes; their major mechanisms have been described already (Barry 1992; McIlveen 1998; see in Miehe et al. 2015 for details) but the ones for HKH are still in flux.

For the HKH region overall, the following large-scale weather concepts find their full application, often acting in synergy:

(i) equatorial weather systems (including intertropical conversion zone ITZ),
(ii) mountain and high-altitude weather,
(iii) monsoon seasonality,
(iv) desert weather,
(v) jet streams,
(vi) ocean coupling and
(vii) climate change (local and outside effects).

Because the HKH region is located near the equator, it is a tropical regime. For equatorial weather systems, those are primarily driven by the intertropical conversion zone (ITZ) and its fluctuations (McIlveen 1998), but here then also interacting with the Asian mountains and oceans etc. (Fig. 2.5).

Beyond the mentioned larger scale regional weather patterns, for mountain weather, and specifically when big peaks and high altitudes are involved, those ones can create and carry their 'own' weather. That's due to the terrain's magnitude, extend, size and steepness, as well as the height, which all are found in the HKH region. Each peak has its own dynamic and then acting in concert with each other towards an outcome: the local weather observed on the ground. The HKH region having some of the highest peaks in the world is just a unique representation of those events, and many of them are not so well understood, studied or modelled. Just consider the weather of Everest (Moore and Semple 2004; Salerno et al. 2015),

Table 2.2 Common weather data metrics used worldwide, and also available in the HKH region for data layers, e.g. Table 2.1

Name	Meaning	Comment
BIO1	Annual Mean Temperature	A widely used, but coarse, metric
BIO2	Mean Diurnal Range (Mean of monthly (max temp – min temp))	
BIO3	Isothermality (BIO2/BIO7) (∗ 100)	A metric expressing difference between summer and winter in percent
BIO4	Temperature Seasonality (standard deviation∗100)	
BIO5	Max Temperature of Warmest Month	
BIO6	Min Temperature of Coldest Month	This metric is usually a good metric for maximum species ranges because freezing limits the range of many species
BIO7	Temperature Annual Range (BIO5-BIO6)	A coarse expression of the climate niche width
BIO8	Mean Temperature of Wettest Quarter	
BIO9	Mean Temperature of Driest Quarter	
BIO10	Mean Temperature of Warmest Quarter	
BIO11	Mean Temperature of Coldest Quarter	
BIO12	Annual Precipitation	A widely used, but coarse metric on rainfall and snow.
BIO13	Precipitation of Wettest Month	
BIO14	Precipitation of Driest Month	A powerful metric for species needing water
BIO15	Precipitation Seasonality (Coefficient of Variation)	
BIO16	Precipitation of Wettest Quarter	
BIO17	Precipitation of Driest Quarter	
BIO18	Precipitation of Warmest Quarter	
Bio19	Precipitation of Coldest Quarter	

This scheme is taken from the global Annuclim, modified in Worldclim (http://www.worldclim.org/bioclim) and also available in the DISMO package in R, as well as re-served from ICIMOD (see Table 2.1 for details; Kandel et al. (2015), Suwal et al. (2016) and Xuesong et al. (2017) for an application and new insights)

and then its adjacent peaks of Lhotse, Baruntse, Makalu and Chamlamg. While this might be 'interesting' for armchair travelers, it means live or death for mountaineers, climbers, helicopter pilots and seasonal farmers living in the wider area (Huey and Salisbury 2003; Moore and Semple 2006). People who can understand, or forecast, such weather patterns are in demand (e.g. http://everestweather.com/ or https://expeditionweather.info/)! The latter is a growing business.

Apart from its spectacular steep peaks, the HKH region is further characterized by large valleys, wind-shadows and high and dry plateaus, e.g. Humla, Tibet and Mongolia (Barry 1992). Some of the peculiar local weathers are partly mentioned by Miehe et al. (2015).

Arguably, weather systems are not static, they are inherently dynamic and move across landscapes and topography in three dimensions, while the earth itself is

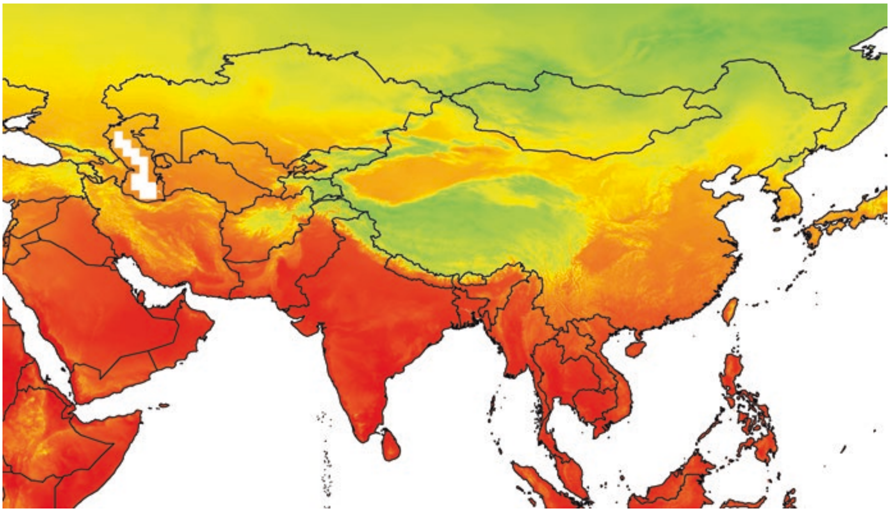

Fig. 2.4 A climate data layer of the Hindu Kush-Himalaya region (source: Worldclim; see text for details)

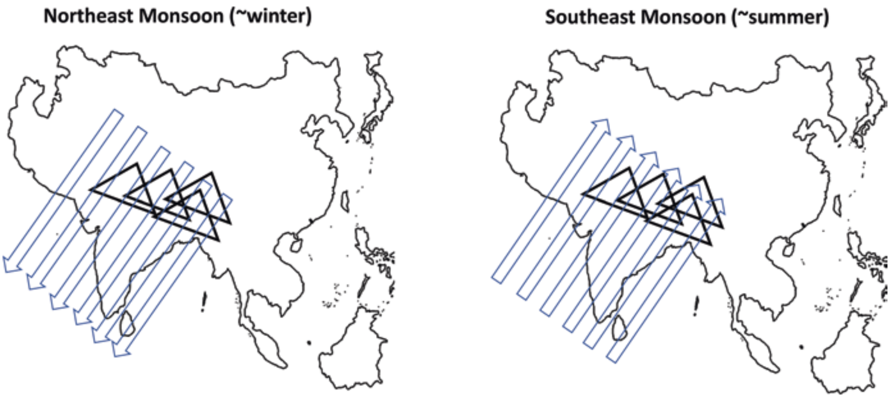

Fig. 2.5 A scheme of Asian weather patterns and the monsoon carrying water up from the ocean, and its seasonal reversal (mountains depicted as traingles)

moving. There are many reasons why these weather systems are dynamic, e.g. because the earth is round and spinning, sun-driven and local temperatures are trying to equal each other out across gradients within the atmosphere and its layers. Counter-currents play a big role as does sun exposure of those heated up layers. As Foley et al. (2000) and the IPPC show, landcover is a big driver of 'weather' (http://www.ipcc.ch/). For Asia and the HKH region that is widely known and described, too.

As a typical counter-current, the monsoon represents such a seasonal change of wind directions associated with the weather. It's even affected by El Nino and other wider global patterns. The monsoon exchanges wind from ocean to land and consequently exchanges 'heat'/energy and humidity. It is a response to global heat gradients and budgets with the ocean (cool or hot) as a relevant engine (much of the world's ocean current is actually closely coupled – driven – by Antarctica and its deep sea currents; Convey et al. 2009). It results into fast and strong dry winds, as well as wet winds throughout the year and specific seasons. It is a reason why growing tea is so lucrative in the Darjeeling, Ilam and Kachenjunga regions near Everest, for instance. This location is uniquely placed for a weather that allows tea growing (wet humid wind without relevant frost). It's a 'true' location of Shangri La (Hilton 1933).

Jetstreams and 'atmospheric rivers' are more global events in the atmosphere, but they can have quite punctual repercussions on earth, e.g. when they hit mountain ridges and high peaks! Generally, they consist of fast wind currents in the lower atmosphere. They carry and concentrate specific masses of air in high altitudes, such as let's say 7000 m above sea level. They tend to be very cold, and they are one reason why weather conditions on mountain peaks can be 'deadly', while the bottom of it looks all 'nice'. Messner (1999) and also others (Bonington 2016) described those experiences from their climbings of high peaks. But jetstreams can also have other properties and carry earthy components in them such as sand, dust or even bacteria! While they are not so well understood yet, it's clear they act big in the HKH region and beynd providing global connections.

There are arguably many other factors that drive 'the weather' in Asia and globally. Namely the sun, distance to the sun, universial whobble, generic expansion and explosion of the universe, sun surface events, radiations, meteorites, clouds, water vapor, atmospheric chemistry, dust clouds and volcanism with ash and gas release, just to name a few (e.g. Duan and Wu 2006; Bollasina et al. 2012). Feedback mechanisms are on the same level of importance and become big drivers. Whoever claims to know the weather and to interpret it without wider and human components (Miehe et al. 2015) must be god… (Fig. 2.6).

But by now, man-made climate change is obviously the major factor for the world to be reckoned with (Flannery 2007, http://www.ipcc.ch). It certainly makes the weather! It is based on several processes and can act stochastic and cyclic. However, the human component in climate change seems to be the major driver for the currently observed and anticipated changes (which otherwise would be in a global cooling phase by now due to being in a far distance cycle to the sun, as determined by the Milankovitch cycle).

Arguably, the crux is that all of those weather processes happen to co-occur and create their own synergies. Often, those synergies are not fully understood yet, not even fully reported on or reported in an incomplete fashion (e.g. Miehe et al. 2015). For instance why are some glaciers in western HKH hardly (or less) retreated, but the eastern HKH ones are on a clear disappearing projection (Armstrong et al. 2010; Bolch et al. 2012)? And when did this start and change? And are they converging now (Bajracharya and Shresta (2011)? While this supports the need to study more and to be even more careful on the global warming argument, most glaciers in the HKH region by now show clear signs of massive thawing; the water run-off creates new lakes and the occurrence of Glacial-fed Lake Outburst Floods (GLOFs) are

Fig. 2.6 Dust clouds enter downtown Ulaan Bataar, capitol of Mongolia. Desert storms have been known for millennia but climate change and its associated drying and desertification puts a major new spin to their relevance. Dust plays a big role in clouds, thus in climate and heat budgets for the HKH region and globally

on the rise (ICIMOD 2011; see Rounce et al. 2017 for Everest). That's a fact and no indication of global cooling or scientific uncertainty on that matter! Spectacular glacier retreats got observed every day by millions of visitors over the year, such as Gangapurna in Manang (Chaudhary et al. 2007; Huettmann 2012; see Bajracharya and Shresta 2011; and Bolch et al. 2012 for a wider overview). Worldwide just a few glaciers are actually 'extending' (=larger area and more volume). And that's probably just in response to global warming because those glaciers have now an increased precipitation due to the thawing but which precipitates as snow and then compresses again on the glacier, leading to certain increases…but presumably declining then soon or later when warming reaches high levels and remains with us for the next 100 or so years, likely longer. Snow and ice simply cannot persistent in increasing/hot temperature regimes; that is known to kindergardeners(details in Huettmann 2012) (Figs. 2.7 and 2.8).

Air pollution plays a crucial role in this discussion also, politically as well as temperature-, culture- and energy-wise. For instance black carbon (sot, dust from burning wood or coal) heats up the snow layers, as well as the air masses overall. It provides a positive feedback loop, making impacts even worse! Black carbon is easily linked to two crucial events: industry and poverty (heating and cooking). The Asian Brown Cloud (ABC) is a major phenomenon on that topic, and it reflects these

Fig. 2.7 A glacier in the HKH region. By now, virtually all glaciers are retreating and loosing volume. The few that are extending are usually also a reflection of climate change events, such as increased humility coming down as snow and then compressing to ice

Fig. 2.8 Freezing temperatures create unique features: Frozen grass leaves in Annapurna, app. 3000 m elevation

features (Stone et al. 2007). Beyond air quality, it makes things worse for climate change and its impacts. ABC is created by a wider mix of causes, but industrial reasons, as well as the burning of coal and done domestically in the millions by poor people, seem to be major contributors. Regardless of its progress, democracy, and flying to space, India maintains a vast poverty cast; likely, 'poverty' reaches up to 70% of its population (the largest population in the world by now). The fact that most domestic cooking in Asia is done by females also shows gender issues coming to play as well. With India being a major player in Asia, and the world, the poverty structure caused -in part- by the cast system and its linked religion of Hinduism must be addressed. India entrenched in many communist ideas still and now embracing neoliberal economy makes it worse. The fact that China adds one of the highest number of coal-fired plants is equally harmful to the world's climate (Tong et al. 2018). China has less people than India and is officially a 'communist nation', meaning it features a so-called equality, no casts nor a state religion. One way or another, one has to add here the automobile and transportation industry into this discussion as a major contributor to exhaust, as well as to land cover change! Already the car production in China, Japan or Korea, as well as the ship and air traffic reaches now epic proportions that are beyond global sustainability levels, as we understand them. These nations engaging into globalization and being players there in full do not make it better.

The global connections in this area of HKH are even more convoluted, and often not well understood yet. For instance, the role of methane, e.g. from cattle and in thawing permafrost regions, seem to be widely underestimated in most climate models. While permafrost is primarily a cold region – boreal forest – land feature, similar processes might also occur and contribute largely in the higher altitudes or in HKH, certainly in the Tibetan and Mongolian Plateaus. The role of temporary permafrost remains to be studied for the world's climate. But it clearly affects wetlands, river run-offs, vegetations, methane and the temperature.

The exact link of weather with habitat, vegetation and wildlife is not so well managed hardly described yet (Flannery 2007), and only a few studies started to look at those topics closer (Xuesong et al. 2017; Mukherji et al. 2018; You et al. 2018). However, impacts known from other areas and from similar set-ups show us rather serious problems (e.g. Pauli et al. 2012 for mountain peaks; Xu et al. (2012) for Asia, Huettmann (2018b) for global ecological niche decay). Some of those are addressed in the following chapters of this book. However, as can be concluded from Table 2.1, more stress, human suffering and climate refugees can be expected in the near future while most of the causing nations are not addressing the problems of man-made climate change (e.g. Canada, the U.S. and China) and no effective changes are to occur. Young generations have caught this problem and start to push for good actions (e.g. Greta Thunberg at UN Climate Change session: https://www.youtube.com/watch?v=VFkQSGyeCWg) (Table 2.3).

Lastly, 'the weather' plays a major role in global farming and agriculture (Flannery 2007); it feeds mankind and supports world peace. This is true for virtually all of the HKH region which relies on water, river run-off and good temperatures to grow crops, e.g. rice (e.g. see Xu et al. 2009 for cascading effects). When the weather dries, the food crop cannot grow well. The rice harvest for billions of

Table 2.3 A selection of climate change impacts, global and in the HKH region (Evidence and many citations are easily found on these details throughout the book and scientific literature)

Climate change topic	Impact	Generic example	HKH example and citation
Warming	Temperature links with all 'live'.	Move of plant & animal communities	Snow leopard
Drying	Water linkages with all 'live'.	Desertification, permafrost disappearance	Mongolian and Tibetan plateaus
Permafrost thawing	Methane release	Change of water table	Tibetan plateau, HKH mountains
Glacier melting	GLOFs, temperature, rainfall	Glacier decline in area and volume	GLOFs in Nepal and Bhutan
Sea level rise	Brackish water in coastal areas	Spoiled/salty drinking water in coastal areas	Bangladesh, Vietnam
Ocean acidification	Ocean water quality change	PH value changes	NA
Carbon budget change	Global impacts of carbon-related metabolisms	Global photosynthesis, farming, carbon sinks, e.g. peatlands and oceans	HKH region, e.g. forests and wetlands
Climate refugees	People move in large numbers to 'better'places, namely cooler and richer ones	Poor people from rural areas have to move into cities	Nepal, Tibet (China), Sikkhim (India)

people gets affected for instance, so is tea harvest and its qualities (which connoisseurs are to detect quickly and thus it affects global tea pricing and subsequent demand). See Mi et al. (2017) for sugar cane and its forecast. But even beyond food crop and quality, much of the cattle relies on water to drink. Needless to say that in some religions like Hinduism cattle are perceived as 'holy' and they are left on their own; natural water and food supply maintains them. And if that changes it affects how people perceive their world around them; starving and dying cattle in public are seen as a bad omen (Fig. 2.9).

Simply put, the water run off in rivers and from rainfall in the HKH region is a matter of life quality, of peace, or of pure survival for many people (Mukherji et al. 2018)! Wider connections of human systems with the ecological system are referred to as 'telecoupling', usually done across nations (Liu et al. 2013). It's a new but rather powerful analysis concept for the Anthropocene, where the human influence has taken over globally and affects virtually all dimensions! A typical example of telecoupling is the trade of river sand and gravel (Torres et al. 2017) that is easily witnessed in the HKH region and its watersheds and which is devastating to rivers, their flow, sediments and nutrients. The wider aspects of climate telecoupling in the HKH region is not well studied yet but presents a major focus scheme for human well-being globally.

Fig. 2.9 Harvesting sand, with a license or without, and from river beds is by now a major business and which affects water sheds and landscapes in Asia, as well as globally (for details see text)

Finally, the weather affects our emotions either way and it's part of our live. Weather – as we know it – is of great spiritual value and it makes us happy, but often it makes us now sad and very worried these days while the human population, industrialization, industrially promoted consumption and global warming are further on the rise virtually still unabated![1]

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[1] This notion has been expressed already many years ago by Czech (2012) in a book resulting from the last International Polar Year (IPY) but we still have not solved this essential problem or addressed in relevant terms! The lack of relevant action on man-made climate change remains not only a massive frustration to the global audience but it represents a tragedy of epic proportions in the universe, with all life as we know it. Who is to be hold accountable?

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Chapter 3
From the Mountains and Glaciers Down to the Rivers to the Estuaries and Oceans: Another Sad Tale of 18 or so Rivers

Falk Huettmann

Everybody Lives Upstream
(ICIMOD 2018)

There is a lot of existing theory and mathematics in hydrology to explain why water runs downhill, and how it actually does it (Lindsey et al. 1982; Boorks and Folliott 2012). However, while western science and education spends huge time, staff, conferences and effort on those and similar questions (see for instance http://www.worldwaterweek.org/) – repetitively and with awards but based on poor data (Surendra and Thadani 2015) and ignoring the crucial problem with economic growth, and the requirement of 'progress' (Alexander 2012) – most people do not care so much about such science and its eloquent words that explains what everybody knows already for millennia. Water is found in valleys; and water management and irrigation is already a well-practiced science and part of human society for over 6,000 years, e.g. practiced successfully in ancient China, Cambodia, Egypt or by the Mayans and in Amazonia. Whereas, the deeper and more relevant questions are still not resolved at all, e.g. as shown already 30 years ago by Dudgeon (1992) or even more relevant by now: how 7–10 billion people on this earth are to receive equal amount of sufficient and high quality water during climate change? And one can easily offer a few more of those relevant topics and unresolved questions to be addressed here such as:

F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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- water as a requirement for human happiness and well-being (this matters when considering that most people in the world life on the edge of water bodies (=coasts). Consequently, a spoilage of water has global repercussions).
- how are jet streams and atmospheric processes linked to water and rivers, and to the fertility of those watersheds (e.g. Armstrong et al. 2019)? How can they really be maintained and managed sustainably for everybody?
- how to really manage and handle the upland grasslands and their ancient connections with estuaries and oceans (Dong et al. 2017)?
- what is an appropriate and sustainable philosophy of water research, what water institutions and what ethics and moral values do we need? Do we need an over-ruling 'global ministry of water'? (Those type of questions really matter in the HKH region because of global religions involving of over 2 billion people)
- what is the meta-physics of water? (A questions that has no easy answer but matters for water as a legal and public entity to be studied, understood, managed and governed correctly)

One can easily add many other, perhaps more direct, questions, such as how to keep water clean, how to distribute water equally for all citizens and for required ecological services, how water is related to food security, 'who actually owns snow or clouds', or who owns the actual rain and clouds, and how to avoid the global water crisis not resulting into warfare and human suffering while natural resource consumption and human populations as well as the world climate are still rising unabated? Water means global happiness, and arguably we cannot easily engineer-out our way from such problems any further (Dong et al. 2017)! (Figs. 3.1 and 3.2). Much of our so-called scientific water management failed.

Labeled as the water towers of this world – or the Third Pole; Huettmann 2012 – the HKH region plays a major role for those questions (ICIMOD 2017a, b). If resolved well it can easily serve as a global role model giving us new ideas on that global problem as well as for any mountain region and for satisfying water needs of over 2 billion people (one may also argue vice versa and infer from it what happens,

Fig. 3.1 Examples of wild water ways. What is more beautiful and inspiring than that?

Fig. 3.2 Examples of Hindu Kush-Himalaya water ways meeting western-style engineering. Who won?

globally, if that actually fails?). Arguably, despite the hydrology textbooks the relevant water science in the HKH region, and specifically a hydrology that actually matters for people, actually still sits at its infancies and hardly is mature, objective or unbiased. Science remains a western-dominated, biased discipline and with such an outcome (Lowe 2004 for an Asian example; see Huettmann 2012; Marsden 2019; Goel et al. 2018 for the 'white world'). Not only many theoretical questions remain unanswered, but also the most basic sustainability and water conservation ones even. Science cannot and must not happen without context (see Rosales 2008 for a critique). In the meantime, The World Bank and most major entities in HKH push for a 'sustainable development' that is virtually not driven by science or wider questions of human well-being, meaningful poverty eradication, a good culture or the public good, or by a sustainable treatment and maintenance of natural resource (Daly and Farley 2010), water for that matter. While water is battled for politically and internationally (Blaikie and Muldavin 2004; Marsden 2019), without good water human life cannot exist (Vörösmarty et al. 2010; The Guardian 2017).

Fig. 3.3 An overview of selected rivers in the Hindu Kush-Himalaya region

Clearly, we have for many decades already a water crisis in Asia (Dudgeon 992) and beyond; those water resources remain widely mis-managed now throwing over 2 billion people and the world climate further into the abys (The Guardian 2017). Arguably, a situation that was fully avoidable. After colonialism and subsequent world wars, Asia gets now exposed to another man-made second-class citizenship. Management of the water table, of soil and vegetation, also means a good management of climates, and of the related global water cycle either way. To be successful, food production also means water management. Many water issues – and thus rivers as the essential piece – are now directly linked to banking and economy questions, beyond global food securities.

For a good context and to start the wider discussion for betterment, in the following sections I will describe some basic features of each river system and watershed that are found in the HKH region (Fig. 3.3):

3.1 Yarlung-Tsangpo River

Located on the Tibetan Plateau, this is one of the quintessential rivers in the HKH region (Buckley 2014). It is the highest large river in the world, originating at the Angsi Glacier in western Tibet, southeast of Mount Kailash and Lake Manasarovar

(Bajracharya and Shresta 2011). While the initial part of this river is running relatively slow it flows through the Yarlung Tsangpo Grand Canyon and with it come fast rapids before eventually reaching the state of Arunachal Pradesh, India, where it forms the upper arm of the Brahmaputra river. It crosses through empty wilderness areas, but this changed in recent decades due to development of Tibet (Harris 2008), and it changes even more when it leaves the Tibetan Plateau. This river is of great strategic relevance for Southeast Asia and it is by now the center of a major international discussion and water dispute about national authority, ethics, upstream responsibilities and global strategy (Buckley 2014).

3.2 Ganges River

This major river south of the Himalayas starts in Uttarakhand, India, located south of the major peaks in Nepal with the mountains of Nanda Kot at app 3000 m and associated peaks. It is fed by several glaciers (Bajracharya and Shresta 2011; Dong et al. 2017 for details). It merges with the Yamun river and has fast water rapids. Many major cities are found along its way. It serves as a major holy river and ends up in the Ganges Delta, Bangladesh. The Ganges river is by now also known for its pollution (e.g. Yeung et al. 2009; Mitra 2019) affecting many associated rivers and estuaries too (Singh 2001). But it is also world-renowned for its cultural value. It's the world's third biggest for water discharge with relevant sediment loads (Mizra 1997) and thus presents not only a massive wetland system overall but also a major water nutrient and associated management issue on a global scale, e.g. for the royal bengal tiger living in the lowland mangrove forests (Mitra 2019).

3.3 Yamun River (Jumna)

This river also starts in Uttarakhand, Northern India. It originates at over 6,000 m with the Banderpooch mountain and its glaciers (Bajracharya and Shresta 2011). It also plays a major religious role and is the second biggest river for the Ganges river. It has many barrages and is famous for supplying New Deli with water, but also for its subsequent pollution (probably the most polluted river in the world; e.g. Singh 2001; Mitra 2019).

3.4 Padma River

This river is actually one of the lower sections of the Ganges River and it is located in Bangladesh. It flows into the Meghna and Hoogley rivers and forms the infamous Mouths of the Ganges (Mitra 2019; Bajracharya and Shresta 2011 for watershed boundaries). The Farakka Barrage at the Ganges has greatly changed the river characteristics, and it impacts parts of the delta. This river features the infamous Padma Bridge (scheduled completion by early 2019).

3.5 Brahmaputra River

This river is actually fed by the Yarlung-Tsangpo and flows into the Jamuna and Padma rivers ending in the 'Mouths of the Ganges' (For watershed boundaries see Bajracharya and Shresta 2011). It features China, India and Bangladesh and is used for transportation and irrigation. It plays a large religious role. It also features large amount of sediment discharge and is essentially located around the southeast of the highest peaks in the Himalaya. This river is very relevant for the downstream nation of Bangladesh and its existence. It has received a lot of river bank engineering and erosion. The international hydrodams are a major topic of generic concern and international debate.

3.6 Irrawaddy River (Ayeyarwady)

This river is another major water source fed by the wider Tibetan Plateau, China (delineations presented by Bajracharya and Shresta 2011 for watershed boundaries)). Its estuary features a major fishery and is has allowed for centuries to ship resources like teak logs out of the country for international export. It is the commercial and strategic waterway for Myanmar (Burma; Mint-U 2007) and has many famous tributaries like the Salween (Buckley 2014). It starts with the N'May and Maili rivers and ends in the Irrawaddy Delta in the Arman Sea. The capital city of Rangoon is located on this river, which has a long legacy. Many controversies developed due to the construction of hydro dams, often supported by outside firms.

3.7 Mekong River

The Mekong river plays a major role for the nation and culture of Vietnam. But many other nations are also part of this river (e.g. China, Thailand, Myanmar (Burma), Laos and Cambodia; Bajracharya and Shresta 2011). The estuary is a main 'hub' and it serves globally as a viable area for all of southeast Asia. In recent decades the Mekong delta has witnessed a major habitat loss as well as a very high development rate in exchange (Le Trong et al. 1991). This river originates in Tibet and presents a great example for international impacts and problems due to hydro damns upstream, often involving China (Buckley 2014; Sabo et al. 2017).

3.8 Yellow River (Huanghe)

The Yellow River flows eastward and is a symbol of China. Much of Chinese history and the Han culture has evolved around this river and its richness for many millennia (Harris 2008). The ancient cultural city of Kaifeng (e.g. Shaolin temple and Zhengzhou city) is located at the Yellow River. It is the sixth-longest river system in the world and its floodings sparked major rebellions in China. This river starts in the mountains of Bayan Har Mountains (Bajracharya and Shresta 2011). It ends in the estuary of the Bohai Sea (Yellow Sea; China). Over 16 major hydro dams are built on the Yellow River alone and its environmental problems are 'massive'.

3.9 Yangtze/Jangtsekiang River

This is nothing but the longest river in Asia, and the third longest river in the world. It starts in Qinghai (Tibet; Bajracharya and Shresta 2011) and ends in Shanghai, Yellow Sea (Gaohuan and Drost 1997). One third of China is located in the Yangtze River watershed, and 20% of the GDP of China are now made in its region; water is part of the industrial process fueling entire national and global ideologies, e.g. socialism and globalization. For several thousands of years, the Yangtze has been used for water, irrigation, sanitation, transportation, industry, boundary-marking and it affected much warfare. Nowadays, the Yangtze plays a global role to fuel water for global industrial processes. Consequently, many hydro dams are built on that river, including the infamous The Three Gorges Dam as the world's largest hydro-electric power station. The Yangtze river affects world-record wetlands like Poyang Lake. Several locks are found on the Yangtze river to allow stable ship navigation. This river sits at the heart of the discussion of the Yellow Sea region as the kitchen sink of globalization, also affecting migratory birds from all over the world (MacKinnon et al. 2012) (Fig. 3.4).

3.10 Heilongyang/Amur River

This river is a major stream for the Russian and Chinese border zone (see for details GIS mapping resources here http://amur-heilong.net/http/gis_index.html). It actually starts on the Mongolian plateau and is affected by the Tibetan Plateau weather in the wider HKH region. The headwaters are part of the wider HKH geology. This river plays a large role for the Sea of Okhotsk, and more specifically, for parts of Sakhalin as well as the Sea of Japan even. Famed fish species like the now endangered kaluga are found there. Recent floodings of this river raise questions about

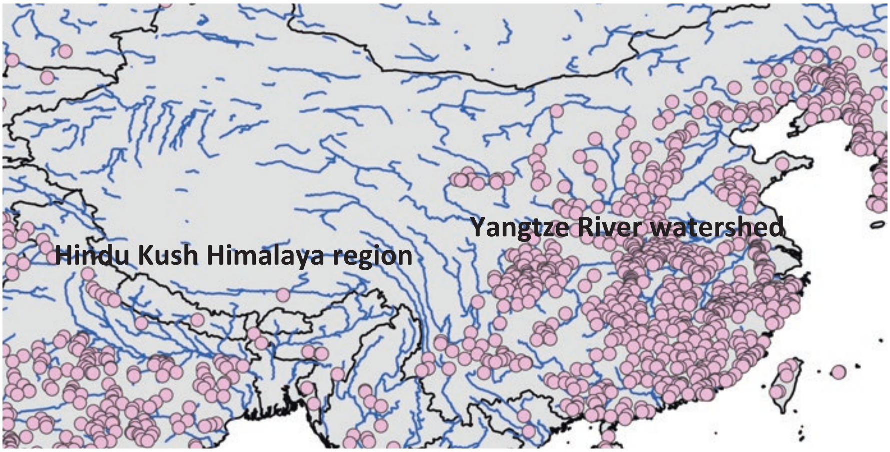

Fig. 3.4 Modifications in the wider Yangtze watershed. (Documented hydrodams in pink. Data SEDAC (http://sedac.ciesin.columbia.edu/ mapped by author in QGIS/ArcGIS)

sustainable watershed management between Mongolia, Russia and China. This river is known for its controversial hydrodam developments that are widely criticized in Russia and internationally for many years, to deliver electricity for China mostly (Simonov and Dahmer 2008).

3.11 Indus River

This river runs westward and is among the most holy rivers in the world. It comes from the Kailash region (Bajracharya and Shresta 2011; Lama 2012) and flows through Pakistan and India. It ends up in the Hindus estuary. The Indus has received a lot of irrigation and it represents a life-line for Pakistan. The major international sea port of Karachi is located in the delta. Pakistan is known for its huge flooding problems, and irrigation projects, e.g. started in the colonial times and continued 1970s onwards those have greatly contributed to such tragedies.

3.12 Jhelum River

This is another life line of Pakistan. This river starts and ends in the Indus river (details in Bajracharya and Shresta 2011). Together with the rivers of Chenab, Beas, Ravi, and Sutlej they are also known as The Five Sisters (https://www.mapsofindia.com/maps/rivers/himalayan-rivers.html).

3.13 Koshi River

This is a somewhat smaller river in Nepal and India but it is famous because it essentially starts in the Mt. Everest and Makalu region and thus is glacier-fed (Bajracharya and Shresta 2011). Originating in one of the world's highest snowpack and watershed it comes down quickly from that high elevation to a region near the Nepal/Indian border, app. 80 m in elevation. In the lower elevations it creates swamps and wetlands, which are pretty famous as nature areas and of international relevance (https://www.iucn.org/content/koshi-tappu-wetlands-nepals-ramsar-site). The decline of wildlife in the area is widely known and published (e.g. see in Huettmann 2012 for waterbirds). The socio-economic issues of this river are featured in ICIMOD (2017c).

3.14 Gandaki River

This is a relatively small tributary of the Ganges but it is Nepal's third largest river. It comes out of the famous Annapurna range (c. 7000 m height; Bajracharya and Shresta 2011). It's a typical HKH river and features holy sites and pilgrimage for both, Bhuddists and Hindus. This river is well known for tourists and paddlers, but is targeted for its electrohydro dam potential with several barrages.

3.15 Tarim River

This is the main river of the Tarim Basin (a desert region of Central Asia located between the Tian Shan and Kunlun Mountains where it originates). It is one of the rivers that does not end in an ocean directly but in a wetland and saltpan (Lop Nur, which now dried out). This is the longest inland river in China. In such high altitude dry areas, such rivers are a true life-line and allowed for (nomadic) human civilization and oasis agriculture to occur there, providing a co-evolution for endangered species like the Black-necked Crane (Xuesong et al. 2017).

3.16 Amu Darya River (Amo or Oxus)

A major river in central Asia, starting with two rivers (Vakhsh and Panj) and ending south of the Aral Lake. It's another river that does not end in the ocean directly. It was formerly used as a boundary between ancient Persian nations. The actual watershed of the Amu Darya includes Tajikistan, the southwest corner of Kyrgyzstan, the northeast section of Afghanistan, a narrow part of eastern Turkmenistan as well as the western half of Uzbekistan. Parts of the Amu Darya basin divide in Tajikistan form that nation's border with China (in the east) and Pakistan (to the south). The Aral lake watershed is by now greatly devastated and drying (e.g. Ferguson 2005).

3.17 Illi River

The Illi river is a main river in the region and is fed by precipitation, mostly through vernal snowmelt, coming from the mountains of China's Xinjiang region. The Ili river is also part of Kazakhstan and feeds eventually into lake Balkash (Petr 1992), it's another of the few rivers that are actually not connected to the ocean. The Illi delta is shipped. Lake Balkash is shrinking by now (just like Aral Lake). The Kapshagay Hydroelectric Power Plant was built on the Ili River in 1970. Ili-Balkhash basin shows emissions due to mining and metallurgical processes, mostly at the Balkhash Mining and Metallurgy Plant operated by Kazakhmys. Other contamination is reported to come from China.

3.18 Onon River

The Onon river in Mongolia comes from the Tibetan Plateau region. It leads to the Amur river and includes farming areas, wilderness and some of the last left Asian great bustards (*Otis tarda*) for instance. For millennia, the water of the Onon river shaped the fate of Asia, and of the Old World continent. The capital of Mongolia gets its water from this river (see Fig. 3.5). The river is also very famous for Taiman angling tourism, with a worldwide list of participants.

From the section above it is relatively easy to understand that the rivers of HKH are of dramatic relevance for mankind (Dudgeon 1992). The water sources tend to come from glaciers and ice fields (Table 3.1; see also Bajracharya and Shresta 2011). But beyond glaciers, and for those who wander down stream, a question easily comes up and that is: "*how did the water came uphill in the first place*"? Arguably that's achieved by ecological processes – the water cycle- all free of charge, and ongoing virtually all the time. The monsoon cycle plays a major role for the HKH region. Wet airmasses rain down once the air pressures change. In winter, this occurs as snow, and compresses over many years, it's how glacier form. Arguably, these processes are driven by seasonality and ongoing for millennia, and they underlay global processes also but they have virtually no legal protection, assigned agency or even any relevant awareness in public.

The seasonal monsoon sits at the core for the water supply of the 18 selected rivers in HKH, and certainly does for entire watersheds there – including the glaciers. Again, c. 2 billion people are directly affected by such ocean-coupled weather systems. Since the monsoon gets its water from the ocean, there is a clear link with the marine systems and marine weather. Airmasses, loaded with ocean water, drain over

Fig. 3.5 Trees growing now in the Onon river in downtown Ulan Batoor, capitol of Mongolia. This waterbed is drying for years!

the HKH. Usually that happens in fall and some processes flip in spring. Such type of coupled processes can be found worldwide, but only the HKH has the big topographic features that make it so potent: high mountains, steep gradients, warm oceans and hot deserts that allow dry airmasses to load up with humidity. Linked with its location in the equator zone, it essentially creates a massive pump which results eventually into 'the monsoon' and spilling its water into the watersheds of HKH, which then run downhill into the gorges, swamps and estuaries back into the ocean, feeding agriculture (e.g. rice), people and landscapes. And so the ancient cycle of live begins again (Karmay and Watts 2007, Lama 2012)!

In the ancient Tibetan and Mongolian tradition, freshwater fish is not really to be eaten or caught (Karmay and Watts 2007). It is left by itself, and consequently the freshwater fish stocks were in a pretty good shape until this taboo was broken (see for instance Harris 2008; Buckley 2014). This ancient and sustainable belief system was given up through new (western) value systems that either did not care about the environment and/or even asked to harvest it and make use of it (neoliberal concept of the west: '*use it loose it*'). To this very day there is wide disagreement between locals and outsiders who come in and impose their value system onto such watersheds and their cultures. By now, arguably, the ancient culture proved more beneficial for the freshwater fish. Impacts on freshwater fish populations are easy to be found in the declining abundance and pure size decline of the fish (this a common feature in fisheries and usually a direct function of the use of monofilament plastic nets and their decreasing net sizes; see for instance Pauly et al. 1998).

Table 3.1 Summary table for glaciers and icefields of selected rivers in the Hindu Kush Himalaya region

Name of river	Directly glacier and icefield fed[a]	App. altitude of origin	Comment
Ganges river	Yes	6,000 m	A highly merged river system
Yarlung-Tsangpo river	Yes	6,000 m	
Mekong river	No	5,000 m	A highly merged river system
Irawaddy river	Yes	4,000 m	
Yellow river	Yes	5,000 m	
Yangtse river	Yes	6,000 m	A major river for China and Asia overall
Heilongyang/Amur	No	4,000 m	
Padma river	No	1,000 m	Merged river system
Indus river	No	6,000 m	Merged river system
Koshi river	Yes	8,000 m	A river from the Everest region
Brahmaputra river	Yes	6,000 m	Merged river system
Gandaki river	Yes	7,000 m	
Tarim river	Yes	6,000 m	
Amu Darya river	Yes	6,000 m	
Onon river	No	5,000 m	

[a]Please keep in mind that the exact point origin of the river cannot always be fully determined, and depends on local terminology also

Beyond watersheds – their climate and development – contamination plays a major role in Asia by now. Asia's rivers are reported to send more plastic into the ocean than all other continents combined: 86% of plastic pollution comes from Asia (Lebreton et al. 2017; https://qz.com/ 1,004,589/80-of-plastic-in-the-ocean-can-be-traced-back-to-asias-rivers-led-by-china-indonesia-myanmar-a-study-by-netherland-based-the-ocean-cleanup-found/); another major source is global fisheries, but it also is widely fueld by Asian fishery fleets. Countries do not really report though how much plastic they are flushing and leaving behind (e.g. https://www.ted.com/talks/dianna_ cohen_ tough_ truths_ about_ plastic_pollution). There are also other peculiarities of the HKH rivers. For instance, some Nepal rivers are known for their large, and unique, heavy metal loadings due to leather tanning and its molybdenum (Bhatt 2015); only few places in the world actually allow for such industries to take place. Further, the hydrodam development is widely described (Table 3.2) for providing electricity to the water shed and its people. Rivers turned here into a certain self-enrichment shop for innovative engineers and political supporters of such mindsets – usually neoliberal – for huge privatized profits. The profits tend to be used by themselves the most, less for the wider public good, with electricity either being sold/exported or used for mining and industrial products that make use of a public resource but crop-off the profit for private entities. And so, in earnest, much of the 'green' energy goes into mining and industrial production instead, which then further creates environmental problems, including a needed road and transportation infrastructure, as well as an initiated political and media

Table 3.2 Conservation-related summary table for 18 selected rivers in the HKH region

Name of river	A selection of hydrodam project names	Minimum number of hydrodams known	Comment on hydrodams	Selection of other human Impacts
Mekong	Dachaoshan, Nuozhadu	7	Large Chinese influence	Upstream irrigation
Ganges	Badrinath II Maneri Bhall I Maneri Bhall II Farakka Barrage	17		Among the highest toxic levels in the world
Irrawaddy river (Ayeyarwady)	None at the moment	0		
Yellow River	Lijiaxia Dam Yanguoxia Dam	24		Huge pollution levels
Heilongyang/ Amur	No dams have been constructed directly on the river yet. However, the tributaries of Zeya and Bureya have two massive hydroelectric dams.	2	Russia tries to set up damns for export of electricity to China	Pollution
Yangtze river	Gezhouba Dam Three Gorges Dam	5		Several locks for stable water levels to allow ship traffic. Huge pollution levels.
Indus	Tarbela Dam Chashma Barrage Islam Barrage Nimoo Bazgo Hydroelectric Plant	31		
Onon River	None recorded	0		Runs dry
Tarim River	Daxihaizi Dam [dried up]	1		
Gandaki river	Kaligandaki A Hydroelectric Power Station` Gandak Barrage	2		Sewage
Koshi river	Sapta Kosi High Dam Multipurpose Project	2		
Yarlung-Tsangpo river	Zangmu Dam	11	Highest damned river in the world	Unsustainable water management upstream and downstream
Yamuna river (Jumna)	Lakhwar Dam Tajewala Barrage	6		
Padma river	No dams recorded directly on Padma river	0	See above Ganges barrage	Controversial bridge construction

(continued)

Table 3.2 (continued)

Name of river	A selection of hydrodam project names	Minimum number of hydrodams known	Comment on hydrodams	Selection of other human Impacts
Brahmaputra river	The Zangmu dam	1		High pollution level
Jhelum river	Mohra Hydroelectric project	2		
	Lower Jhelum Hydroelectric project			
Illi river	Kapshagay Hydroelectric Power Plant	1	A river that does not connect to an ocean	Shipping.
				Contamination or air and water
Amu Darya river (Amo or Oxus)	Rogun Dam	3		Sewage
	Nurek Dam			
	Tuyamuyun dam (known as THC) complex.			

culture to make it all happen. Entire systems get corrupted and destroyed. The local people do not get the full benefit but pay the environmental and social bills including clean-up costs; it's more than a double-whammy when man-made climate change enters the stage (Buckley 2014, see Rosales 2008 for general concepts). Other electricity- and hydro-dam based funds in Asia tend to go to outside nations, such as India and China. Water resources in Nepal, even get exported by the bottle, as the case for Korea and Japan, or glacier ice cubes for luxury bars all over the world! In such cases, such water also has a vast carbon footprint!

Another environmental river reality are barrages: a cluster of several hydro dams. While it might be technically meaningful, ecologically it is a large disaster: wilderness gets destroyed, sediments get stuck and the entire watershed gets affected. Specifically the Nepali waterways, located by nature strategically on top of mountains, present a great and cheap military value that many nations are trying to benefit from and/or control. Warfare in Afghanistan can be controlled by water; and if not that, then the water supply can be used to control farming harvest outcome. Again, in the case of Afghanistan, this might well mean poppy seed production and thus global drug market and repercussion on many other drug markets, e.g. cocain or meth (Peters 2010 for heroin and global warfare), which is a major reason of the international warfare in Afghanistan with EU engagement. Arguably, any recent warfare in the region was dominated by such water control, resource, food and even drug questions, and water supply plays a major role in this. Already the bible refers to the Garden of Eden and its two rivers (Fig. 3.6) (Table 3.3).

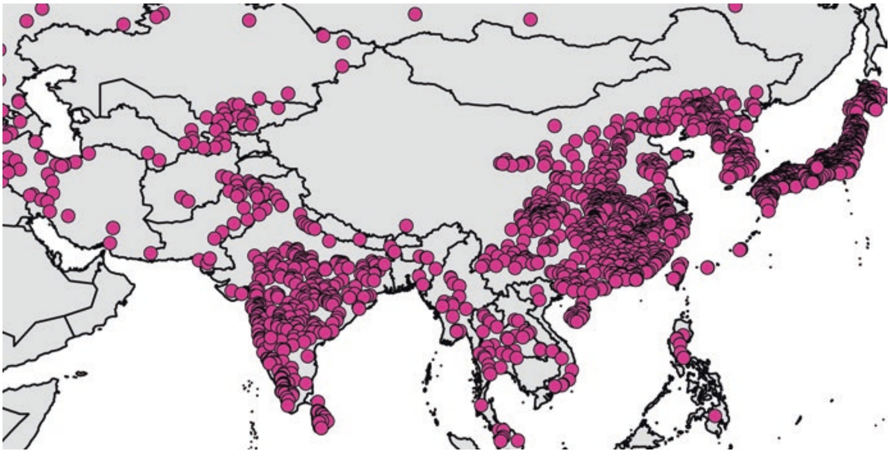

Fig. 3.6 Map of documented hydrodams (pink) in the study region. (Data SEDAC (http://sedac.ciesin.columbia.edu/) mapped by author in QGIS/ArcGIS

Table 3.3 Ocean water bodies, seas or significant end points affiliated with selected rivers from the HKH region

Name & country	Connected river	Relevance of river
Arabian Sea	Indus river	Major inflow
Sea of Okhotsk	Amur/Heiliongyang river	Large inflow
Bay of Bengal	Ganges river	Major inflow
Yellow Sea	Yellow and Yangtze rivers	Major inflow
Eastern China Sea	Yangtze river	Inflow contribution
Balkash lake	Illi river	Major inflow and delta
Aral lake	Amur Daya	Former inflow (now dried up)
Lop Nur	Tamirpeople	Former inflow (now dried up)

3.19 A Needed Unifying Watershed View for Rivers of HKH

Rivers are based on water agglomerating downhill, and thus water runs into elevation depressions (e.g. fault lines, valleys or lakes as natural reservoirs). It's the topography, dynamic plate tectonics, geological processes, snow and ice (glaciers), that affect where and how water flows (e.g. Armstrong et al. 2019). Humans tend to follow the water accordingly and entire cultures and their pathways are centered around it (=depressions on the surface of geological plates, coasts or along fault lines; see Diamond 1997 and Harari 2015 for an overview of such locations). Watersheds are those spatial units, the draining areas, that provide the water agglomerations (see Abell et al. 2008 for a global classification of those ecosystems, with Surendra and Thadani 2015 for a call towards better underlying data). Much can be said about watersheds and how humans interacted with them and managed them over the last millennia (Diamond 1997; Harari 2015; Ostrom 1990; Ostrom and

Fig. 3.7 An endpoint of the river flow from the Hindu Kush-Himalaya? An example from the Yellow Sea, Yangtze River watershed!

Hess 2007). However, seeing how we treat watersheds these days it represents a dramatic divorce from sustainable practices and from harmony with nature and its spirituality, including respecting 'Mother Earth' (Karmay and Watt 2007; Lama 2012). Instead, it reminds more of rape, abuse, rupturing and pilfering whatever earth has to offer, all approved and promoted by the new forms of 'modern' governance and loss of taboos (Ostrom 1990; Rosales 2008; Alexander 2013). Just looking at the state of the watersheds and rivers in HKH is not the type of modernity most people are proud of or initially strived for (Colander 2000; Cockburn 2013). It must change towards a water culture and approach that is truly sustainable, instead of a 'sustainable development' that just destroys all resources and senses, including the atmosphere. The upstream people are connected with all else, so are the downstream ones (ICIMOD 2018; Dong et al. 2017). Already the change of climate – all now being man-made- demands for no other (Immerzeel et al. 2010; ICIMOD 2017b) (Fig. 3.7).

3.20 *Aqua quo vadis* (During Climate Warming, Human Consumption Rise, Human Population Explosion, Lack of Water, and all Synergies Combined)?

The world currently is not in a good shape, nor is the HKH region or its watersheds and rivers; and the outlook is not rosy at all (Miller et al. 2012). There are great and unique settings left in the HKH region though but they will get easily sacrificed on the ruthless altar of globalization and its promotion. Globalization was meant to be a success story, not a tragedy, a global debacle and a disgrace (Alexander 2013). Leaders who promoted it seem not to care for their own legacy even. The rivers of the Tibetan Plateau stand here as much as role model (Buckley 2014; see Xuesong et al. 2017 for reported GDP growth of over 300%) as any other of the rivers really in the HKH region (Mongolian perceived boom-and-bust cycles, with GDP growth of over 20% in some years due to mining etc). It's just not possible that this is ever sustainable in social, environmental, atmospheric and economic terms! Waters of the HKH region will show us not other. Beyond water, humans pay the price and beyond starvation and conflict, issues of genocide are already claimed or implied (Rosales 2008; Buckley 2014). This does not end in China but continues in India, in Vietnam and in other areas, the western world experience showed us no other. The Mekong, the Ganges, or the Yarlung-Tsangpo all report the same tale, and did so for long time (see Elvin (2004) for ancient times; Dudgeon (1992) for more modern periods; also see Le Trong et al. (1991) for Vietnam, Mint-U (2007) for Burma, Mizra (1997) and Mitra (2019) for the Ganges for instance). One may slice it or dice it in any way, and whatever got stated otherwise with the nicest words: with science or without, the outlook for the HKH region and its water resources looks truly disastrous and with no good end in sight. Period.[1]

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[1] It is difficult to not agree here with Ripple et al. (2017)

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Chapter 4
The Hindu Kush-Himalaya (HKH) in the Global and Marine Context: Major Estuaries, Coast-Scapes, Ocean Coupling, Seawalls, over 2 Billion People and Global (Food) Security

Falk Huettmann

When water comes down – from the atmosphere dropping onto the high mountains, glaciers, alpine tundra, old-growth forests, and then eventually running from rock and soils through the rivers, gorges and waterfalls – it tends to get accumulated first in swamps and wetlands before it finally enters the ocean via estuaries (Fig. 4.1 for an example). The estuaries of this world are the contact zone between river's freshwater and ocean saltwater. These regions are 'coupled' with the ocean and many ocean processes (the monsoon weather system in Asia and the HKH region is a classic example).

Some of the wetlands and swamps are found in the highlands (http://www.meltdownintibet.com/; The Guardian 2017; Fig. 4.2), but most are in the low-land plains or near the coast and its estuaries (Tables 4.1, 4.2 and 4.3; see Scott 1989 for an overview and generic description of Asian wetlands). Some of those wetlands and swamps are world-famous and internationally renowned, e.g. some National Parks in Nepal (e.g. Bardiya, Chitwan) and where tigers, elephants, rhinos, buffalo and gharials are still found (Cocker 2006). In those river-fed wetlands and swamps water tends to slowly flow towards the coast and finally mixes with salt water in estuaries before the full link is made with the world's oceans again, where the water's journey actually started via atmospheric transport. There are a few rivers in HKH that do not connect directly with the ocean (Table 4.4) but they still present major lifelines in desert areas, and their water tends to evaporate into the atmosphere or soil to complete the cycles there eventually.

Water and nutrients do cycle, globally (Begon et al. 2006, see Cook 2017 for details and summary in regards to river and oceans). From a global perspective, the

F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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Fig. 4.1 A typical estuary of a river originating in the Hindu Kush-Himalaya region, Cox Beach in Bangladesh (a very relevant wetland for many species internationally)

Fig. 4.2 A typical high altitude ‘wetland’ in the Hindu Kush Himalaya region: Water is sparse in many parts of those regions and those areas are easily overused by cattle, e.g. sheep and yak

ocean-link (‘ocean coupling’) is essential in this cycle (Zhu and Shukla 2016). It tends to involve deep currents, and those can literally go around the world and involve decades, if not centuries, of flowing near the sea floor around the globe also passing by Antarctica (the Antarctic Circumpolar Current is a major ‘engine’ for global processes, certainly for water; De Broyer et al. 2014). Water cycles are truly

Table 4.1 A short selection of famous estuaries of global relevance and some of their environmental details

Name and location	River and origin	Habitat and example of wildlife (selection)	Conservation status (selection)	Conservation issues (selection)
North Sea (Europe)	Rhine (Alps), Elbe (Giant Mountain range)	Tidal mudflats, beaches; shorebirds, fish, marine mammals	Protected as a World Heritage Site	Contamination, overfishing, global traffic hub, tourism, development
Puget Sound (Western U.S., Canada)	Fraser River and others (Rocky Mountains)	Sound, tidal mudflats; shorebirds, salmon, marine mammals	Widely unprotected	Contamination, overfishing, urbanization, international watershed regimes, megacities (Seattle, Vancouver)
Delaware Bay (Eastern U.S.)	Delaware river (Appalachians)	Tidal mudflats, beaches; red knot, shorebirds, horseshoe crab	Partly species protection, fisheries control	Urbanization, contamination, decline of red knots, overharvest of horseshoe crabs and some fish
Mississippi Delta (southern U.S.)	Mississippi river (Rocky Mountains)	Swamps, mudflats; Shrimp, fish, waterbirds	Widely unprotected	Contamination, development, overfishing, shipping
San Francisco Bay (western U.S.)	San Juaquin river (Rocky Mountains)	Tidal mudflats, beach; fish, sharks, marine mammals	Widely unprotected	Contamination, development, overfishing, shipping, tourism
Baja California (Mexico)	Colorado river (Rocky Mountains)	Coastal sea; high bio-diversity	Widely unprotected	Loss of river inflow, irrigation, tourism, development, shipping
Rio Platte (Argentina, Uruguay)	Rio Platte (Andes)	Tidal mudflats; fish, seabirds and marine mammals	Widely unprotected	Fisheries
Danube Delta (Romania, Ukraine)	Danube river (Alps)	Swamps, wetlands; migratory birds, waterbirds	Widely unprotected	Fisheries, development, contamination
Nile delta (Egypt)	Nile river (Blue Nile and Lake Victoria)	Swamps, wetlands; migratory waterbirds	Widely unprotected	Development, pollution, irrigation

global and they fully include the atmosphere. A water molecule might easily encounter through this journey the habitats of albatross, vultures, snow leopards, tigers, elephants, frogs, sharks, plankton and deep sea squid!

In the case of HKH, which is a rather elevated landscape (but not located on the highest continent, which actually is Antarctica), rain often accumulates there as

Table 4.2 A selection of wetlands and swamps that are fed by Hindu Kush-Himalaya rivers; all of these wetlands connect mountains with oceans and they float into major river estuaries

Name of wetland	Nation	River	Mountain origin	Estuary connection	Comment
Koshi	Nepal	Koshi river	South of Makalu Barun National Park and Kanchen-junga Conservation Area	Ganges Delta	South of Mt. Everest; a major river and wetland for eastern and southern Nepal. Sustains the Koshi Tappu Wildlife Reserve, and floats into the Ganges river feeding parts of India and Bangladesh.
Poyang Lake	China	Yangtze river	Tibetan Plateau, glacier of Jianggendiru	Yangtze mouth	This region is known as China's Bermuda Triangle with many ships and people disappearing. Water levels are currently very low, drying.
Inle lake	Myanmar	Mekong river connections	Tibetan Plateau	Mekong estuary	Shan plateau (app 850 meter altitude), a world heritage. A relatively small lake but many endemic species and famous human societies. Water level varies but siltation and many environmental problems are dominant. (IUCN 2014)
Russian/ China border (Qiqihar)	Russia/ China	Heliongyang/ Amur river	Eastern Mongolian Plateau	Amur river Estuary	A massive wetland based on a huge international watershed
Lop Nur	China	Tarim river	Borderland of China, India and Pakistan	None	A major historic salt lake and relevant wetland (now widely dried up; ~desert of Taklamakan)
Peatland in Ruoergai	Tibet/ China	Yellow and Yangtze rivers	Tibetan Plateau	Yangtze River estuary	A highland peatland
Yarlung Tsangpo valley wetlands	Southwest Tibet/ China	Yarlung Tsangpo river	Tibetan Plateau	Mouths of Ganges	High altitude Wetland of relevance for human settlements
Jhelum river basin	Kashmir	Jhelum river	Pir Panjaal Range, western HKH	Indus river Delta	Lifeline of Kashmir; many dams and barrages

Table 4.3 Selection of estuaries that are fed by HKH through rivers

Name of Estuary	River	Ocean	Name of the sea	Comment
Sundabans	Ganges, Padma, Tsangpo and Brahmaputra	Indian Ocean	Mouths of the Ganges, Bay of Bengal	The world's largest delta
Bohai Sea Delta	Yellow river	Pacific Ocean	Yellow Sea	Bohai Sea is a major landscape and part of Chinese farming and culture.
Yangtze river Delta	Yangtze river	Pacific Ocean	Yellow Sea	Gigantic mega cities such as Shanghai, Najing, Hefei. Major international ports; a very dense transportation network, including railways and airports.
Indus river Delta	Indus river	Indian Ocean	Arabian Sea	Provides for major ports like Karachi (~22 mio peope). Large-scale irrigation and the Guddu Barrage and Wasak Dam resulted in less water, but also catastrophic floodings. Topic of India-Pakistan boundary conflicts, e.g. for fishery.
Amur river Delta	Amur river	Pacific	Sea of Okhotsk	One of the least developed and least fished estuaries
Mekong Delta	Mekong	Pacific	Gulf of Thailand	One of the most destroyed and developing estuaries in the world. Beyond Vietnam, it also affects Cambodia

Table 4.4 Selection of two rivers in HKH that do not directly end in estuaries

River	Origin	River end	Comment
Amu Darya (Amu or Amu or Oxus river)	Border range of Tajikistan and Afghanistan	Aral Sea and wetlands (Uzbekistan and Kazakhstan)	Former, a major river in Central Asia
Illi	China	Lake Balkash (Kazakhstan)	A major river and lake in Central Asia used for shipping

snow and glaciers (Bajracharya and Shresta 2011). A melting event in these high watersheds eventually results into massive estuary water, simply because there is so much topography, so much area and so much water running downhill on a steep altitudinal gradient within the rivers of the complex watershed. These watersheds of the HKH region have a global meaning because they are among the highest in the world and thus get affected by atmospheric warming early and strongly! The water catchment areas of those estuaries are 'humongous'. Specific dynamics occur when water is fixed for years, even centuries, in glaciers and 'snow pack' where it gets compressed before it thaws again (this is specifically a problem with man-made global warming; Bajracharya and Shresta 2011). Many mountains also feature permafrost, which fixes water for centuries (now it gets released again due to man-made global change thawing ancient water!). The downriver swamps and estuaries are natural buffer zones for such water accumulating from the mountains.

Estuaries are the nursing grounds for fish (Miller et al. 2015; Teichert et al. 2018), but also host sea turtles, sharks and marine mammals; they also tend to feature unique coastal forests, including mangroves (Giri et al. 2011). As ocean coasts tend to be tidal, strong mixing regimes exist there. Consequently estuaries are very rich and abundant in coastal biomass and biodiversity (Fig. 4.3), that holds even on a global scale (Zoeckler et al. 2016 for Arctic species there; see Der Spiegel 2017 and references within for new species found in the Mekong). Mankind settled well in such areas for millennia. These estuary areas are essentially ‘bread and rice’ baskets full of fish (Le Trong et al. 1991)! It’s a certain cradle for humanity and civilizations. But by now, we see the vast modification of such watersheds throughout the HKH region (Fig. 4.4).

The mangroves found in those areas provide globally relevant ecological services, e.g. for carbon sequestration (Spalding et al. 2010). Considering the changes and pressures in the HKH region and beyond, no wonder then that those forests – in global demand for charcoal – are on the verge of extinction (Giri et al. 2011).

Already the Indus Basin is home to more than 300 million people (Mizra 1997; Mitra 2019). Its meltwater affects Afghanistan, China, India and Pakistan, showing the international relevance and also the global explosive force of the HKH and its estuaries (Fig. 4.5 for overview)! Virtually all estuaries in Asia carry such relevance. But beyond the main estuaries, of equal or more relevance are the many small water sources, tributaries and spin-off estuaries and lakes! They are a critical network and resources for human civilization and culture!

Considering those waterways – from the ocean upstream to the mountain peak – it makes the first but rather ancient connection for migratory species in an abiotic world initially without humans. Many fish species, as well as marine mammals then took those paths from the estuary further upwards and virtually free of any relevant

Fig. 4.3 A selection of abundant and diverse estuary biodiversity in Asian wetlands of the HKH region

Fig. 4.4 Watershed modification in wetland regions, also done to protect against floods (earth works in a wetland area the new airport at Lumbini, Nepal, is shown here!

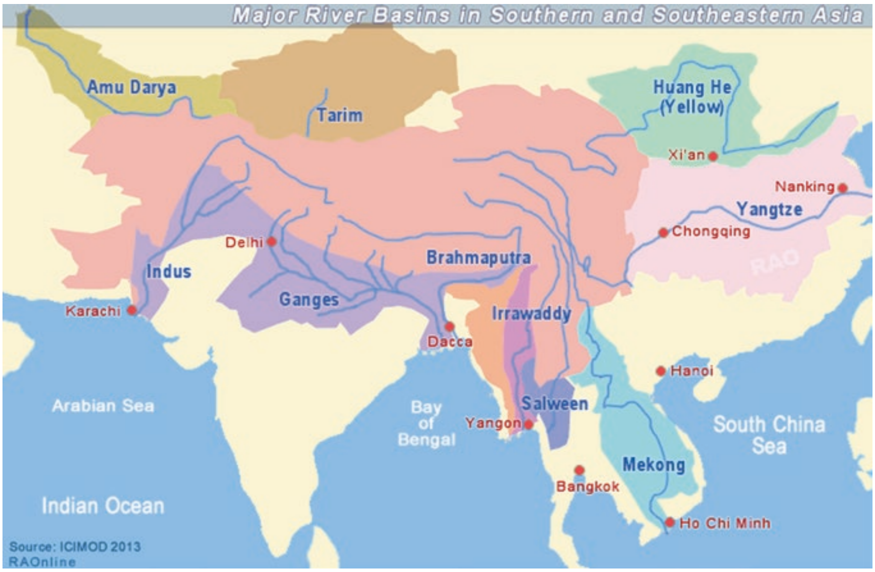

Fig. 4.5 Major rivers, watersheds and coastlines in the Hindu Kush Himalaya region. (Source: ICIMOD: (http://www.raonline.ch/images/edu/map/southasia_riverbas001.gif)

interference, interruption and pollution. Classic species that make such a connection are salmon. In the Asian context, the list of migratory species consist of sturgeons, or river dolphins and even sharks and purpoises. The mixing zones, where oceans and freshwater meet and mix, are biodiversity hotspots and ancient centers of life. Those 'basins' tend to go back deep into human time and earth time. They were the mentioned food baskets for vast civilizations and they were also fought about (see Elvin 2004 for China). These areas often rely on a natural flood regime to obtain fertilizers. Two to four harvests a year are common there. From that it is easy to see that estuaries and their surrounding regions play a major role for (global) food security and wealth. Not only locally and regionally but with a global impact, e.g. trading. This global impact is not only due to the physical provision of food, e.g. rice and grain, but starvations and riots affect global politics. Classic examples can be found in Burma, Laos, Bangladesh and how it affected the British Colonial politics (Myint-U 2006), Vietnam (Le Trong et al. 1991), or Japanese and American invasions, and subsequently the U.N. and the wider world. The World Bank deals with those topics to this very day. Nowadays, climate change makes these issues more relevant than ever (e.g. http://www.ipcc.ch/ and economic assessments within).

What we see today is a wide destruction and wholesale modification of those estuaries, and consequently, of its initial species composition and the associated waterways of ancient and sustainable life styles (see Fig. 4.6 for an example). The associated mangroves in those estuaries -many in Asia are actually fed by the HKH rivers – are by now globally threatened ecosystems, and species living in such friction zone are subsequently endangered, if not even extinct (Table 4.5). Many people there are mislead and poorly governed; the urbanized population virtually eats away the otherwise well-sustained wealth of the earth. This makes for virtually a global

Fig. 4.6 Plastic pipes – carried here by a human porter in Nepal – are a common sight in the Hindu Kush Himalaya region. As done elsewhere in the world, piping is widely used to divert water from rivers. It represents the 'death by 1,000 cuts' for estuaries which run dry for the supply of freshwater. For a real world example see for instance Chaudhary et al. (2007)

Table 4.5 Details of estuaries affiliated with rivers coming from the Hindu Kush-Himalaya region

Estuary name	City nearby	People affiliated	Other characteristics
Sundabans	Chittagong, Dhaka	Over five million people	A massive wetland area of major relevance for fisheries, shipping and global politics
Irawaddy	Yangon (Rangoon)	Over five million people	A major river in Myanmar (Burma) and affecting wider estuaries, swamps and wetlands
Yangtze river Delta	Shanghai	Over 40 million people	A huge industrial complex of global relevance with over 4000 years of human civilization
Indus river Delta	Karachi	Over 25 million people	Major international port
Amur river Delta	Nikolayevsk	Less than one million people	Strategic access to Russia (Sea of Okhotsk and interior) as well as China
Mekong river Delta	Ho Chi Minh City	Over 17 million	A vast system of swamps and rivers

phenomenon and paradox these days, e.g. Alexander (2013). A fitting example can be found with the ganges shark (*Glyphis gangeticus*) which is now pushed to the verge of extinction in the watersheds where it was found earlier in high abundance (Compagno 1997; see for IUCN redlist http://www.iucn-redlist.org/details/9281/0; Table 4.6).

Another tragic but representative case for many examples of a species affected by watershed changes in the wider HKH region is the Bajii (*Lipotes vexillifer*) in China. It was 'stressed to death' by the Three Gorges Dam and others, and where afterwards five natural reserves were set up for its protection. But it all was in vane as this species is now functionally extinct (Turvey 2009; Table 4.6). Those five natural reserves are empty, showing the failure of such industrial conservation mind sets, and it might serve us as a stern warning about such policies and their ineffectiveness and harm.

As a widespread and already mentioned problem, it's clear by now that Asia's rivers send more plastic into the estuaries, and oceans, than all other continents combined (see Fig. 4.7 for an example). A stunning 86% of plastic pollution is estimated to come just from Asia alone. (Other sources of plastic come from offshore fisheries practices for instance). Most countries do not report how much plastic they are flushing (details found in Lebreton et al. 2017). Even more severe, the concept of chemical leakage from those micro-plastics remains unknown and widely understudied; likely it's a big and underestimated topic of global contamination though affecting human and ecosystem health (Moore 2012).

And on the inner side of the actual water equation, now even the water itself that comes down from the mountain peaks – the highest in the world are located in HKH – is affected and it makes downstream issues worse; either water gets used up and dries out for the rivers, or it gets polluted by many contaminants (see Fig. 4.8 for an example), or the water runs become unpredictable (see flood-inundated areas in Bangladesh; ICIMOD 2017). Those problems can be easily detected in estuaries

Table 4.6 Species that are affiliated with estuaries and need clean rivers from HKH, but that are now in conservation troubles

Species	Estuary	Conservation status	Reference
Irawaddy Dolphin	Mekong river, Bay of Bengal	Various levels of endangerment in Asia (Critically endangered outside of Bangladesh and India)	http://www.iucnredlist.org/details/15419/0
Baiji (Chinese River Dolphin)	Jangtze river, Yellow Sea	Functionally extinct	Turvey (2009)
Ganges Shark	Ganges river, Hooghly River (West Bengal), Brahmaputra, and Mahanadi	Critically endangered	Compagno (1997)
Gharial (gavial)	A few Ganges tributaries, e.g. Narayani-Rapti and Karnali-Babai rivers (Nepal), and Son & Gadaki river (India)	Critically endangered (2% of its former range)	http://www.iucnredlist.org/details/8966/0
Finless porpoise	Asian coastline	Unfavorable conservation status (~vulnerable)	http://www.iucnredlist.org/details/198920/0
Yangtze Sturgeon	Yangtze river	Critically endangered	https://www.iucn.org/content/sturgeon-more-critically-endangered-any-other-group-species
Amur Sturgeon	Heilongjang	Critically endangered	https://www.iucn.org/content/sturgeon-more-critically-endangered-any-other-group-species
Sakhalin Sturgeon	Sakhalin	Critically endangered	https://www.iucn.org/content/sturgeon-more-critically-endangered-any-other-group-species
Spoon-billed Sandpiper	In selected coastal estuaries all over southeast Asia	Critically endangered	Zoeckler et al. (2016) and Melville et al. (2016)

where problems accumulate 'end of the pipe'. Those problems tripling down now even to the actual molecule show that with our lifestyle and industrialization we reached and affect the inner metaphysics of water, of life itself that is. What is left then once the molecules are affected by humans?

The examples of environmental devastation in these estuaries in Asia are currently virtually endless. Once more, the Yangtze river region might serve us here as a classic example: This region is by now the global kitchen sink of globalization; it's

Fig. 4.7 A common view: a high amount of plastic waste on the river banks of the Hindu Kush Himalaya region

Fig. 4.8 In the Hindu Kush-Himalaya region herbicides – here a disposed bag of Glyphosphate in the Yangtze river watershed is shown – are quite easy to see and to find

water management gone awful (MacKinnon et al. 2012). While it is easy to blame China, the question remains: Who really produces there, to what social, environmental sub-standards, and for whom? The limits were set by somebody and got approved by others while everybody knows and sees it. Clearly, Apple (U.S.) in

Kaifeng, VW (Germany) and other car makers like Volvo (Sweden but linked with China) and General Motors (U.S.) in Shanghai are involved; many more can be named. The Yellow Sea, widely relying on water inflow from the HKH region, is a widely declared reclamation disaster (e.g. MacKinnon et al. 2012 published for the U.N.). It is difficult to deny that aquifer declines, land management mismanagement as well as a modern form of socialism are gone 'brutal'. There was little enforcement thus far, no adherence to conservation policy, no international minimum standards, no data sharing for best possible decision-making, and well-known wider connections as well as migratory shorebirds, cranes, marine mammals and fish all got essentially ignored when things got built. International policies were ignored or had no effect (see Kanai et al. 2002; Wu et al. 2009 for Siberian crane as one example of many). Overall, it's a widely unsustainable system and governance allowing for such things to happen, with the Yellow Sea and other estuaries fed by HKH as environmental indicators of failure. People, biodiversity and Mother Earth are paying the bill. This region is heavily affected by the new seawall (Ma et al. 2014), sewage, the global car industry, globalization, urban planning, entertainment parks, farming, electrification, airports and a certain air quality management. China, as the global governance, has simply forgotten here to be in 'harmony with nature.'

By definition, estuaries are on a zero sea level; they are part of a tidal zone. But arguably, with climate change coming up unabated, estuaries are becoming the prime victims of sea level rise, of brackish water intrusion and even ocean acidification (might be the biggest of all serious impacts due to man-made climate change). It is common knowledge that as part of the China's gigantic South– North Water Transfer Project, the Yangtze Delta has become a spillover system which is by now suffering from increasing seawater encroachment due to the reduction of water from the sending system of the transfer project (upstream regions of the Yangtze River) but not directly connected with the receiving systems (water transfer destinations, including Beijing; public details are for instance found at: https://en.wikipedia.org/wiki/South%E2%80%93North_Water_Transfer_Project).

While on-the-ground effects are well known and notable (e.g. Buckley 2014) many data sets do not exist with a sufficient quality to capture impacts along coastlines and estuaries relevant for human-wellbeing and pro-active management. Table 4.7 shows publicly available coastline and estuary data for such assessment and in the HKH region (see Fig. 4.9 for a mapped example). Virtually all over the world though digital GIS maps for coastlines carry a large offset and are blurry where the coastline actually is located. A 1 km uncertainty is common in coastline maps and where tidal changes occur; for estuaries it tends to be more severe. Considering additional sea level rise, coastline erosion and brackish water intrusion, or even tsunamis, such map information – digital or hard copy – is widely insufficient and effective conservation management cannot be done. Further, estuaries are dynamic and changing fast, whereas those changes remain widely unaddressed and unmapped in such maps. This results into hazards and dangers. People pay the prize.

Estuaries in Bangladesh are well known to be flooded with up-coming climate change and sea level rise (Buckley 2014). They are already poster children in this respect; victims of this situation are clear. But beyond the estuaries, it will affect the

Table 4.7 Digital GIS maps for coastlines and estuaries in the HKH region

Data source	Estuary	Resolution	Comment
Global Self-consistent, Hierarchical, High-resolution Geography Database (GSHHG) https://www.ngdc.noaa.gov/mgg/shorelines/	Global	Various	An unorthodox and not updated merger of World Vector Shore-lines (WVS), CIA World Data Bank II (WDBII) and Atlas of the Cryosphere (AC).
National University of Singapore http://libguides.nus.edu.sg/gis	Asia	Various	A merged data set compiled from sources like above etc.
Penn Library http://guides.library.upenn.edu/c.php?g=475518&p=3254777	Asia	Various	Library map resources
Diva-GIS http://www.diva-gis.org/gdata	Global	Various	Various national data

Fig. 4.9 Digital coastline and estuary map of the Ganges Delta, Bangladesh. (Source Diva-GIS; for details see also Table 4.7). As detailed as those maps look like, they are by now outdated and are not be used for navigation and most real-world applications, including ecological ones. Mapping of those wetlands in HKH is widely inaccurate and still not available for many meaningful and needed applications

people and most of the coastal areas and the wetlands. The Heliongyang/Amur river showed also those floodings in recent years also for the Sea of Okhotsk. And large sections of entire nations, such as Vietnam as an example, have vast regions of their territory located within just a few meters above 0 meters sea level. Another ongoing effect of climate change is that drinking water near the coast gets spoiled. That is already an ongoing effect in coastal India – as well as Bangladesh of course – with massive impacts (e.g. Buckley 2014; ICIMOD 2017).

By now, the Mekong is another tragic case study where all major and modern signs of estuary destruction can be found (Poff and Olden 2017). This region is a major hub in Southeast Asia and widely connected (Myint-U 2006) but on the verge of its ecological wilderness collapse (Buckley 2014).

China has acted already on the issue of estuary protection, and built a seawall (Ma et al. 2014; Melville et al. 2016). This seawall is to protect against future harm, an investment against initial sea level rise caused by man-made climate change. It has even been proposed as a good role model for other coastlines in Asia and the world as well (see also Stokestad 2018 for recent Chinese goals), but arguably, it's not feasible nor a realistic or cost-effective protection against global forces of nature. Those are pipedreams 'to engineer ourselves out of global problems' and they just ignore the underlying causes and the world's ecology. Many other bad examples do already exist elsewhere in the world (Reisner 1993).

Those problems of the modern world and its management are becoming recognized, but many of the ongoing efforts still do not break out of the existing mindset and their dominating institutions. The following is a typical example of many of those issues and stubborn lobbies, here stated by *the International Water Management Institute (IWMI; http://www.iwmi.cgiar.org/)*. It makes for a vivid example showing us that nothing really gets addressed and resolved, beyond promoting the inherent economic growth and neoliberal agenda within the existing world order of greed and ignorance which carries inherent abusive structures (Rosales 2008):

> *For the Indus Basin, together with the International Water Management Institute IWMI and supported by The World Bank (Indus Basin Knowledge Forum) Sri Lanka has an ICIMOD effort (supported by Australia through the Sustainable Development Investment Portfolio) to tackle Indus Basin efforts due to climate change. IWMI wants to strengthen the knowledge landscape, building on opportunities for knowledge sharing and co-development and also making the knowledge already available more readily accessible; all as identified by its experts (but not democracy). IWMI leads the Informing Change in the Indus Basin (ICIB) program funded by DFID (Department for International Development UK), as part of the IWMI's Sustainable Growth strategic program.*

While perhaps a nice and kind attempt, the World Wetlands Day (held last time Feb 2nd 2018) will achieve similar, just like the many designed nice-looking coastal and estuary wetlands with board walks but that are actually to cater economic and industrial interests and associated recreation the most (see Fig. 4.10 for an example). Nothing really is resolved with those approaches but while the global destruction machine eats up more wilderness, more resources, keeps contaminating waterways and just helps to destroy more of the wider HKH region!

Arguably watershed and estuary problems are highly multi-dimensional ecosystem topics that require effective actions across nations and cultures. They need a detailed management sophistication which is truly embedded in ecology and wider views (Naess 1989). Every textbook in Ecology (Begon et al. 2006) and any Ecology 101 class taught to freshmen shows us no other; such decisions are time-critical, too: We have no time to loose. The HKH is part of that equation, as is the atmosphere and global treaties about how we handle the earth. But such views were not prevalent in the global governance thus far (e.g. The World Bank, GATT, FAO, World HydroDam Commission) and thus, problems then developed accordingly! And if those concepts of connectivity were included, they have not focused on ecosystem health and services, effectivity or the well-being of all humans and Mother Earth! Considering that these estuaries deal with the livelihoods of over 2 billion people, and with their food (which easily affects global commodity prices; see Fig. 4.11 for an estuary fisheries of the HKH region), it's a major global issue and

Fig. 4.10 One of many artificial estuary wetland situations in the Hindu Kush Himalaya region: Somewhat protected perhaps but widely built up with commercial infrastructure, tourism board walks, and to serve other needs like buffer zoning. That's not wilderness for the Hindu Kush Himalaya (HKH) but all what is left

Fig. 4.11 Fisheries in Bangladesh, down river from the Hindu Kush-Himalaya (HKH) region, becomes a big driver for Global Food Security and commodity pricing!

can affect warfare (see for instance Peters 2010 for poppy and heroine, and Myint-U 2006 for Burma). It's urgent time we actually start that process beyond careerism, poor funding models, poor leadership and odd nation state constructs, ideology, capitalism and vanity.

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Chapter 5
A View from Space on Poyang Lake: What We Can Already See and What It Means

Yuanbo Liu and Guiping Wu

5.1 Introduction

Poyang Lake is the largest freshwater lake in China. It is located on the south bank of the middle Yangtze River, 1200 km away downward from the east edge of the Tibet Plateau. The lake has multifaceted functions of high ecosystem services receiving much international attention (Shankman et al. 2006; Jiao 2009; Hervé et al. 2011). First, the lake hosts the Poyang Lake wetland, which is well-known in the priority list of The Ramsar Convention of Wetlands of International Importance (The Ramsar Convention 2012). It provides essential habitats for migratory birds. Second, there are over ten million people living at the marginal areas of the lake. Further, the surrounding rice-growing region is one of China's nine food bases. Third, the lake receives water from five river systems of the wider Poyang Lake Basin. It flows out into the Yangtze River, supplying 17% of the annual discharge of the river. Meanwhile, the outflow is also influenced by the complicated interactions between the Yangtze River and the lake itself (Guo et al. 2012).

The Poyang Lake is very complex for its spatial and temporal context. The lake expands to a large water surface area (>3000 km^2) in summer, and it shrinks to a small area (<1000 km^2) in winter (Shankman and Liang 2003, Wu and Liu 2015a, b). Spatially, benthic topography differs significantly among the different areas of the lake. The lake bottom shows a decreasing trend from the south (>16 m) to the

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Y. Liu (✉) · G. Wu
Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, Nanjing, China
e-mail: ybliu@niglas.ac.cn

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north (<12 m) (Cai and Ji 2009). Temporally, the discharges from upstream catchments vary in amount and by season, adding further complexity into the lake variation (Guo et al. 2012). Especially, the actual change rate of lake expansion and shrinkage varies in the lake. This has very important implications in determining the ecological condition of wetland and aquatic organism and water availability of agricultural irrigation and for drinking water (Qi et al. 2009). In addition, the timing and duration of surface exposure and submersion directly affect plant regeneration, species richness and ecological processes (Nishihiro et al. 2004; Raulings et al. 2010). Thus, capturing the spatio-temporal variation of Poyang Lake is essential to understanding the fundamental processes in the wetlands.

Poyang Lake has been undergoing hydrological alterations in recent decades (Jiao 2009; Hervé et al. 2011; Liu et al. 2013; Zhang et al. 2014). Typically, the lake water area decreased significantly (Hervé et al. 2011), and severe lake droughts have occurred frequently in the past decade (Liu and Wu 2016). The lake shrinkage and droughts resulted in tremendous hydrological, biological, ecological and economic consequences (Wu and Liu 2014). Given that the lake is located in a humid subtropical monsoon region with millions of residents, the lake declines are attributable to both climatic and anthropogenic influences. The climatic forces include increased air temperature, decreased precipitation and a weakened blocking effects of the Yangtze River (Zhang et al. 2014; Liu and Wu 2016). The anthropogenic forces involve land reclamation, irrigation and reservoirs within the Poyang Lake basin (Shankman et al. 2006; Jiang et al. 2008). The Three Gorges Dam (TGD) constructed upstream of the Yangtze River also contributed to the lake declines, but its exact influences remain largely argued (Zhang et al. 2012; Lai et al. 2014).

5.2 In Situ Observation and Satellite Technology

Poyang Lake is surrounded by the Poyang Lake Basin, a sub-basin of the Yangtze River Basin (Fig. 5.1). The lake has a maximum area of 3860 km^2. It has an average depth of 8 m when the lake range is 22 m (Shankman and Liang 2003). The lake receives water principally from Xiushui, Ganjiang, Fuhe, Raohe and Xinjiang (Fig. 5.1). The lake region is ungauged, but downstream it includes seven control hydrological stations. That zone has an area of 23,089 km^2, six times of the maximum lake size. The Poyang Lake Basin with an area of 162,225 km^2 belongs to a subtropical climate zone. It has an annual mean surface air temperature of 17.5 °C and a mean annual precipitation of 1640 mm for 1960–2010 (Liu et al. 2012). The dominant land cover types include forestlands, agricultural fields, grasslands, bare lands and water surfaces (Liu et al. 2012). The diversity of land cover types and lake topography requires both extensive in situ measures as well as frequent space satellite observations for accurate monitoring.

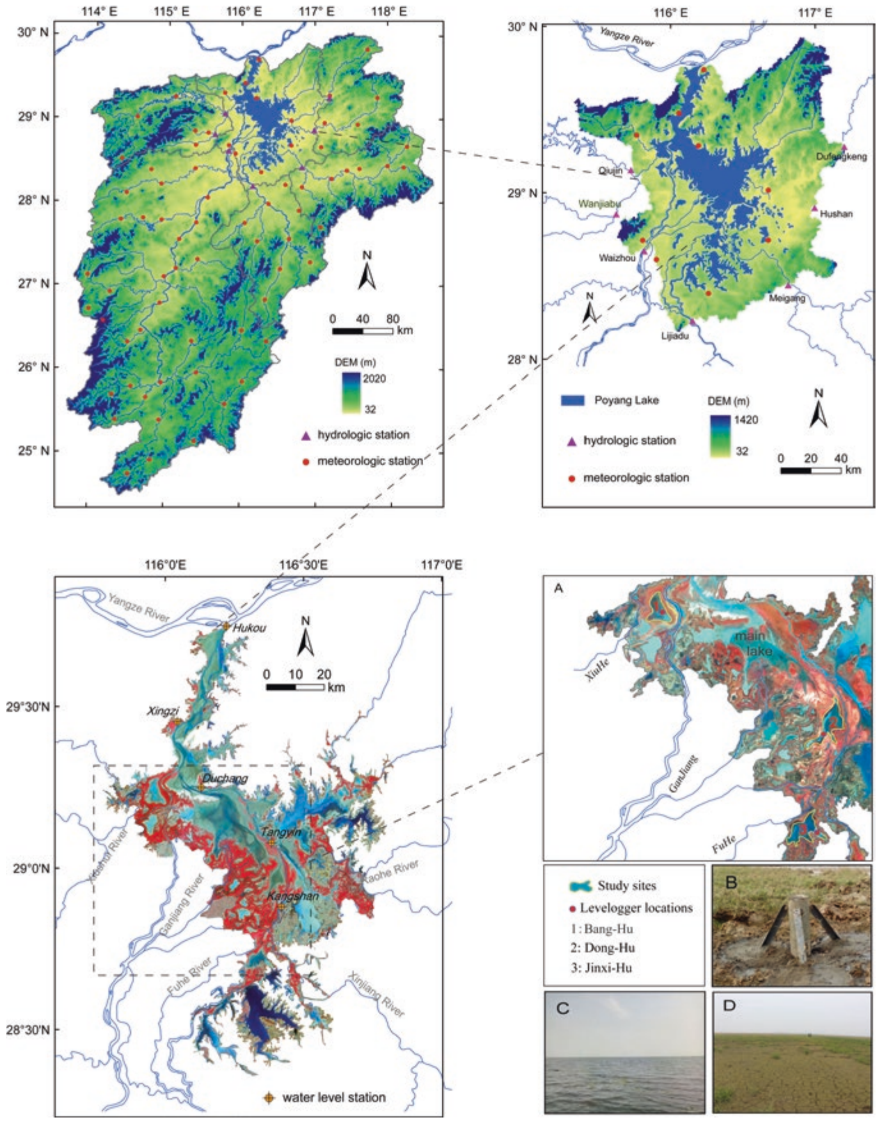

Fig. 5.1 Geographic location of Poyang Lake, China. Lake water comes principally from five river systems of the Poyang Lake Basin. Lake water flows out into the Yangtze River via a sole outlet at the Hukou. There are 5 water-level stations (yellow triangle) in the lake, 7 hydrological control stations (pink triangle) and 73 meteorological stations (red dots) within the basin. The bottom panel shows the locations of water level loggers (red dots circled) anchored in three saucer-shaped depressions (Bang-Hu, Dong-Hu and Jinxi-Hu) along the lake bed

5.2.1 The In Situ Observation Network

There are 73 national standard weather stations within the Poyang Lake Basin (Fig. 5.1). The meteorological data – including daily precipitation, radiation, temperature, humidity and wind – are available 1950 onwards from the National Meteorological Information Center of China.

There are 7 hydrological control stations, including Qiujin, Wanjiabu, Waizhou, Lijiadu, Meigang, Dufengkeng and Shizhenjie (Fig. 5.1). Hukou station measures the lake water flows into the Yangtze River. Within the lake, there are 5 water-level stations, including Kangshan, Tangyin, Duchang, Xingzi and Hukou (Fig. 5.1). They measure lake status across the lake from the south to the north. Daily lake stage data from five hydrological stations and daily discharge data from seven control stations are available from the Hydrological Bureau of Poyang Lake. Daily discharge data for the Hukou outlet are available from the Hydrological Bureau of the Yangtze River Water Resources Commission.

In order to capture more details of the lake structure several Solinst® 3001 Levelogger pressure transducers (Solinst, Canada) were installed in the lake bed in February 2015. The levelogger measure water levels in 30-min intervals at an accuracy of 10 mm. It helps to determine the hydrological connectivity between mian lake and its surrounding depressions.

5.2.2 Known Satellites and Their Environmental Applications

Traditionally, detection of spatial change in a lake relies on *in situ* gauge measurements and hydrological models. These methods, however, cannot provide an overall distribution pattern on a regional scale due to their low efficiency and some absences in inaccessible regions. At present, the advance of remote sensing offers a great alternative way for monitoring large lakes from space (Alsdorf et al. 2007). Here we provide a brief review of satellite approaches for monitoring water surface area and water level variations in the Poyang Lake region.

5.2.2.1 Inundation Extent Delineation from Remote Sensing Imagery

There are several remote sensing data available for mapping inundation extent. These include multispectral, synthetic aperture radar (SAR), and passive-microwave observations (Birkett 2000; Alsdorf and Lettenmaier 2003; Cazenave et al. 2004), each of which has its strengths and weaknesses. Some of the high spatial resolution optical sensors (e.g., Landsat TM/ETM+, SPOT, ASTER and ALOS) make it possible to accurately detect and delineate the water body information (Smith 1997). However, the routine inundation monitoring using high spatial resolution optical data is difficult due to a narrow scanning coverage and the long return period between successive satellites overpasses (Alsdorf and Lettenmaier 2003). High temporal resolution multispectral data including MODIS and AVHRR have therefore been widely used to conduct routine inundation monitoring on a mesoscale (Brakenridge and Anderson 2006), but the resolution is relatively coarse. The overall uncertainty of these measurements is ~6–13% for small lakes (Bryant and Rainey 2002), which identified coarse spatial resolution imagery's inability to detect small inundated regions. In addition, active microwave remote sensing data like SAR (e.g., RADARSAT, JERS-1, and ERS) can penetrate clouds and thick forest canopies but they perform poorly on water with wind waves or roughened surfaces from emergent vegetation.

Many methods exist for the delineation of the inundation extent from remote sensing data. Commonly used methods are based on single spectral band thresholding, two spectral bands such as the Normalized Differenced Water Index (NDWI) (McFeeters 1996) or multi-band indices. Then, the water mask is derived from thresholding the chosen index. Another method consist of using a combination of spectral bands and other variables and classification trees to develop models based on a range of predictor variables rather than selected indices (Alsdorf and Lettenmaier 2003). According to these methods, several researchers have begun to investigate the changes in the water surface area of Poyang Lake based on different remote sensing imagery (Table 5.1). For example, Andreoli and Hervé (2007) reported the variations in the lake during 2004 and 2006 using time series ENVISAT images. Hui (2008) used eight Landsat Thematic Mapper (TM) images to examine the changes in the lake between 1999 and 2000. More recently, Zhao et al. (2011) used HJ-1A/1B images to monitor the lake from April 2009 to March 2010. Feng et al. (2012) used the MODIS images to analyze the inundations of Poyang Lake from 2000 to 2010. Wu and Liu (2015a) investigated the spatial-temporal distribution and changing processes of inundation in Poyang Lake based on MODIS images from 2000 to 2011. A defined water variation rate (WVR) index revealed the magnitudes and processes of water expansion and shrinkage in different zones in Poyang Lake, as well as the inundation frequency (IF) index. Regional differences and significant seasonality variability were found in the annual and monthly mean inundation frequencies.

5.2.2.2 Water Level Estimation from Remote Sensing Data

There are several accepted methods for retrieving water levels using various remote sensing data. These methods can be summarized in three main categories: (i) the method of water level/area relationship, (ii) indirect approaches based on optical data, and (iii) radar altimetry approaches. The first method is the simplest approach that uses the water level/area relationship to estimate the water level (Pan and Nichols 2013). However, the derived relationships between water level and area are essentially empirical, and the transferability from one hydro-geomorphological setting to another has not been well proven. Second, water level can also be estimated using the land-water contact method, which uses satellite imagery in combination

Table 5.1 Summary of satellites and their environmental application in Poyang Lake region

Target	Data types	Satellite mission	Operation period	Spatial resolution	Temporal resolution	Main algorithm	Accuracy	References
Water area	Visible/ near-infrared images	NASA Landsat_TM/ ETM+	1982–2013	30 m	16 days	NDWI, MNDWI	90–95%	Hui et al. (2008)
		NASA MODIS_Terra/ Aqua	2000–present	250 m	1 day	FAI threshold segmentation, NDWI, MLM		Feng et al. (2012) and Wu and Liu (2015a)
		CRESDA HJ_1A/1B CCD	2008–present	30 m	4 days	NDVI		Zhao et al. (2011)
	Active microwave	ESA ENVISAT ASAR	2002–2012	150 m	35 days	Threshold segmentation method; object oriented method	~90%	Andreoli and Hervé (2007)
								Shen et al. (2008)
		NASDA ALOS PALSAR	2006–2011	10–100 m	2 days	Threshold segmentation method		Wang and Liao (2010)
	Passive microwave	DMSP SSM/I	1987-present	25 km	1 day	Linear estimation method; linear mixing model	85–90%	Tanaka et al. (2000) and Shang et al. (2015)
Water level	Satellite altimetry	NASA/CNES T/P	1992–2005	315 km	10 days	H = Alt-R-T_E, waveform analysis	30–40 cm	Daillet et al. (2013)
		ESA Envisat RA-2	2002–2012	80 km	35 days		30 cm	Cai and Ji (2009) and Lu et al. (2015)
		ESA Cryosat-2 SIRAL	2010-present	7.5 km	369 days		5–10 cm	Shen et al. (2008)
		ISRO/CNES Saral AltiKa	2013-present	80 km	35 days		~10 cm	Daillet et al. (2013)
		NASA ICESat/ GLAS	2003–2009	170 m	91 days		3–14 cm	Wang et al. (2013)

with high-resolution *in situ* topographic maps to derive water levels (Smith 1997). Wu and Liu (2015b) illustrated the use of MODIS images combined with topographic data to characterize complex water level variations in Poyang Lake. An error analysis was conducted to assess the derived water level relative to gauge data. Validation results demonstrated that this method can capture spatial patterns and seasonal variations in water level fluctuations. However, the absolute accuracy of the resulting map depends too much on DEM uncertainties and errors – both in the horizontal and vertical directions.

At present, radar altimetry is a promising technique for directly detecting water levels (Frappart et al. 2006). A satellite altimeter measures altitude using the time it takes for a signal to travel to, and reflect back from, the target surface. Radar altimeter and laser altimeter are the two main types of satellite instruments which have been applied for estimating the elevations of the Poyang lakes (Table 5.1). Then, the derivation of time series of surface height variations involves the use of repeat track methods. This methodology employs the use of a mean lake height profile (Cretaux and Birkett 2006). The most commonly used radar altimeters are Topex/Poseidon (T/P) (1992–2002), ERS-1 (1992–2005), ERS-2 (1995–2003), ENVISAT (2002–2012), Jason-1 (2002–2008), Jason-2 (2008–present), Cryosat (2010–present), SARAL (2013–present) and Sentinel-3 (2015–present). These radar altimeters have different spatiotemporal resolution. Combining altimetry data from several altimetry missions can increase the spatiotemporal resolution of the remotely-sensed water level. Recently, the application of this technique to monitor inland waters has shown several limitations. For one thing, it is difficult to analyze altimetry waveforms over a complex, varying surface (Cretaux et al. 2009). For another, altimetry is a profiling technique, not an imaging technique; and thus it can only provide a limited footprint of a lake and is unable to depict overall spatial distribution on a wider, regional scale (Frappart et al. 2008). Despite these limitations, satellite altimetry is also considered the best method for measuring water elevation variations from space (Alsdorf and Lettenmaier 2003), especially with the upcoming Surface Water and Ocean Topography (SWOT) mission in 2023.

5.3 Spatio-Temporal Variations of Poyang Lake

From field data and multi-satellite multi-temporal images, we now have an improved understanding of the complicity of Poyang Lake. The complicity can be expressed in terms of lake area, lake stage, and spatial patterns. The improved understanding also fosters to reveal the casual structure of extreme hydrological processes such as flooding and droughts.

5.3.1 Change in Lake Water Surface

5.3.1.1 Total Lake Area

In 1954 Poyang Lake was 5160 km^2 in size. It reduced to 3860 km^2 in 1998 (Shankman and Liang 2003). The lake area further decreased significantly in the twenty-first century (Hervé et al. 2011). Reconstructed time series data provide variations of annual mean ± standard deviation (S.D.) of the lake area for the period from 1973 to 2011 (Fig. 5.2a). The annual mean denotes the average state for a whole year, and the annual SD represents the seasonal variation within the year. The multi-year mean of the lake was 2385.8 ± 230.7 km^2. The top three largest values include 2886.8 ± 826.7 km^2 in 1998, 2829.2 ± 828.7 km^2 in 1983, and 2706.8 ± 871.3 km^2 in 1973. In these 3 years, flooding events occurred in the region. On another extreme end, the top three smallest values include 1828.9 ± 599.5 km^2 in 2011, 1985.7 ± 687.9 km^2 in 2006, and 1997.8 ± 762.5 km^2 in 1978. Severe drought events emerged in those 3 years. For the whole period, the lake area had a slight decreasing trend, which can be described by $y = -6{:}15x + 2508.8$ ($p = 0.1346$), where x is the calendar year. Besides, an abrupt change occurred in 2006 ($p = 0.0218$), indicating a regime shift in lake state (Fig. 5.2a) (Liu et al. 2013). The multi-year mean of the lake area was 2433.7 km^2 for the first regime (regime-1) and 2122.1 km^2 for the second regime (regime-2).

At the seasonal scale, the annual SD had a range from 608.5 km^2 to 1116.8 km^2 (Fig. 5.2a), with a mean of 830.5 ± 117.3 km^2. The seasonal variation (830.5 km^2) was 3.9 times the inter-annual change (210.3 km^2), confirming the high degree of lake variation. The annual SD decreased slightly with no abrupt change detected. It implies that the lake decrease in annual mean did not necessarily accompany a reduction in seasonal variation. In regime-1, the largest water area appeared in July, August and September (Fig. 5.2b). In regime-2, the largest area occurred in July, but it was followed by August and June. It confirms a seasonal shift. In comparison, the lake area decreased in all months except March when the lake increased by 64.3 km^2. Alternatively, the largest drops appeared in October (−688.3 km^2) and November

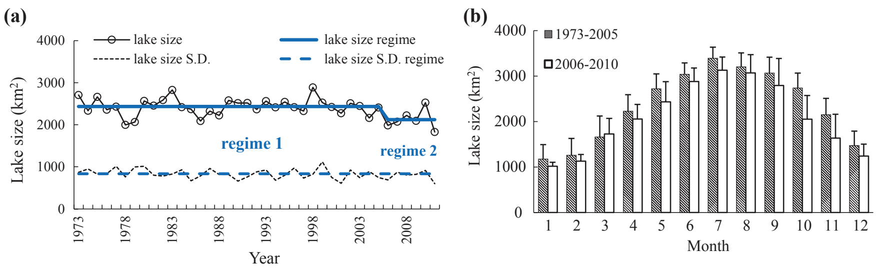

Fig. 5.2 Declines in Poyang Lake, China for 1973–2011. (**a**) Solid lines represent change of lake annual means and dashed lines denote change of annual standard deviation. (**b**) Multi-year average of monthly lake size for 1973–2005 and 2006–2010

(−513.4 km^2). In addition, the monthly SD increased significantly in September (242.8 km^2), October (196.9 km^2) and November (163.7 km^2). It is clear that the lake regime shift mainly resulted from the size decrease in September, October and November.

5.3.1.2 Inundation

Poyang Lake changes unevenly. Inundation frequency describes the frequency of inundation over a study period, for example, a month or a year (Wu and Liu 2014). Figure 5.3 displays a clear spatial distribution of inundation for all calendar months. The inundation area is 30–50% larger in April through September than from October through March. In the low-water season, only the water body connected to the Yangtze River was inundated with a narrow meandering route in the north. In March, the inundated area expanded to nearly the entire lake in July, and then shrank

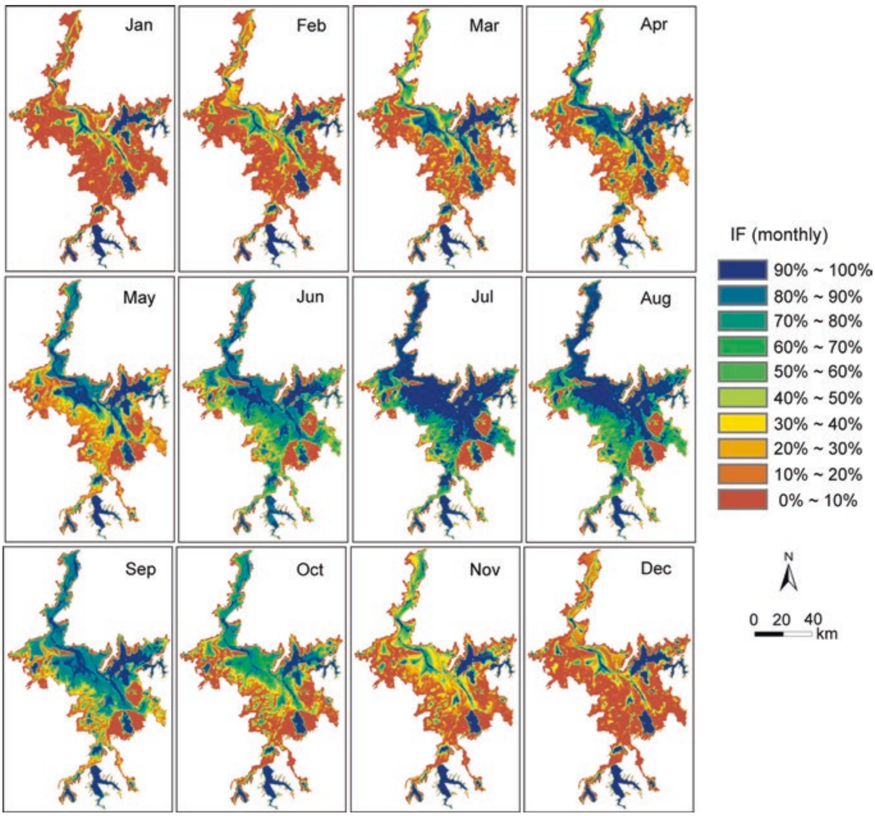

Fig. 5.3 Poyang Lake expansion and shrinkage from January to December. IF is inundation frequency within a 250 × 250 m pixel. The darker blue color represents a higher IF and the darker red color denotes a lower IF

to minimum in December. Overall, the lake expanded and increased slowly from north to south from February to August, and shrank quickly from south to north from September to December. The expansion and shrinkage patterns are primarily controlled by the discharges from five tributaries and the Yangtze River.

In addition to the extent of lake expansion and shrinkage, the rate of change is more important to increase habitat diversity or alter the availability of foraging sites for migratory birds. Figure 5.4 illustrates how fast the lake expands or shrink in each calendar month. The rate of water surface variation (WVR) varies spatially but consists with IF. Overall, WVR remains relatively stable in some areas throughout a year, including Junshan Lake and Qinglan Lake located at the southern part of Poyang Lake. High WVR appears in the northwestern lake. Positive WVR occurs from January to August, and negative WVR from August to December. In spring, the main lake body has the fastest rate of expansion, followed by the channel body. In summer, the alluvial deltas expand fast due to increasing inflows from five

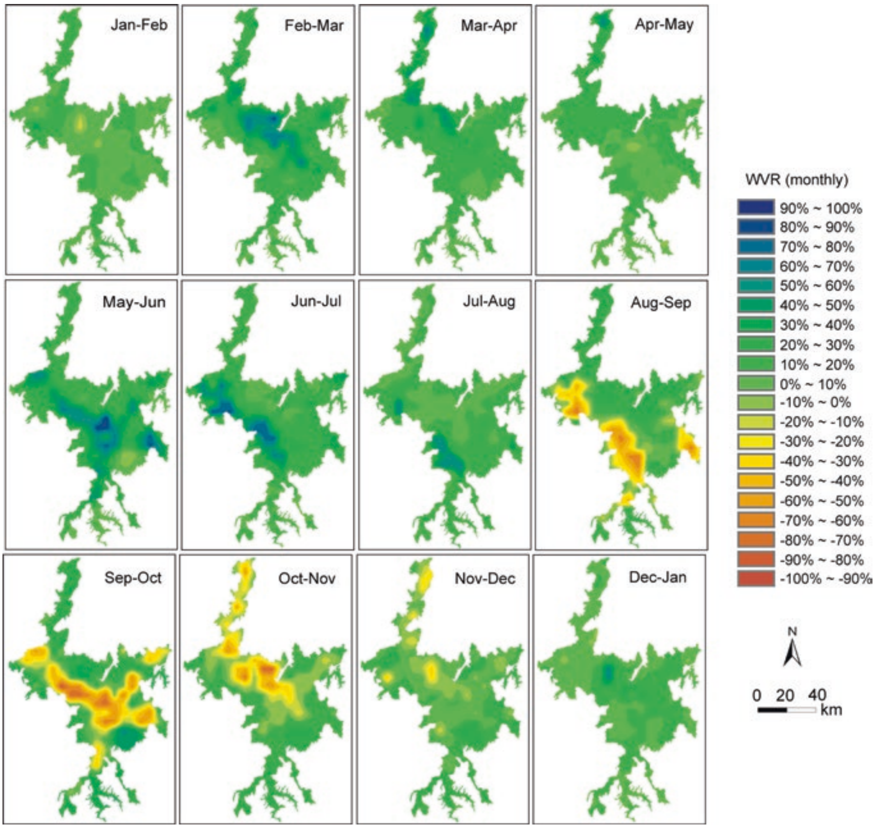

Fig. 5.4 Rate of Poyang Lake expansion and shrinkage from January to December. WVR is a water surface variation rate within a 250 × 250 m pixel. The blue color represents expansion and the red color denotes shrinkage

tributaries. In autumn, the alluvial deltas shrink fast due to decreasing inflows from the tributaries. In winter, the channel connected to the Yangtze River shrinks rapidly. It is clear that the lake has different expansion and shrinkage rates in different areas throughout year. Since Poyang Lake is an important natural habitat for fish stocks and migratory birds, the lake water change produces direct impacts on the structure, function and availability of these biotic habitats. In particular, the alluvial deltas inundated or exposed at different rates would change habitat diversity for migratory birds.

5.3.2 Lake Stage

Before the satellite era lake area is more intuitive but more difficult for monitoring lake variation than lake stage. Long-term decadal data is only available for lake stage. Since it is approximately a 110 km distance from the north to the south of Poyang Lake, the lake stage differs between hydrological stations. Among five stations to measure the lake stage, the Xingzi station had the highest correlation with that averaged from five stations available for the period 1960–2008 ($y = 0.9953x$; $R^2 = 0.99$, $p < 0.01$), representing the lake stage. Figure 5.5 shows the annual mean of lake stage for 1960–2015. A long-term decreasing trend is clear, particularly for 1950s and 2000s. The lake stage is highest in 1954 and lowest in 2011. It has a similar changing pattern to lake area for the same period (Fig. 5.2).

In combination with a digital elevation model (DEM), satellite and gauge data, we obtained the lake stage of Poyang Lake for 2000–2012. A cross section is determined along the main lake channel (red line in Fig. 5.6). The lake depth along this profile was extracted at a sample interval of 1 km. Figure 5.6 shows the variation of lake stage across the section in a distance-time domain for three different situations: multi-year average, high-water and low-water years. The distance between the

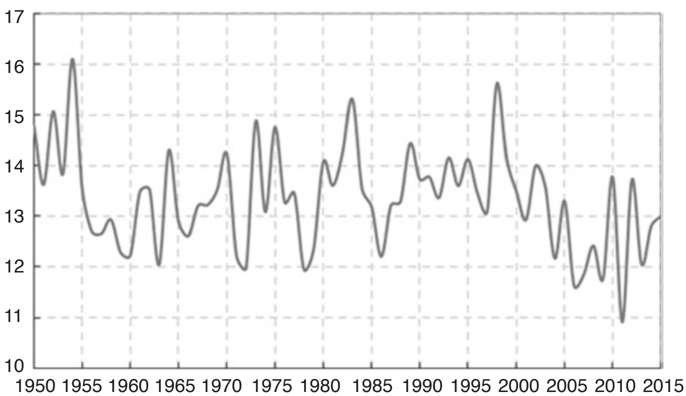

Fig. 5.5 Interannual variation of Poyang Lake at Xingzi for 1950–2015

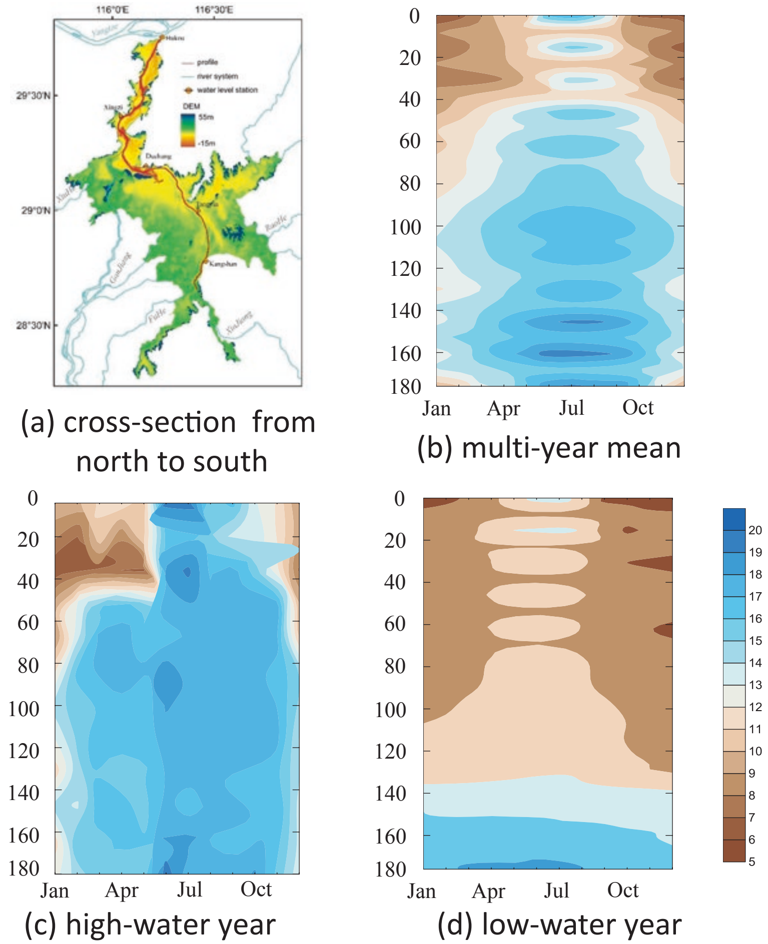

Fig. 5.6 (**a**) A cross section of lake water surface determined along the main channel from north to south (in red line). Lake stage varies along the cross section from January to December for (**b**) multi-year average, (**c**) high-water year (2012) and (**d**) low-water year (2011). Contour lines show lake stage

contour lines indicates how much the lake stage changed over a horizontal distance. The closer the contour lines to each other are, the steeper the stage gradients are. The multi-year average has two major water regimes (Fig. 5.6). The first emerges in dry seasons (October–May) and the second in wet seasons (June–September). In dry seasons, stage gradients were relatively high from north to south. In wet seasons, lake stage is almost the same from south to north. In a high-water year (2012), evenly distributed contour lines demonstrate mild stage gradients throughout the year. A low lake stage appeared in November–May (8–10 m) in the southern lake. In a low-water year (2011), lake stage was much lower than that in 2012, with a large gradient from south to north. The gradients are large, not only in dry seasons but also wet seasons.

5.3.3 *Landscape Pattern*

Landsat series images from 1989/02/13 (low-water season), 1989/07/15 (high-water season), 2013/12/24 (low-water season), and 2013/07/01 (high-water season) were selected to respectively represent the pre- and post-TGD periods. The images are classified into four types, namely, sand, mudflat, water, and vegetation, with Kappa indices ranging from 0.863 to 0.911 (Wu and Liu 2017). Figure 5.7 shows the dominant land cover categories in Poyang Lake. In terms of landscape composition, water surface areas were reduced from the pre- to the post-TGD period. Specifically, it decreased from 1456 km^2 to 1136 km^2 in low-water seasons, and from 3451 km^2 to 2753 km^2 in high-water seasons. In contrast, the marshland areas increased. The increased marshland is likely to facilitate the fitness of adult plants, beneficial for

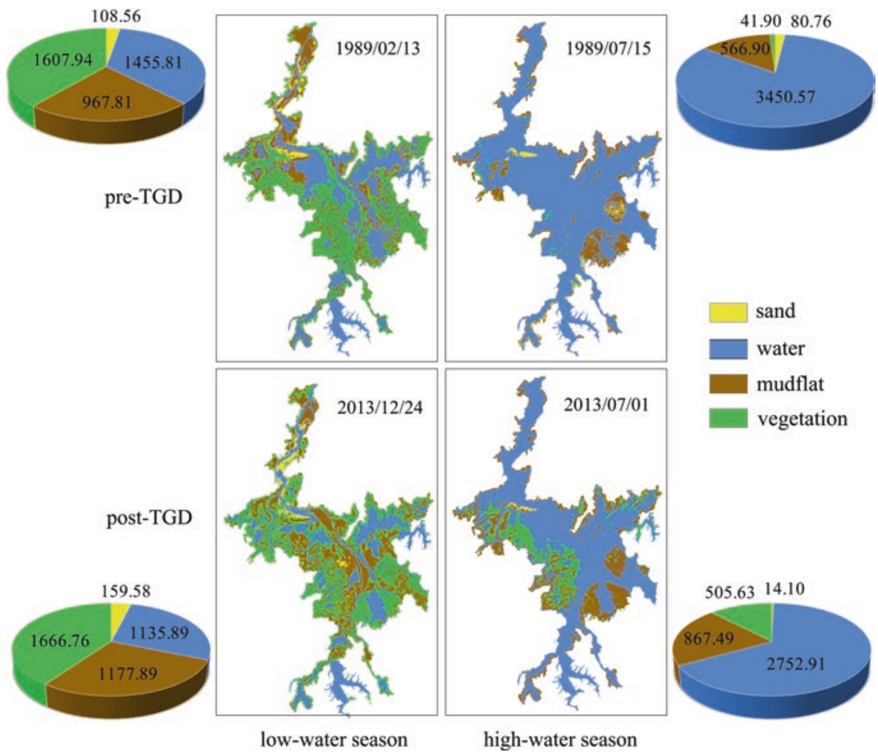

Fig. 5.7 Land cover maps in low-water and high-water seasons during the pre- and the post-TGD periods

seed regeneration. Vegetation areas increased by 59 km^2 in low-water seasons and 464 km^2 in high-water seasons, and the most significant changes occurred in the estuary delta of the Ganjiang and the Raohe Rivers. The floodplain area is extremely sensitive to hydrologic regime changes. The operation of the TGD has altered the lake regimes and this could affect regional vegetation distribution. The partially inundated area was subsequently replaced by marshland, and, accompanying this process, the floodplain plants grew and expanded.

In terms of landscape configuration, Table 5.2 shows the changes in landscape metrics from the pre- to the post-TGD period. In the pre-TGD period, the landscape was composed of 27,659 patches in low-water seasons and 14,942 patches in high-water seasons. In contrast, in the post-TGD period, the habitat patch number (NP; fragmentation) increased significantly to 32,144 and 18,741, respectively. Mean patch area decreased from 12.83 to 10.97 in low-water seasons and from 27.72 to 22.09 in high-water seasons. All the metrics indicate an increase in landscape fragmentation while the landscape tends to become more complex and heterogeneous. On the other hand, the contagion index decreased from 46.58 to 42.16 units in low-water seasons and from 75.81 to 62.24 in high-water seasons. It indicates that the connectivity among the dominant patches declined, and the patches distributed more unevenly after the TGD construction. In addition, Shannon's diversity index increased from 1.07 to 1.30 in low-water seasons and from 0.55 to 0.88 in high-water seasons.

Landscape pattern offers biodiversity and other ecological processes (Ouyang et al. 2010). Human-induced land change produces substantial impacts on landscape composition and configuration. The landscape diversity increased and became more complex and fragmented. It was attributable to the weakened lake-Yangtze River interaction under the influence of the TGD regulation. The changes may alter landscape connectivity, and in turn, modify hydrologic regimes resulting in other unexpected effects on aquatic organism and habitats. There is a strong need for working strategies to balance the TGD impacts on ecological services in Poyang Lake.

Table 5.2 Landscape metrics for the entire landscape in the pre- to the post-TGD period

Metrics		Number of patches	Mean patch area	Edge density	Mean fractal dimension	Contagion index	Shannon's diversity index
Pre-TGD	Low-water	27,659	12.83	47.19	1.0126	46.58	1.07
	High-water	14,942	27.72	17.63	1.0331	75.81	0.55
Post-TGD	Low-water	32,144	10.97	50.71	1.0524	42.16	1.30
	High-water	18,741	22.09	23.87	1.0666	62.24	0.88

5.3.4 Lake Droughts

Lake droughts refer to an abnormal decline in lake stage or lake size (Liu and Wu 2016). It differs in low water level and persistent dryness. Lake stage can be low in dry seasons, but not necessarily result into a drought. Persistent dryness means a long-term water decrease, usually unrecoverable in the short term. Droughts have a recurrent feature. It may happen in any season, lasting several months or longer Feng et al. (2012) used satellites to describe the drought severity of Poyang Lake in 2011, attributable to low basin-scale precipitation. Wu and Liu (2014) applied satellite images to delineate two extreme lake droughts in 2006 and 2011. Liu and Wu (2016) utilized a standardized lake index to quantify lake droughts in 2000s. They confirmed that the lake droughts strengthened in terms of duration, frequency, intensity and severity.

The extreme drought of the year 2011 was the most severe in the Poyang Lake region, followed by extreme droughts of 2006. Figure 5.8a shows the monthly mean

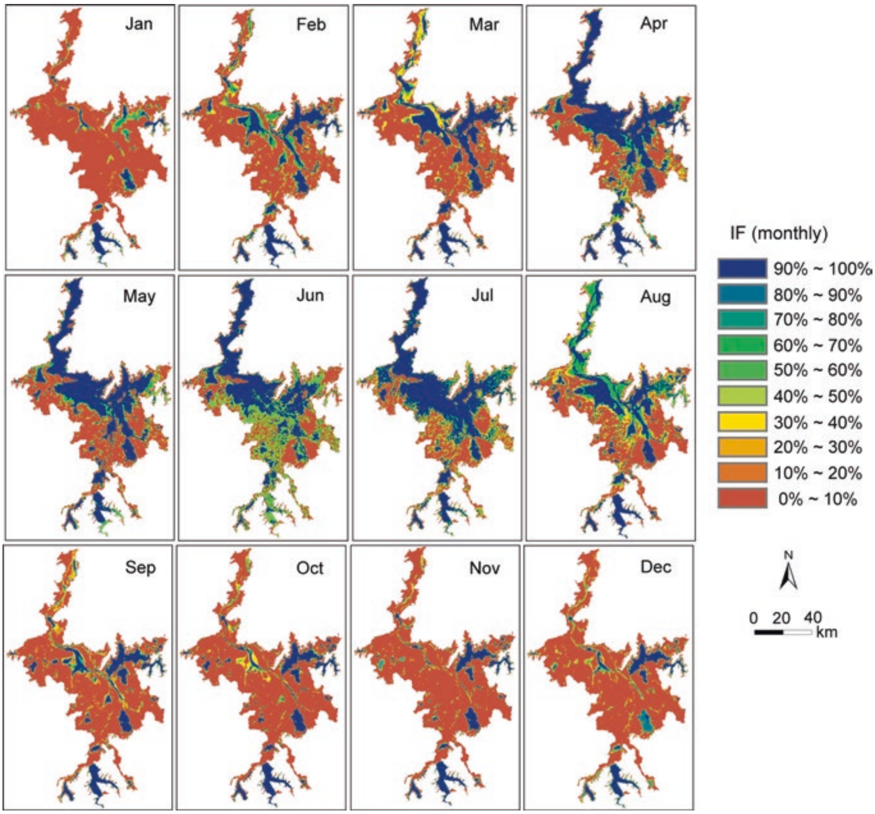

Fig. 5.8 Spatial distribution of monthly mean inundation frequency for 2006 (**a**) and 2011 (**b**). In reference to Fig. 5.3, it shows the developments of the drought events

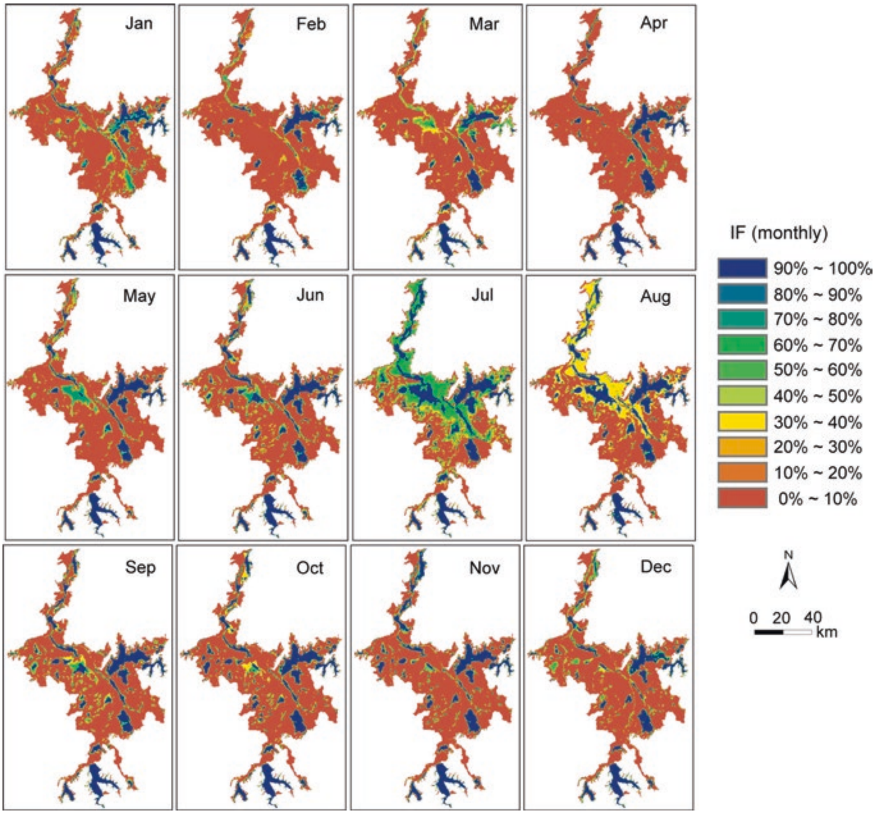

Fig. 5.8 (continued)

inundation frequency for 2006. Dark blue areas have high inundation frequency, and dark red ones have low frequent inundation. The inundation frequency expanded slowly from north to south from January to July. It decreased quickly reversely from south to north from August to December. The inundation frequency was 30~60% lower than the normal. Apparently, the large lake shrank at a fast rate to a narrow water channel and disconnected other small lakes such as Junshan, Qinglan, and Chenjia. The channel-type water body suffered the most serious water shortage.

Figure 5.8b displays the monthly mean inundation frequency for 2011. Throughout the year, water body areas were quite small compared the normalsituations (Fig. 5.3). The lake expanded during a short period from spring to autumn. Approximate 70% of the inundation area disappeared, demonstrating the extreme severity of the drought. Particularly, many small lakes nearby dried up completely in the Poyang Lake National Nature Reserve located at the Xiushui estuary delta zone.

Lake droughts result directly from abnormal changes in the lake water budget. It suffers from the anomalies of some or all the water components, including precipitation, evapotranspiration, inflow, and outflow. The relative contribution of individual water components is 68% from low regional precipitation, 57% from high evapotranspiration, −125% from high lake inflows and 99% from high outflows for 2006 event. In 2011, the relative contribution is 13% from low regional precipitation, 8% from high evapotranspiration, 51% from high lake inflows and 18% from high outflows for 2011 event. It indicated that the 2006 drought was mainly attributed to an abnormal increase of lake outflows into the Yangtze River, and the 2011 drought was due to both inflows and outflows.

The increased outflows are attributed to the weakened Yangtze River – Poyang Lake interactions. The weakened effects involve climate change in the upper reaches of the Yangtze River, and water impoundments of the TGD. The TGD impoundment begins usually in mid-September, spanning 1~2 months. The water impoundments reduced the downstream levels in the outlet of Poyang Lake. The lowered lake stages resulted in a water loss of $7.1 \times 10^8\ m^3$ in 2006, and $13.2 \times 10^8\ m^3$ in 2011. It suggests that the TGD impoundments would intensify the droughts, if occurred.

5.4 Concluding Remarks

The ‘seascape’ of Poyang Lake has a complex spatial and temporal structure, requiring extensive investigation for better understanding of fundamental processes in the wetlands. In the recent decade, the lake underwent hydrological alterations in lake water area and lake droughts. In combination with field observations and multi-satellite multi-temporal images, we detailed the complicity in terms of lake inundation, lake stage, and landscape pattern. The expansion and shrinkage patterns of the lake are controlled by lake water budget and the interactions between the Yangtze River and the lake. Meanwhile, the landscape diversity increased and the landscape became more complex and fragmented. Particularly, two extreme drought events occurred in this period. The 2006 event was due to abnormal increase of lake outflows and the 2011 drought was due to reduced inflows and increased outflows. In general, the overall change in Poyang Lake is attributable to the weakened lake-Yangtze River interaction, in which the TGD plays a role in regulation. It is therefore a strong need for developing strategies to balance the TGD impacts on ecological services in Poyang Lake.

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Chapter 6
Effective Poyang Lake Conservation? A Local Ecology View from Downstream Involving Internationally Migratory Birds When Trying to Buffer and Manage Water from HKH with 'Modern' Concepts

Falk Huettmann

Asia offers huge wetlands, many are still 'wild' and virtually all are unique and have great international relevance, e.g. for biodiversity, climate and water management (Keddy 2010); they certainly lack a comparison with Europe and most of North America, where the majority of wetlands got massively drained as part of a government policy already for longer than 300 years (Diamond 1999). Similar policies were also applied to Asia, specifically China where irrigation was practiced for millennia (Elvin 2006). But often those policies left most wetlands 'wet'. Industrialization was not unleashed there to the same extent than in 'the west' and with more space available, and thus until recently the impacts were less serious (e.g. Elvin 2006; Harris 2008). To this very day those vast wetland landscapes usually contribute to world civilizations even (examples are found in Hungary, Shanghai-China, St. Petersburg-Russia or Great Lakes of North America). Most of those wetlands are directly fed by the waters that come from downhill (mountains). In this case here, the watersheds of Poyang Lake get fueled by the highest mountains in the world: the Hindu Kush-Himalaya (HKH).

From all of those Asian landscapes and watersheds, Poyang Lake is definitely standing out and it's easily among the top wetland landscapes in the world. Its size, renewal power and biological wealth allows for humans to make a good living, all done in a benign and somewhat sustainable fashion. For many centuries it provided an Asian culture and lifestyle central to the core of China's culture (Elvin 2006). Cities like Nanchang, Jingdezhen, Fuzhou, Yingtan and Jiujang are driven directly

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F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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Fig. 6.1 Poyang Lake fisheries and its products offered by restaurants and street vendors

by that lake, its wealth and dynamics. Many dynasties took that wealth of this vast wetland systems and lived from it. Poyang Lake had its ups and downs over time (e.g. Elvin 2006). However, it remains a major biodiversity hotspot (Wang et al. 2007, 2017). But the environment is strongly changing and now drying, and thus its role and wealth is starting to decay (Zhang et al. 2012, 2014). Recent development plans for the area are presented (e.g. Duowen and Xueqing 2011), more are to come and all are well-known for impacts (Lai et al. 2014a). Specifically, these impacts affect the ancient waterflow and subsequently the freshwater fisheries (see Fig. 6.1), the local culture, and then also the wintering sites of arctic and asian migratory species. Those details will be elaborated in the next sections.

6.1 Waterflow and Changes of the Poyang Lake

Poyang Lake is primarily fed through the rivers of Gan, Xin, and Xiu which are channeled through a canal by the Yangtze river. It starts from the Tangula Mountain region, app. 5, 170 m high, in the Hindu Kush-Himalaya region of Qinghai, China. The Yangtze river is the longest river in Asia running downhill from the HKH region to the Yellow Sea eventually. And before its water slows down -running from the mountains – eventually it accumulates in Poyang Lake. Several other large lakes and wetland systems are also linked with Poyang Lake and its watershed acting as a natural buffer. Those lakes are Daguan Lake, Longgan Lake, Changhu Lake, Pohu Lake, Huanghu Lake and Junshan Lake for instance. Eventually, several rivers from there end up in the Yellow Sea running by the famous and ancient cities like Kaifeng and Shanghai. These cities have a large human, often global, history and legacy

Fig. 6.2 Dykes used for a safe water management leave many impacts, including road and development facilitations. Note: this area is directly used and frequented as a wintering site by the critically endangered Siberian Crane migrating from the High Arctic

(Elvin 2006). The Yellow Sea – as a tidal mudflat system linking with the Chinese Sea – is not short of its own records but now also in big environmental troubles (MacKinnon et al. 2012).

From deep time Poyang Lake is famous for its seasons and for the associated water fluctuations (Barzen 2012). It is all part of an Asian life line that maintained parts of the global civilization easily for over four millennia (Elvin 2006). The lake is also famous for ancient naval battels, as well as for ships getting lost there for mysterious reasons and never to be found again. There are many mysteries about this lake and its inherent processes. Irrigation projects have been carried out for centuries (Fig. 6.2). To no surprise Poyang Lake plays that big role in the Asian culture, and the HKH region upstream is a direct driver for this watershed, including its weather (some details in Fei et al. (2016)). This is all a ‘big deal’ and not to be taken lightly.

6.2 Modern Changes of Poyang Lake

But in modern time, many changes occurred for Poyang Lake. Already upstream, the Three Gorge Dams and the newly planned dykes that are to handle the water management are a problem and they present a major item of disturbance for the wider ecosystems by now. It’s part of the Anthropocene. Those issue have received an international attention and are widely discussed (Guo et al. 2012; Feng et al. 2013; Lai et al. 2014a) and for wider impacts (Wu et al. 2009).

More complete assessments of the wider Poyang Lake situation do exist – entire research institutes are set up to tackle those issues already for decades – but those elaborations are primarily done in Chinese and can lack a western-style vetting and openly-discussed conservation view that most of the global community is usually used to and as it is commonly done for good performance. For instance, Poyang Lake awaits an assessment that is done with an Ecological Economics perspective (e.g. Czech and Daly 2004; Daly and Farley 2010; see also Czech et al. 2000; Huettmann 2014). That's because it should be emphasized that most western-style research comes from an capitalistic ideology usually involving NGOs, whereas China pursues a marxist-leninist governance scheme and tends to run a different science concept and institution. Thus, aim, culture, perceptions and outcome do differ. But where there is less difference and good agreement is in the concept that wetlands are of global relevance and provide ecological services to the global community! Climate and migratory species are a good example for that, and so is food security, water supply, waste, contamination and ecological cleansing, or the human need to have recovery areas to engage with nature (Table 6.1).

The large water system of Poyang Lake was used by local fishermen in relatively low harvests for millennia. However, during different regimes these methods and concepts have changed: It went from wilderness to an indigenous and Asian feudal system to the Chinese empires, foreign dominations, and then, an almost century-long communistic regime, and now, a new exploitive capitalistic development focus also using computing power and remote sensing as well as globalization (Diamond 1999; Elvin 2006). Like elsewhere in the world, essentially a devastating cash

Table 6.1 Selection of roles of Poyang lake in the wider ecosystem perspective

Ecosystem Service	Relevance	Study (selection)
Biodiversity	Hotspot and species source	Wang et al. (2007; for invertebrates see also in Wu et al. 2009, Sullender et al. 2016)
Water cleaning	Major relevance for clean water	Zhang et al. (2012) and Lai et al. (2014a)
Microclimate feedback	Embedded in wider cycles and systems; the local weather is also driven by the lakes affecting farming etc.	Fei et al. (2016)
Food production	Fisheries and farming	Huang et al. (2013)
Irrigation for farming	Food security for millennia	Elvin (2006)
Migratory bird habitat	Arctic and tropical waterbirds, including internationally endangered species during wintering	Rogacheva (1992) and Sullender et al. (2016)[a]

[a]See also https://www.iucn.org/content/poyang-lake-wetlands-management-report, https://www.savingcranes.org/poyang-lake-report/, https://www.ramsar.org/news/poyang-lake-and-the-status-of-chinese-wetlands

economy now rules the resource management (Fig. 6.1, Czech et al. 2004). Another major impact came simply with monofilament (plastic) nets in the 1970s creating *havoc* in the ecosystem, e.g. small net sizes, bycatch and unregulated poaching all happening on a dramatic scale. And like elsewhere in Asia it is known that nets are not only used under water but also on land catching there songbirds (incidentally but in large and persistent numbers). In both cases, this is an indiscriminate catch and thus very devastating, specifically when it occurs on a vast landscape-scale without relevant enforcement to stop it entrenched as a culture and somewhat institutionalized in the 'status quo'. Such catching is still ongoing to this very day (see for instance recent campaign by Audubon Society http://www.audubon. org/magazine/may-june-2014/fighting-bird-poachers-chinas-poyang-lake). Consequently, the natural resource pays the price. Primarily, that is the freshwater fish that gets reduced, but also several endangered species are among those, and certainly the ecosystem overall and virtually all of the ecological services. The finless porpoise, a small cetacean from the Yangtze River, is already heavily reduced and could get extinct (https://www.chinadialogue. net/article/show/ single/en/839-Poyang-Lake-saving-the-finless-porpoise; Fang et al. 2006 for context). Songbirds are in generic decline in Asia, especially in China (Jiao et al. 2016; see Kamp et al. 2015 for 90% population crashes). Another widely forgotten side-aspect are the millions of unnamed migratory waterbirds that make use of Poyang Lake as a resting and winter grounds. Simply by 'developing' Poyang Lake the wintering habitats for those species are sacrificed further, just like their food items. Such wilderness systems are on an overall and consistent decline, so are the surrounding areas, flyways and by now the atmosphere overall (Table 6.2).

But by now, not only the natural resource but the landscape itself is modified. This is due to the dykes, and the road systems, including housing, farming and tourism that is heavily encroaching further onto this ecosystem. In this context a surprising but destructive feature for outsiders might be sand mining (for details see here de Leeuw et al. 2009; Lai et al. 2014b; see also maps presented online https://theconversation.com/the-world-is-facing-a-global-sand-crisis-83557). Aside of generic river bed destruction sand mining is said to be a major cause for the massive decline of the finless porpoise (https://www.chinadialogue.net/article/show/single/en/839-Poyang-Lake-saving-the-finless-porpoise). Other factors associated with those developments are the excessive use of herbicides, insecticides and pesticides (see Fig. 6.3 for examples and evidence); many other parts of the world ban such type of use of those problematic substances and in that amount. It will leave impacts on the wider food chain, certainly on the food source for many species – insects and plankton – which the spraying is to reduce. Long-term impacts are not so well known, yet but one may assume they are very serious and to be pre-cautionary is suggested (Fig. 6.4, Table 6.3).

The water levels of Poyang Lake are now dramatically in decline and the lake area shrinks accordingly (Zhang et al. 2014; Lai et al. 2014b; see also Ives 2016). Water is the essence of life and it's the very foundation of the Poyang Lake and its wider community at large. Much of this water comes from the HKH region, making the atmospheric and ocean links ('couplings'). But beyond the actual lack, and

Table 6.2 Some charismatic migratory animal species of Poyang Lake that are relying on this ecosystem

Species and status	Usage of Poyang Lake	Origin and Connectivity	Citations
Chinese alligator (Critically endangered)	Habitat	Yangtze River and wider Poyang Lake	Fang et al. (2006). See also 1. (URL below)
Finless Porpoise (Endangered)	Habitat	Yangtze River and wider Poyang Lake	Fang et al. (2006). See also 2. (URL below)
Siberian Crane (Critically endangered)	Winter habitat for 90% of the population	High Arctic Russia	Kanai et al. (2002) and Wu et al. (2009) See also 3.(URL below)
Other cranes, e.g. Hooded, White-naped and Common cranes	Winter population	Boreal forest zone	See also 3.(URL below)
Oriental Storks (Endangered)	Winter habitat for most of the world's population	Forests	See also 3.(URL below)
Eurasian Spoonbill (Conservation concern)	Winter habitat	Northern reedbeds and marshes	Sullender et al. (2016) See also 3.(URL below)
Geese (e.g. Arctic Geese and Swan Geese) (Partly declining)	Winter habitat	High Arctic Russia	Rogacheva (1992) See also 3.(URL below)
Songbirds (Many species are in a strong long-term decline)	Stop-over and winter habitat	Boreal forest and tropics	Jiao et al. (2016)

1. http://www.iucnredlist.org/details/867/0
2. http://www.iucnredlist.org/details/41754/0
3. https://www.savingcranes.org/poyang-lake-report/

contamination of, water, and just to show how bad it has gotten, fishery bans are now also implemented and more are discussed. With that, a sustainable practice applied for millennia came to a halt.

Arguably, 'the law', or the international community did nothing really to stop it and just watches. It's the common pattern found throughout the world but it's widely ineffective (Table 6.4; see also for instance Moores 2006 for Saemangeum and Yang et al. 2011 for Bohai Bay, and MacKinnon et al. 2012 for a wider overview in that part of Asia). This is fully in-line with the status of most migratory birds from the Arctic (Huettmann 2012) and for Asia (Jiao et al. 2016; MacKinnon et al. 2012 for habitats). It also follows the generic pattern of climate change, which is plagued for decades by inefficiency and failure for progress.

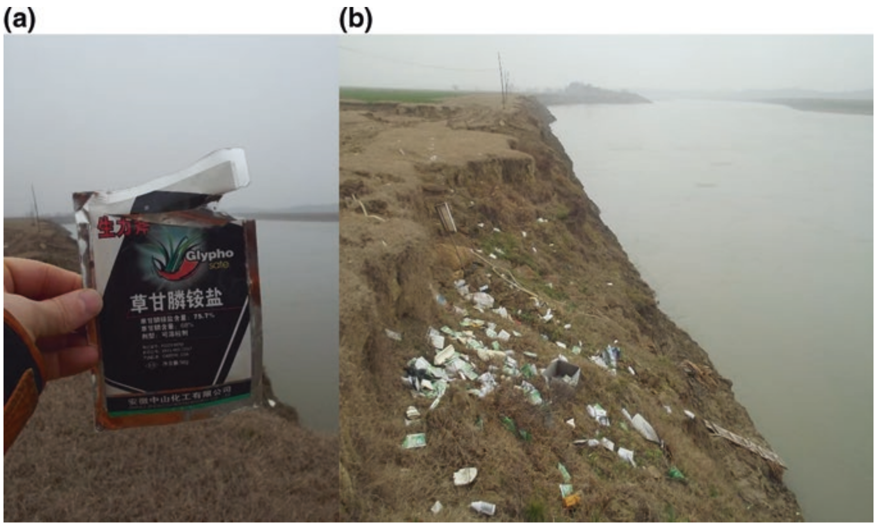

Fig. 6.3 Herbicide products are widely used in Asia (a); left-overs of herbicide products disposed at a river bank near a road (b)

Fig. 6.4 Sand Mining as a devastating industry in the wider HKH region (Note the strong shipping traffic and the waste in this watershed of international relevance)

Table 6.3 Selected list of features that are known to be intrusive and destructive to Poyang Lake (see also Keddy 2010)

Destructive Feature	Impact	Comment
Irrigation	Water drainage out of the lake; canals	Irrigation and water deviation has been ongoing for millennia in Poyang Lake. However, modern large-scale technology assisted systems for commercial and industrial applications are not sustainable.
Dykes	Large changes of the landscape and water flow dynamics	Major dykes have been built in the region, upstream and downstream.
Poaching	Comes in many shapes and forms, e.g. illegal fisheries, bird catching, and unapproved hunting	It is easy to witness many cases of illegal mist nets to catch passerines etc.
Three Gorges Dam	Change of water flow and man-made	One of the largest hydro dams in the world, widely debated for environmental impacts for over a decade. As per definition any dam that fully blocks waterflows is destructive. Same can be said for virtually all mega projects and for gigantomania. Many earlier dams now get eradicated in other parts of the world.
Tourism	Tourism consumption	Requires tourism infrastructure and a vast foot print beyond 'just' Poyang Lake.
Fishing	Not really based on enforceable sustainable quotas	A large freshwater fish harvest and resource.
Urbanization	Increasing on the entire landscape, e.g. Duowen and Xueqing (2011)	A global pattern, the Anthropocene.
Sand mining	Serious problem and not well managed (de Leeuw et al. 2009)	A global demand, related to economic growth promotion.
Intense use of herbicides, pesticides and insecticides	Applied in support of tropical farming	A generic problem in Asia and widely left unmanaged
Diseases	Spreading of diseases	Caused for instance by farming of cattle (Guo et al. 2001) or poultry (Herrick et al. 2013).

The recent Corona Virus Pandemic started and spread from Wuhan city, not too far away from Poyang Lake

Table 6.4 International laws that apply directly or indirectly to Poyang Lake and its bird species

Law	Species affected	Efficiency
Bonn Convention (Convention of Migratory Species CMS; 1979)	Siberian crane, geese, songbirds	Low (has no relevant budget nor enforcement; does not address habitat issues and as a concept is widely outdated by now; see also review in Huettmann et al. 2011)
Migratory Bird Act MBA 1916 (and 1970s extended)	Cranes, waterfowl	Low (has no relevant budget nor enforcement; conceptually outdated by now; see also review in Huettmann et al. 2011)
Best Professional Practice, e.g. Conservation of Biodiversity Conservation (Rio Convention)	Biodiversity Data sharing	Low (various legal variations and policies stand in a way of a meaningful implementation; see for instance Mace et al. 2010 for status)
Crane Treaty and Special Agreements (e.g. in MBA and CMS)	Crane	Low (has a high perception but no relevant budget nor enforcement or performance assessment for outcome)
IUCN	Endangered species, e.g. ibis, cranes and porpoise	Medium (Political species lists that lack bias, mandatory habitat and atmospheric protection)
Australasian wetland agreement	Shorebirds	Low (has no relevant budget nor enforcement or track record; hardly a reporting)
RAMSAR convention (1971)	Waterbird species, namely ducks	Low (has no relevant budget nor enforcement and allows for many counterproductive activities in RAMSAR sites; widely outdated concept; see also review in Huettmann et al. 2011 and[a])
Science (carried out worldwide)	Any species and ecosystem aspects	Medium (thus far, science is not really geared towards conservation. Lack of track record can be seen in Mace et al. 2010)
CITES	Many endangered species	CITES is designed to facilitate trade, not to halt it. It's certainly not a conservation measure and it has not worked well either way. Many CITES violations are found in Asia and its borders, often related to China and Globalization.

[a]https://www.ramsar.org/news/poyang-lake-and-the-status-of-chinese-wetlands

6.3 A Relevant Future in the Anthropocene for Poyang Lake as We Know It

So where is Poyang Lake heading? Arguably, Poyang Lake is not turning back into wilderness, or into its early status, any time soon, e.g. Fig. 6.5 for culturally entrenched and government-supported practices. Just too many development trends speak against it (Ma et al. 2009; Duowen and Xueqing 2011; Table 6.5). Sullender et al. (2016) stated already:

Fig. 6.5 Fishing gear set up at a channel for catches during changed water levels. Incidental bycatch, including for birds cannot be excluded

Table 6.5 Some future developments that can be expected for the Poyang Lake ecosystem

Poyang Lake future feature	Scale	Justification for trend	Impact
Climate change	Global, national and local	Warming	Drying and water loss; lack of snow pack and glaciers in the HKH result into less water running downstream
Development	Local	Consumption of resources projected	Resource overuse and loss
Upstream Dams (e.g. Three Gorges Damn)	National	Water flow and natural processes got halted and 'managed'	Water dynamics are interfered
Human population increase	Global	Human population growth	Consumption increases
Human waste	Global, national and local	Global waste travels, national waste travels, local waste	Spoilage and pollution increases
Contamination	Global, national and local	Industrialization and associated air pollution on the rise	Increase resulting into health and death hazards

Human-caused alterations to this system threaten to compromise the long-term viability of these bird populations due to the role of water in driving habitat suitability.

A synthesis view leaves no other forecast than one of wider destruction and ongoing decay. It matches many other environmental trends in the region, e.g. MacKinnon et al. (2012) for the Yellow Sea or even Liu et al. (2001) for Giant

Table 6.6 Famous examples of massive wetland declines and losses in the world with comparable features than Poyang Lake (see also Reissner 1993 and Keddy 2010)

Wetland name	Country	Process	Status
Aral lake	Former Soviet Union	Aggressive irrigation; drying	Widely destroyed, desertification ongoing
Elbe river riparian zone and estuary	Germany	Urbanization of landscape and watershed, eradication of riparian forests	Riparian gallery forests widely disappeared, wetlands and buffer systems widely gone, estuaries are developed for intense shipping, fisheries and even (industrial) waste disposal
Colorado river	Mexico and USA	One of the world's most controlled and litigated rivers, hydrodams, farming etc	Ran dry; Baja California in Mexico lacks inflow and initial ecosystem status decays. Indigenous people affected; major farming area in the US affected
Eastern Canada wetlands	Canada	Urbanization of landscape	Most wetlands are dramatically lost, duck species become reduced and endangered
Wetlands of California	USA	Urbanization of landscape	App. 90% of wetlands lost, duck populations become reduced and endangered
Reed bed swamps	Hungary	Irrigation	App. 80% of all reed beds in Hungary are lost during the last 400 years, specifically under royal and absolutarian governance
Riparian forests	EU	Modern water management related to urbanization and industrialization	Most riparian forests are by now endangered; the vast majority was removed creating major problems with flooding due to missed buffering and cleaning capacities in the watersheds. Famous cases are found in rivers of the Danube, Donau and Rhine

Panda habitat. It is difficult to assume that Poyang Lake will not follow what other wetlands in the world have already experienced in times of a dominating western globalization (Table 6.6). Again, this is for one of THE major landscapes and wetlands in the Chinese and Asian history and with a global civilization legacy. Entire bird flyways rely on this wetland system. But with many development initiatives ongoing 'full steam', it will simply be 'hit' further while everybody watches it and until it reaches a point of no return…like we all have seen with most other wetlands and wilderness areas we are aware of (see Fig. 6.6, Tables 6.5 and 6.6).

It is clear that without relevant changes Poyang Lake, as we know it, as an undisturbed habitat and wilderness landscape with international relevance for a benign human society will disappear soon or later (Czech et al. 2004), and so will its' species, often on an international scale. The affiliated culture is equally in transition. Smaller enforcement of compliance might look and sound impressive but hardly can fix the problems anymore. Perhaps the destruction can be halted…in 100 years

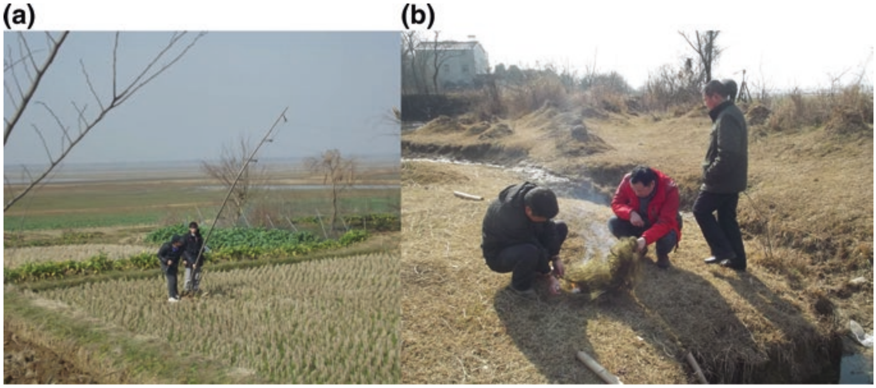

Fig. 6.6 Taking down illegal mistnets that can catch songbirds (**a**). Confiscation and burning of confiscated mistnets (**b**)

or more and some base features might remain by then. But even if local processes can get under control, the destructions upstream in the HKH region must also be addressed, namely globalization, dams, human expansion and climate change resulting into water loss, massive glacier melt and warming. And judged by the consistent but ongoing failures of climate agreement and COP meetings, and the dominance of neoliberal mind sets on global governance (e.g. Huettmann 2012, 2014) the real-world outlook to stop those processes seems to be slim for the next 100 years or so. This will all be very costly too (Wang et al. 2013). It's part of a wider western template of nature destruction (Czech et al. 2004). We shall see then what will remain under such global governance. Hope and spirituality appears like some of the best companions we have left thus far unless reason is allowed to act again in a good way.

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Chapter 7
The Future of Biodiversity in the Changing Watersheds of Kashmir Himalaya, Pakistan: Conservation Challenges and Opportunities

Muhammad Naeem Awan, Muhammad Kabir, Shakeel Ahmad, and Falk Huettmann

7.1 Introduction

The state of Azad Jammu and Kashmir (AJ&K) lies between longitude 73°–75° and latitude 33°–36° and comprises an area of 13,297 square kilometers (5134 square miles; Fig. 7.1). AJ&K falls within the organic belt of the Hindu Kush-Himalaya. As such, its topography is mainly hilly and mountainous and characterized by deep ravines, as well as rugged and undulating terrain. The northern districts (Neelum, Muzaffarabad, Hattian, Bagh, Haveli, Poonch, and Sudhnoti) are generally mountainous while the southern districts (Kotli, Mirpur, and Bhimber) are relatively plain. Dry areas are found throughout this region. Within this fragile environment, however, there is a great variety of ecological niches upon which people base their livelihood. People actually lived in those areas for millennia (Wani 2002). Small land holdings and scarcity of cultivable land are the main factors limiting the on-farm income. The area is full of natural beauty though with thick forests, fast flowing rivers and winding streams. There are three main rivers in the region: the Jhelum, Neelum and Poonch.

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M. N. Awan
Earth Day Network, Islamabad, Pakistan

M. Kabir (✉)
Department of Forestry & Wildlife Management, University of Haripur, Haripur, Pakistan
e-mail: kabir_ajk@hotmail.com

S. Ahmad
Hagler Bailly Pakistan, Islamabad, Pakistan

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department,
University of Alaska Fairbanks, Fairbanks, AK, USA

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Fig. 7.1 Map of the state of Azad Jammu and Kashmir and its watersheds, Pakistan

Whereas many small and large streams join these rivers from different catchment areas (AJ&K 2015). The rivers drain into the Mangla dam (see Fig. 7.1 for details).

Here we present our analysis on the future of biodiversity of this fragile Hindu Kush-Himalayan ecosystem with changing watersheds caused by unsustainable development, changing land use pattern and a growing human population. We also highlight here how many species of global conservation concern are under risk of local extinction due to habitat loss. Finally, we aim to present here what the challenges are for protecting these species and show opportunities which can help in the conservation of biodiversity in this part of the Hindu Kush-Himalaya.

7.2 The Human Population and Belief System in the Azad Jammu and Kashmir Watersheds

According to the 1998 population census, the State of Azad Jammu and Kashmir had a population of 2.973 million people, but by 2015 it has grown to 4.466 million. The rural to urban ratio is 88:12 and a population density of 336 persons per Sq Km is found (AJ&K 2015). Almost 100% of the communities there are Muslims and practice Islam in the state of AJ&K. Islam there means a complete code of life; it's a religion which guides humans in every sphere and aspect, including the governance of landscapes and the atmosphere. It emphasizes cleanliness and it urges followers to adopt every measure to maintain it in all circumstances. It clearly forbids excess, injustice and unlawfulness in words and in action. It stresses conservation in good detail and helps to inculcate a sense of responsibility among people. Today, the world has become a global village, where individuals can play an important role in the generic development of society and environment. Islam gives attention to protecting the environment and biodiversity for the wellbeing of humans and it urges the Muslim community to show support for the conservation of environment (Thefridaytimes 2015).

Many living things live in the universe and they all eat and drink from the environment surrounding them and also use it for other things. But by now it is the human alone who has been made responsible for causing disorder/imbalance/mischief/injustice/wrong in the universe. This is for the basic reason that a human being is endowed with two capabilities that do not widely exist in the remaining animate world. For example, the capability of thinking, speaking and planning in a strategic way. Due to these faculties a human being, though bio-physically and by disposition a weaker creation than many in the animal kingdom, he/she uses all other animate and inanimate things for his/her objects. As a result, the environment and the stores of natural resources are facing various sorts of dangers (WWF 2003). In the Holy Quran and Sunnah, humans are guided towards purity and cleanliness. As summarized in The fridaytimes (2015), moreover, Islam has already provided a rather complete code to protect the environment and it stressed the need to promote sustainability. Almighty Allah and the Holy Prophet (PBUH) paid special attention in protecting the environment and stopped people from harming the wild. To use the natural system for self-interested objectives comes within the definition of injustice (zulm). Where a human commits such injustice he or she, in fact, commits wrong to him- or herself (WWF 2003). Following the guidelines from the Holy book (The Quran), religious leaders and other players try to teach communities about the importance of conservation in Islam. Now, conservationist in that region use Islamic teaching to educate communities for the conservation of biodiversity in those watersheds.

7.3 Languages in the Azad Jammu and Kashmir Watersheds

Urdu is the official language of Azad Jammu and Kashmir, but is spoken by only a minority of people. Other languages are Gojri, Kashmiri and Pahari. The dominant language spoken in the state is Pahari with a different accent which is very similar to Pothwari and Hindko (AJ&K 2015). Beside all these local languages English is also spoken especially as the mode of higher education is English and upper class families use to speak in English.

7.4 Climate of the Azad Jammu and Kashmir Watersheds

Depending on the altitude (varying from 360 m in the South to 6325 m in the North), in the Azad Jammu and Kashmir Watersheds have a wide range of climatic conditions. The South has a dry sub-tropical climate while the North is mostly moist temperate. There is significant variation in the rainfall pattern across different regions, both in terms of amount and distribution. Average annual rainfall ranges from 1000 to 2000 mm. In the northern districts 30–60% of the precipitation occurs in the form of snow. In winter, the snow line is found around 1200 m, while in summer it is located at c. 3300 m. The average maximum temperature ranges from 20 to 32 °C while the average minimum temperature range is 04–07 °C (AJ&K 2015).

The area is also influenced by the summer monsoon which is likely to show an increase in total precipitation, precipitation intensity, inter annual variability in monsoon strength, and inter-daily variability (Lutz et al. 2016). The southwest monsoon (July–October) provides rainfall of about 100 cm or more in the mountainous northern areas of Pakistan. Rainfall can vary significantly from year to year, and successive periods of flooding and drought are common (Karen and Hamid 2012).

7.5 Forest Biodiversity in the Azad Jammu and Kashmir Watersheds

About 42.6% of the total geographical area (0.567 million hectares), is controlled by the Forests Department. The per capita standing volume is 299.5 Cft, and the per capita forest area is 0.35 acre. The annual wood demand for the study area is 1.65 million cubic meters per year and the sustainable production is 1.94 million cubic meters. The local communities have traditional rights in terms of use of the forests, and on an average three trees are burnt by one household every year for the fuel-wood requirements in the absence of alternate energy sources. Similarly, about 5 trees on average are required to construct a house for which the wooden roofs have to be replaced after every 8–10 years (AJ&K 2015; Termizi and Rafique 2001).

Some important conifers are Chir pine (*Pinus roxburghii*), Blue pine (*Pinus wallichiana*), Deodar (*Cedrus deodara*), Spruce (*Picea smithiana*), Fir (*Abies pindrow*) and Barmi (*Taxus wallichiana*). The Barmi (also called Himalaya Yew) is an endangered conifer of global significance. That is because of its recently discovered anticancer properties (Termizi and Rafique 2001). Some other Important broad leave species in this area are Tarkana (*Acer caesium*), Bankhor (*Aesculus indica*), Phulai(*Acacia modesta*), Sum (*Fraxinus excelsior*), Akhrot (*Juglans regia*), Kao (*Olea ferruginea*), Kangar (*Pistacia integrrima*), Kala Kat (*Prunus padus*), Batangi (*Pyrus pashia*), Bagnoo/Palach (*Populus ciliata*) and several species of Oaks (*Quercus* spp.) (Termizi and Rafique 2001).

7.6 Some Important Wildlife Species in the Azad Jammu and Kashmir Watersheds

Due to the diversity in climate, physiography and vegetation this landscape provides a variety in habitats for important wildlife species. Many are endemic to western Himalaya. The important wildlife of the Azad Jammu and Kashmir Watersheds include for instance Snow leopard (*Panthera uncia*, VU), Common leopard (*Panthera pardus*, VU), Asiatic black bear (*Ursus thibetanus*, VU), Brown bear (*Ursus arctos, LC*), Musk deer (*Moschus chrysogaster*, EN), Kashmir grey langure (*Semnopithecus ajax*, EN), Himalayan ibex (*Capra sibirica*), Western tragopan (*Tragopan melanocephalus*, VU), and Cheer pheasant (*Catreus wallichii*, VU) (Awan et al. 2016; Dar 2006).

7.7 Rivers and Wetlands in the Azad Jammu and Kashmir Watersheds

The study area still features a natural beauty (Fig. 7.2) and rivers and wetlands play a crucial role within. The wetlands of the study area comprises of storage dams, rivers, lakes, streams, brooks and springs. The important and main rivers are Neelum, Jhelum and Poonch along with their tributaries. Although these rivers originate from the border areas beyond Line of Control (LoC) between Pakistan and India, actually the whole of the Azad Jammu and Kashmir Watersheds is drained through these rivers into the Mangla Reservoir. The water levels in these rivers fluctuate with the season. In addition, small lakes like Rati Gali Sar, Dharian Sar and Patlian Sar also add greatly to the number of wetlands. The Mangla reservoir is the biggest wetland in the study area with a size of 25,500 ha. These water bodies and rivers are all rather important wetlands, providing habitat for thousands of migratory birds and water birds. About 67 fish species are also found in these rivers and lakes. Among these fish, Brown and Rainbow trout are exotics species and were

Fig. 7.2 Pristine landscapes, water and ecological processes in the Azad Jammu and Kashmir Watersheds

introduced in cold and fresh waters in the upper reaches of rives and stream. But the main threat to these wetlands and associated waterfowl and fish population is the pollution from chemicals and solid waste. The economically important species by now are Brown and Rainbow trout and Chinese carps (exotics), Mahasheer, Cat fish and Major Carps (indigenous).

7.8 Protected Areas Systems and Conservation in the Azad Jammu and Kashmir Watersheds

For *in-situ* conservation of wildlife in the study area, the department of Wildlife and Fisheries established a system of protected areas throughout the state. The total area of these protected sites is 57,547 ha, which is about 8.5% of the total land area of the state. Although these protected areas were initially established with the aim of providing protection and for the regulation of the population status of wildlife species, due to many reasons this objective could not be achieved well thus far. The situation remained not much different from the free-use areas around them. Most of the protected areas are essentially just paper parks and have no established management system which is in no way benefiting the biodiversity conservation objectives in the state of the Azad Jammu and Kashmir Watersheds.

Although commercial tree felling, crop cultivation, hunting wildlife, introduction of exotic flora or fauna, domestic animals and starting fires are all legally prohibited in Pakistan's protected areas, the enforcement is weak and resources are lacking and so that illegal logging and poaching are widespread (Awan and Buner 2014).

7.9 Destruction and Threats to Biodiversity in Kashmir, Hindu Kush-Himalaya

Habitat loss can reduce prey populations or other resources for species. And it can increase human-wildlife conflicts, which are important threats to wildlife worldwide (Woodroffe et al. 2005). While relatively undisturbed ecosystems exist in the study area (Fig. 7.2), they are increasingly fragmented and isolated by agriculture, urban, and industrial activities (Caro et al. 2012; Convention on Biological Diversity 2010; Fig. 7.3). Because of high variation in altitude and climate, the territory of the Azad Jammu and Kashmir Watersheds has a rich but sensitive diversity of species and ecosystems. Conservation of biodiversity is obviously very essential to maintain the ecological balance and to sustain the production and ecosystem services. In times of globalization that is not easy as a recent evaluation of macro-economic effects on current patterns of land use predicted that land cover change will continue into the future, with dramatic increases in urbanization and peri-urban development (van Asselen and Verburg 2013). The forest ecosystems and biodiversity in the Azad Jammu and Kashmir Watersheds are under very heavy use by humans and their livestock that are living in and around these areas. Grazing pressures and destruction throughout centuries left their marks in the landscape, often showing strong erosion and a missing or heavily converted initial vegetation. If the present pace of direct and indirect human uses continues, the forest ecosystems and associated biodiversity in the study area are likely to become extinct, and that might happen in the near future (examples of this trend have been seen elsewhere, e.g. Sahel zone in Africa, or Mongolia). The over population of human beings and their livestock, as well as poverty and modern rural living – loss of environmental taboos – are among the main reasons for the decline of forests and associated biodiversity in these areas. Therefore, at least some biologically critical areas and their species are to be protected by limiting the human uses of fauna and flora and to sustain their ecological functions.

Fig. 7.3 Roads, too many goats and electricity do harm landscapes and watersheds

7.10 Rights and Concessions for Natural Resources in the Azad Jammu and Kashmir Watersheds

A vast majority of the human population (88%) in the study area live in villages, practicing subsistence agriculture and holding livestock. They therefore have traditional and granted rights and concessions on nearby forests and wilderness areas to satisfy their daily needs of timber, fuelwood, forage and fodder. Besides these uses by the local people, the commercial and illicit exploitation of forest is also a main reason for the forest decline, both in their size and potential. The given rights and concession of these people are:

(i)-Free grazing and grass cutting except those areas that are closed for regeneration under closure rules, (ii)-Trees at concession and specific ‘Zamindara’ (farmers) rates to the local residents and free of cost for the construction of mosques (except deodar), (iii)-Removal of dead and fallen trees free of cost, except deodar, (iv)-Removal of fire wood, dead, dry and fallen trees not fit for building purposes, (v)-Lopping of some broad leave trees for fodder and branch cutting for agricultural riggings, (vi)-Removal of minor forest product, except those for which contracts has been granted by the forest department, is allowed free to those Zamindars.

In the current set up the above rights and concessions are already too many and too high for the forests to sustain in a healthy way. Further, they provide a lot of opportunities for misuse. With the increase in human and livestock population, over the past decades, the extent of exercise of above rights and concessions has also increased manifold. These levels are by now much beyond the actual sustainability of what those resources really can stand. The current situation is thereby very seriously and negatively affecting the forest size and its potential; future generations are harmed. Whereas, between 1993 and 2013, the demand for fuel wood in the country has been increased from 46,455 to 67,028 m^3 (Wani 2002). It is very high in view of the large population, free collection, long and cold winter season, the generally wasteful methods of fuelwood use and the lack of alternate means of household energy. As a synergy and cumulative effects this all acts in concert and thus makes things very serious for everybody, and the watersheds (consider that forests act as a cleansing tool for water tables).

7.11 Commercial Uses of Forests in the Azad Jammu and Kashmir Watersheds

In addition to having to meet the needs of local communities, these forests are also commercially exploited. This is done to generate revenue for the Forest Department through the sale of timber and non-timber forest products (NTFPs). There are additional users and with the advent of a commercial approach those forest uses add to the overuse of the now generic forest resource. In a country where only around 2% of its total territory is actually forested (Government of Pakistan 2000; FAO 2010) significant demands are being made on this natural resource, worsened by illegal logging by commercially operating logging companies (Awan 2008; Ali and Nyborg 2010; Awan and Buner 2014; Awan et al. 2016).

Mother earth has actually established a good system of continuous supply and proper distribution of water on the earth and in the air to maintain the system of life. This system can work for infinity. Underground water is absorbed by the roots of various kinds of plants. The remaining water, after the nourishment of the plants, dissolves into the air by the process of vaporization. A great quantity of water also joins the air by vaporization from the surface of the sea, the lakes and other water bodies. Vapors present in the air are converted into clouds. Swift and severe winds take these clouds to virtually every corner of the world and thereafter these clouds are converted into rainfall. In areas where there is a shortage of forests and other vegetation, rainwater flows with the fertile earth and turns itself into channels and rivers (WWF 2003). Watershed degradation has led to greater recognition of the numerous ways watersheds do support human well-being through ecosystem services and, consequently, to greater value being placed on them. These services may include provision of freshwater for various uses, regulation of both water and sediment flows, and maintenance of natural flow regimes that support entire ecosystems and ways of life (FAO 2008).

7.12 Grazing Issues in the Azad Jammu and Kashmir Watersheds

In the study area, most of the livestock are free to graze in the forest areas, or are fed on the fodder collected from the forests. Goats comprise 46% of the total livestock population. Since the goat is a browsing species, heavily nibbling at the young shoots and growing tips of trees and shrubs, it makes a major factor in the loss of tree and shrub cover on a landscape scale. Due to grazing pressure and the disturbance caused by livestock, the wildlife habitat is seriously degraded. Traditional sustainable pastoralism, including harvesting of natural products, has been practised in the area for centuries but today the sustainability is in doubt due to the rapid growth in the human population and due to a lack of alternative livelihoods (Awan and Buner 2014). This is widely found in the Hindu Kush-Himalaya landscape, as it is elsewhere in the world. By now, the wild animals have been pushed to remote areas marginal for them without sufficient food and shelter availability. Often, diseases play a critical role in this interaction too. This reduces the chances of breeding and survival of wildlife. It’s a process ongoing worldwide, but also in the wider Hind Kush-Himalaya, as well as in the study area discussed here.

7.13 Hunting and Poaching in the Azad Jammu and Kashmir Watersheds

Many bird and animal species are experiencing population declines in Pakistan due to illegal hunting for sport, meat, trade and even persecution (Government of Pakistan 2000). Once hunting was an activity and sport of powerful and rich people; usually it was either reserved to the rulers (e.g. for big game, trophies) or it was carried out by the peasants (e.g. focus on small game, meat). It was very difficult and challenging to hunt a fast-moving animal or bird with spears, bows and arrows. Even trapping had its limits. But together with an increase in the human population the advent of firearms has become a turning point for the fate of wildlife. Firearms made it easy, for virtually every man, to shoot any number of animals and birds at his will. It resulted in systematic killing of some commercially important species of animals and birds; this has been ongoing now for over 100 years and left its consequences, worldwide. Lack of protection, staff, budget and a slack of law enforcing agencies, besides hunting also eventually encouraged the practice of poaching of wild animals. Furthermore, illegal hunting and weak law enforcement add to the major regional conservation issues. Overall, this turned into a culture. Poaching is done using different techniques, and traditional pitfall traps were found to be used in and around Salkhala Game Reserve, Jagran valley and the Pir-Chinasi area (Awan 2009). This overall situation is of concern for the entire mountain ecosystem within the region (Awan et al. 2016). In history, the herds of big game were found roaming around in the wild, but now a wild animal is a very unexpected and rare sight. With a break-down of taboos, and even regimes and their laws, this becomes a more serious issue when the official economy promotes the marginalization of environmental costs and just labels them as ‘externalities’.

7.14 How Many Species Are Gone Extinct in Pakistan, Thus Far?

At least four mammal species are known to have disappeared from Pakistan within the last 400 years: tiger (*Panthera tigris*); swamp deer (*Cervus duvauceli*); lion (*Panthera leo*); and the Indian one-horned rhinoceros (*Rhinoceros unicornis*). Two more species have probably gone extinct in recent decades: cheetah (*Acinonyx jubatus*) and the hangul or Kashmir deer (*Cervus elaphus hanglu*). The blackbuck (*Antelope cervicapra*) has been listed as locally extinct but has now been bred in captivity while the Asiatic wild ass (*Equushemionus*) is believed to be threatened with extinction in Pakistan (Ahmad 1997).

Out of these, the hangul or Kashmir deer was a species of the Azad Jammu and Kashmir Watersheds. It was last time recorded in the late 80s from watersheds of the river Neelum and now no more of them occur in the Azad Jammu and Kashmir Watersheds. Similarly, the killing of many leopards and bears in retaliation also leads those species toward local extinction (author pers. comments). There could be many more species with such a fate and which probably gone extinct before their discovery even. This is alarming and deserves much more attention than ever before in order to help protect many globally important species in the changing watersheds of Azad Jammu and Kashmir.

7.15 Example: Guchhi or Black-Mushroom Harvest

Guchhi or Black mushroom (*Morchella esculenta*), is a product of very high value and an esteemed delicacy in some foreign countries. Therefore, it is collected from different moist temperate forests in Pakistan including the study area for the prime purpose of export. Guchhi grows on the forest floor with the receding of snow in the months of March and April. Women and children, usually in groups of 10–15, also systematically search the forest for wild vegetables for immediate consumption or to dry for winter use, including species of *Dryopteris, Mentha, Phytolacca, Polygonum, Rumex, Plantago, Angelica and Dipsacus*. Collection of the morel mushrooms *Morchella* sp. is also common and widespread in the mountains of north Pakistan due to their high financial value as food and their medicinal value as a treatment for pneumonia (Awan and Buner 2014). It puts a massive pressure onto the resources though! Although this practice directly is not that harmful to the biodiversity as such, indirectly it is a serious threat to the bird fauna and other ground-living species. The practice of Guchhi collection almost coincides with the egg laying and brooding time of ground nesting birds especially, prized pheasant species. The Guchhi collectors either disturb nesting of these birds or take their eggs due the reason yet to be known. This could be just for fun or to be hatched under a domestic brooding hen, at home. It's a certain practice that harms the resource further. This damage -tightly associated with commercial mushroom collection – is in our view one of the main reasons for the actual decline of pheasant population and overall ecosystem destruction in that region.

7.16 Forest Fires in the Azad Jammu and Kashmir Watersheds

There are generally a lot of physical and biological injuries to the forests which can be done by humans, or without them. Some might be natural succession, others are coined as 'stochastic'. But a main risk in the study area is the damage caused by forest fires resulting subsequently in the complete local destruction of the ecological processes, biodiversity and the habitat. Forest fires mostly occur in warmer areas in dry and hot summer months. Forest fires are frequent in Pakistan and about 50,000 ha of forests (1.27% of the total forest area of 3.95 million ha surveyed) are affected annually (Wani 2002). We acknowledge cyclic fire outbreaks but which are not well described and understood yet for the study area.

Forest fires are often ignited by lightning, and when dry conditions are met in forests that accumulated sufficient fuel to actually burn. But by now deliberate or accidental human activity is the main reason behind the break out of forest fires. Forest fires usually break out during the dry and hot summer and autumn months. Local people mostly set fires for mischief or to burn the ground vegetation to improve grazing conditions in spring. Other causes are accidental (unextinguished cigarette ends, camp fire cinders or rifle shots during celebrations). The cross-border fire exchanges along the line of control in Kashmir is the main reason for forest fires in Jammu and Kashmir e.g. the 1998 fire that affected 51,639 ha or 9.1% of the total forest area (Wani 2002).

7.17 Construction of Dams and Hydro Power Projects in the Azad Jammu and Kashmir Watersheds

Demand of electrical power is expected to increase as a result of rapid industrialization, urbanization, and increase in demand for food for an ever-growing population under an economic growth regime (Lutz et al. 2016). Over the last decade, the development of hydropower resources in the study area has actually become a priority for the state government as a result of Pakistan's significant shortfall in energy production, which is estimated to rise to over 8500 MW. This shortfall has resulted in prolonged power cuts and has adversely affected economic growth and development, thereby becoming one of the top challenges facing the political leadership of the country (Annandale et al. 2014). Building 62 dams in a relatively small area will likely affect the interests and livelihoods of many stakeholders (see Appendix). There are currently 12 operational hydropower projects in the state, and additional 13 are under construction while 37 more sites have been identified for detailed feasibility studies on different rivers of the Azad Jammu and Kashmir Watersheds. In the late eighties, the Water and Power Development Authority (WAPDA) conducted comprehensive hydel potential reports on the three main rivers of the stud area, namely the rivers Jhelum, Poonch and Neelum. Various sites with an estimated total capacity of about 4635 MW have been identified in those watersheds and have been included in WAPDA's Vision 2025 program. (Fig. 7.4, Hagler Bailly 2014, Appendix).

Impacts from smaller HPPs, less than 200 MW in size, should not be underestimated. Although they may only be responsible for 13% of the total installed capacity of the Plan, there are 52 of those ones in total. Individually these may be considered to have little environmental and social impacts. But a number of them concentrated on the same river systems within a limited geographical spread, however, result in greater environmental and social impacts (Annandale et al. 2014). It contributes to the 'death by 1000 cuts.'

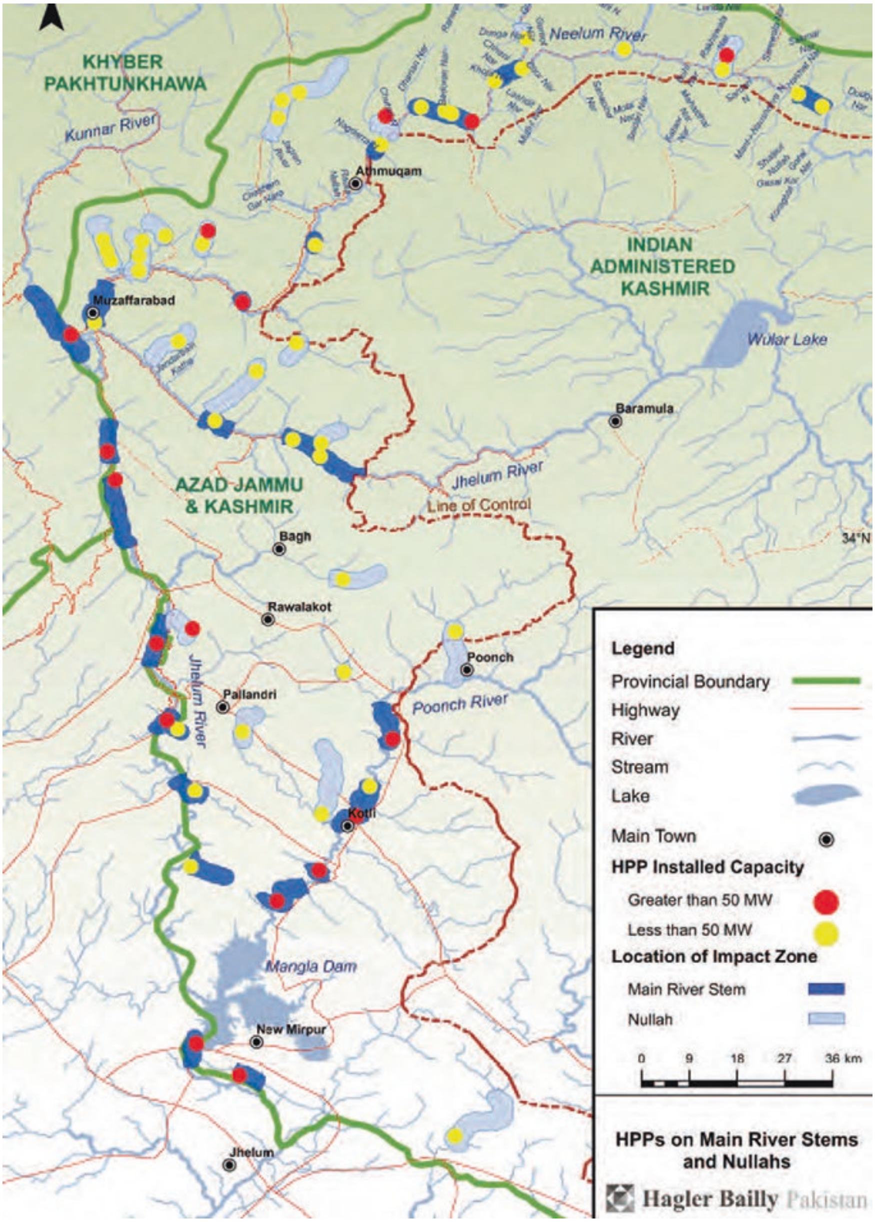

Fig. 7.4 Map showing different hydro power plants (HPPs) in the Azad Jammu and Kashmir watersheds. (Source: Hagler Bailly 2014)

Site clearance and construction of project infrastructure such as power houses, weirs, inlet and outlet of power tunnels result in immediate and direct modification of land. It means a potential loss of terrestrial habitat and vegetation cleared and the associated floral and faunal species are lost during the dam construction (Hagler Balley 2014). The area flooded by the reservoir is a strong proxy variable for many environmental and social impacts described to occur throughout the world too. A large reservoir surface area means that there will be loss of more natural habitat and wildlife and displacement of more people. Very big reservoirs are found usually in lowlands with resultant problems such as tropical diseases, aquatic weeds and algae blooms. They also usually impound large rivers putting many aquatic and fish species at risk (Annandale et al. 2014) (Table 7.1).

Table 7.1 Potential cumulative impacts on different environmental and social sectors from the AJK Hydropower Development Plan

Cumulative impact sectors	Cumulative impacts in AJK
Wildlife and its habitats	The distribution and abundance of riverine species in AJK will be effected by the effects of flow regulation.
	Three kinds of adverse impacts on aquatic biodiversity are expected because of changes in the natural flow due to HPPs in AJK: (a) stagnated water in the submersible zones of HPPs which are not conducive for torrent hill stream/river fishes such as snow trout and Himalayan loaches, (b) less or no water flow in the dry zones of HPPs which is also expected to adversely affect aquatic biodiversity but it may be mitigated by maintaining minimum environment flow and (c) changes in the natural flow may also fail to provide the natural environmental cues to the aquatic biodiversity to breed or maintain annual life histories, but this can again be mitigated by following minimum environmental flows even though it would help partially to maintain the current status of aquatic ecosystem and its biodiversity
	Dam or any construction across rivers in AJK will be barriers for fish which move from one part of stream/river to another as part of their life cycle processes. These structures are always detrimental to the survival of fish especially on migrants which use different habitats for different life history requirements.
	Changes in flow volume and patterns can adversely impact the structure, distribution and composition of fish communities in AJK rivers. Therefore, significant areas of the fish habitat may either be modified or lost due to proposed hydro projects in the basin.
	Migratory fish species such as the Mahseer migrate from the main river to smaller streams for spawning, or downstream of river to upstream for the same. Any obstacle such as a dam/barrage across rivers will break this normal migratory behavior which would ultimately affect the breeding cycle In AJK, the terrestrial habitat loss is in the form of forest land taken for the HPP infrastructure and areas submerged under water by reservoirs.

(continued)

Table 7.1 (continued)

Cumulative impact sectors	Cumulative impacts in AJK
Water	This may result in no flow downstream of power house for an entire day or more.
	Or, on the other hand, sudden releases of huge quantity of water in other times.
	This may result in injuries, accidents and fatalities of people and cattle and destruction of property in downstream areas.
Sedimentation	Changes in the sedimentation flows due to dam/barrier construction, especially in Himalayan rivers, are expected to have an adverse impact on fish habitat.
	Some fish species in AJK rivers prefer substratum that are pebble, cobble, boulders, gravel, sand and occasionally loamy soil. These substrata are considered to be ideal grounds for foraging and spawning of Snow trout and many more Himalayan fishes.
	Dam construction and diversion weirs would change the sedimentation flow.
	Even a few centimeters of sediment layer over the natural substrata is enough to effect the foraging and spawning fish negatively.
Ways of life territorial organization land use protected areas economics	Natural ecosystems (including riverine ecosystems) and their biological components provide a range of services that are of substantial ecological, economic and cultural value to society. The changes in the riverine ecosystem due to impairment of its provisioning, regulating, cultural and supporting functions that are linked to the construction of HPPs often lead to substantial economic and social impacts.
	People living in AJK depend on the agriculture that provides major support to the population and with the rise in population; individual landholdings significantly shrink over the years. In addition to the expansion of urban areas and road building activities, HPPs may further marginalize individual landholdings in AJK possibly contributing to the hardship of the local population.
	Apart from providing life's basic needs, changes in river flows influence livelihoods, income, and local migration, which in turn may sometimes lead to unrest and even political conflicts.
	The consequent impacts on economy and physical security, freedom, choice and social relations have wide–ranging impacts on well–being and health.

Derived from Annandale et al. (2014)

7.18 Generic and Wide Lack of Capacity in Climate Changes Mitigation and Adaptation

The glaciers of the Hindu Kush-Himalaya region are nature's renewable storehouse of fresh water that benefits hundreds of millions of people downstream, if properly used. However, glaciers in the region are retreating in the face of accelerated global warming, and the resultant long-term loss of natural fresh water storage

(Samjwal et al. 2006). Climate change is already affecting temperature, precipitation pattern, sea levels, frequency of extreme events, and phenology, but it also shows more subtle and indirect impacts like desynchronization and spatial uncoupling of ecological interactions (Bellard et al. 2012). They easily result in changing species distributions and abundances in individual sites. Climate change also affects availability of resources (e.g., water) and ecosystem services (e.g., crop production). Local management is also challenged by an increasing number of adaptation activities in other sectors (e.g., flood protection and water management), and above all this there further is a strong interaction with changes in land use (e.g., for biomass production). Structured and standardized long-term monitoring can provide reliable evidence of these changes in ecosystems (Kuussaari et al. 2009). It can also help us to understand the effects of different drivers of change. Monitoring is an essential element of adaptation to climate change (Rannow et al. 2014).

Forecasts can easily be found stating that up to a quarter of the global mountain glacier mass could disappear by 2050 and up to half could be lost by 2100. Climate change is causing the net shrinkage and retreat of glaciers and the increase in size and number of glacial lakes and thereby the frequency of GLOFs in recent years. These changes in climate will have effects ultimately on life and property of mountain people (Kuhn 1993; Oerlemans 1994; IPCC 1996 and updates).

7.19 Conservation Challenges and Opportunities for the the Azad Jammu and Kashmir Watersheds

Conservation professionals fear that Pakistan is experiencing the world's second highest rate of deforestation. This destruction is leading to the wholesale disappearance of trees, shrubs, and ground flora, together with the vertebrate and invertebrate fauna they normally support. The loss of forest habitat has had already a severe impact on Pakistan's biodiversity, and it has serious implications for the nation's natural and agro-ecosystems (Karen and Hamid 2012). Under the current situation when the region is losing its biodiversity at high pace an urgent action is indeed to help protect the biodiversity. Implementation of the available policies is the requirement of the time whereas development of new policies to help mitigate the new threats like climate change must be started at the earliest too.

Fact is that in this part of Hind Kush-Himalaya, the human population is growing at a fast rate and demanding for land for housing and other infrastructure development. This unsustainable development is leading to biodiversity loss. Growth is not the only route to livelihoods security, and other aspects related to distribution of assets (for example land), vulnerability and human development are proving equally important by now (Hobley 1987; Sneddon 2002). Adaptation of sustainable development policies could help to reduce habitat loss and consequently species extinction.

Inside the existing protected areas, movement of the local communities and their livestock must be prohibited together with the collection of eggs and mushrooms and virtually all logging. Outside the protected areas, alternative livelihoods must be provided, illegal logging must be eradicated and commercial logging should be based on ecological as well as economic considerations (Awan and Buner 2014). Development of a management plan for all 'paper parks' is very important to help manage the pressures on the natural resources of the state. This could actually be one of the best opportunities to protect biodiversity of the area through proper management of these parks which will help to protect at least 20% of the land from further degradation. The national forest policy (Govt. 2015) has emphasized the establishment of a system of inter linked Protected Areas through biological corridors which could be proved as best opportunity to help rehabilitate the fragmented ecosystem if the policy is implemented effectively.

Analyzing the forest policies of Pakistan it is found that most of the policy initiatives, until recently, were aimed at forest conservation and ignored the livelihood provisions for local communities. However, even the conservation aspect of those policies was never implemented effectively. People's participation in plantation and management of forests was not given sufficient attention and social and cultural aspects of forest management were essentially ignored (Shahbaz et al. 2006). All policies are needed to be revised. Adding priorities for biodiversity conservation may help to protect the important biodiversity of the Hind Kush-Himalayan landscapes and their watersheds.

The construction of 62 dams in a relatively small area where downriver waters are under threat like climate change and dying watershed system is of great concern both for the sustainability of the biodiversity resources and local livelihoods. In a country like Pakistan, where deforestation rate in estimated at 0.2–0.5% annually, is the highest in the world, which accounts for a 4–6% decline in its wood biomass per annum (Wani 2002), forests should be regarded as one component of an integrated approach to watershed management that includes land-use and management practices (FAO and CIFOR 2005). Under such threatening scenario, we will not only loose our important biodiversity but also water for our hydropower project as "there will be no water downriver, and subsequently no livelihoods, no biodiversity and no hydropower". In order to sustain all these resources we need to think for an integrated approach and the government needs to follow such an approach to help sustain local's livelihood and important biodiversity of this fragile watershed system of Azad Jammu and Kashmir.

Appendix: List of Hydropower Projects in the Azad Jammu and Kashmir Watersheds in Various Stages of Development and Under Different Agency Jurisdictions

Number	Name	Power	Agency	Status
1.	Patikka	0.05	HEB	Operational
2.	Changan	0.05	HEB	Operational
3.	Kel	0.4	HEB	Operational
4.	Kathai	1.6	HEB	Operational
5.	Leepa	1.6	HEB	Operational
6.	Kundal Shahi	2	HEB	Operational
7.	Sharian	3.2	HEB	Operational
8.	Jagran – I	30.4	HEB	Operational
9.	New Bong Escape	84	PPC	Operational
10.	Jari	1	PPC	Operational
11.	Chinari	0.2	PPC	Operational
12.	Mangla	1000	WAPDA	Operational
13.	Halmat	0.32	HEB	Under construction
14.	Hillan	0.6	HEB	Under construction
15.	Dhanna	1.5	HEB	Under construction
16.	Hajira	3	HEB	Under construction
17.	Sharda	3	HEB	Under construction
18.	Rerah	3.2	HEB	Under construction
19.	Battar	4.8	HEB	Under construction
20.	Chamfall	6.4	HEB	Under construction
21.	Jhing – I	14.4	HEB	Under construction
22.	Jagran- II	43.5	HEB	Under construction
23.	Patrind	147	PPIB	Under construction
24.	Kohala	1100	WAPDA	Under construction
25.	Neelum-Jhelum	969	WAPDA	Under construction
26.	Naghdar	39	HEB	Planning or feasibility stage
27.	Doarian	46	HEB	Planning or feasibility stage
28.	Shontar	52	HEB	Planning or feasibility stage
29.	Luat	63	HEB	Planning or feasibility stage
30.	Jari II	2.5	PPC	Planning or feasibility stage
31.	Dakhari	2.2	PPC	Planning or feasibility stage
32.	Kathai – III	1	PPC	Planning or feasibility stage
33.	Hotreri	5.4	PPC	Planning or feasibility stage
34.	Jhing – II	4	PPC	Planning or feasibility stage
35.	Riali – III	3.7	PPC	Planning or feasibility stage
36.	Riali-II	4.9	PPC	Planning or feasibility stage
37.	Riali-I	1.6	PPC	Planning or feasibility stage
38.	Ashkot	40	PPC	Planning or feasibility stage

(continued)

Number	Name	Power	Agency	Status
39.	Jagran-III	35	PPC	Planning or feasibility stage
40.	Khoja Seri	2	PPC	Planning or feasibility stage
41.	Kundian	48	PPC	Planning or feasibility stage
42.	Madar Batdara	10.2	PPC	Planning or feasibility stage
43.	Samani	1.6	PPC	Planning or feasibility stage
44.	Sarhota	1	PPC	Planning or feasibility stage
45.	Sarswah	0.7	PPC	Planning or feasibility stage
46.	Pothi	1	PPC	Planning or feasibility stage
47.	Barar	1	PPC	Planning or feasibility stage
48.	Gumot Nar	40	PPC	Planning or feasibility stage
49.	Rajdhani	132	PPIB	Planning or feasibility stage
50.	Gulpur	100	PPIB	Planning or feasibility stage
51.	Kotli	100	PPIB	Planning or feasibility stage
52.	Karote	720	PPIB	Planning or feasibility stage
53.	Azad Pattan	222	PPIB	Planning or feasibility stage
54.	Kohala	1100	PPIB	Planning or feasibility stage
55.	Changan-II	9	PPIB	Planning or feasibility stage
56.	Taobat	10	PPIB	Planning or feasibility stage
57.	Janawahi	12	PPIB	Planning or feasibility stage
58.	Mahl	511	PPIB	Planning or feasibility stage
59.	Harighel	53	PPIB	Planning or feasibility stage
60.	Abbasian	360	PPIB	Planning or feasibility stage
61.	Kundal Shahi – II	600	WAPDA	Planning or feasibility stage
62.	Dudhnial	960	WAPDA	Planning or feasibility stage

Sources: Annandale et al. (2014)

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Chapter 8
Towards a Landscape Perspective of Diseases in Plants: An Overview and Review of a Critical but Overlooked Ecology Issue in the Hindu Kush-Himalayan Region

Sandhya Neupane and Tirth Raj Ghimire

8.1 Introduction

A disease is a disorder of structure or function in a human, animal, or plant, especially one that produces specific symptom or that affects a specific location and is not simply a direct result of physical injury (Oxford Dictionary, Oxford University Press). The term Plant Disease has been referred to the physiological disorder for structural abnormality that is harmful to the plant or any of its part or product that reduces the economic value (Charles et al. 2018). To produce a disease, there must be three components like host, pathogen, and environment. In this context, the pathogen represents viruses, viroids, virus-like organisms, bacteria, fungi, protozoa, nematodes, and arthropods. The pathogens must be host-specific and virulent, the host must be susceptible, and the conductive environment like temperature, moisture, nutrition, available of gases, and others must be favorable to pathogens in order to get successfully multiplied, established, and transmitted. These pathogens are transmitted by various means, principally the air, water, insects, birds, and other animals that can sustain or accept the pathogen and pathogenic nature in the environment. These means or modes of transmission of pathogens in various plants resulting in different diseases have been expressed in Table 8.1.

S. Neupane
Ministry of Agriculture and Livestock Development, Singhadarbar, Kathmandu, Nepal

T. R. Ghimire (✉)
Animal Research Laboratory, Faculty of Science, Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur, Nepal
e-mail: tirth.ghimire@nast.gov.np

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Table 8.1 Different means of dissemination of pathogens and or diseases in various plants (Taylor 1972; Card et al. 2007; Anonymous 2017)

Dissemination by	Diseases (with their pathogens or means of transmission)
Air currents	Potato Blight (*Phytophthora infestans*), rust (*Puccinia* spp.), and Downy mildew of cucurbits (*Pseudoperonospora cubensis*).
Angiospermic plant	Pea mottle virus (*Cuscuta campestris).*
Animals other than insects	Nematodes, snails, birds, and wild and domestic animals (many plant viruses including *Nepovirus* and *Tobravirus*).
Exporting and importing of commodities	Tomato leafminer infection (*Tuta absoluta).*
Field operations and implements	Tobacco mosaic (*Tobacco mosaic virus*).
Insects (bees, flies, beetles, butterflies, moths, and wasps)	Bacterial soft rot (*Erwinia carotovora* transmitted by seedcorn maggot), Bacterial wilt of cucurbits (*Erwinia trachiphila* transmitted by stroped cucumber beetle), and Bacterial wilt of corn (*Pantoea stewartii* by toothed flea beetle).
Manure	Damping-off of seedling (*Pythium* spp., *Rhizoctonia* spp.).
Pollen grains	Head blight of rapeseed (*Sclerotinia sclerotiorum*), wilt in alfalfa (*Clavibacter michiganense insidiosum*), potato and tomato ringspot (*Nepovirus*), and Soyabean mosaic (*Potyvirus*).
Propagating stock	Mosaic disease of sugarcane and Citrus greening disease.
Seed	False smut of rice (*Ustilaginoidea virens*) and pearl millet ergot (*Claviceps fusiformis*).
Shooting out of spores	Peach leaf curl (*Taphrina deformans*).
Soil	Club root disease of crucifer (*Plasmodiophora brassicae*).
Water	Potato wart (*Synchytrium endobioticum*), citrus canker (*Xanthomonas axonopodis*), and red rot of sugarcane (*Colletotricum falcatum*).

8.2 Landscape Concept of Plant Diseases

Landscape epidemiology deals with the factors that regulate the spatio-temporal spread of diseases in order to design the host protection strategy and to design a management strategy of landscape structures. Although this concept was already popular in the medieval periods (Galuzo 1975), the term was actually coined by a Russian parasitologist in the 1960s (Kartman 1967). The concept of landscape ecology and disease appearance in animals have been popular and established among veterinary and public health workers, for example, Lyme disease (Brownstein et al. 2005) and malaria (Sallares 2006) in humans, and sylvatic plague in prairie dogs (Collinge et al. 2005). However, that one in plants is still in the initial phase, yet popular in forest pathology (Holdenrieder et al. 2004). A model for landscape epidemiologic analysis of disease transmission accompanied with various properties has been well illustrated (Ziegler 2016). These landscape properties also play a critical role in disease dynamics by favoring a large gene flow facilitating the spread of a virulent strain and a high pathogen genetic diversity resulting in a high probability of the appearance of a virulent strain (Plantegenest et al. 2007). The landscape properties involve topography, watersheds, moisture, temperature, human activities like site selection, preparation of fields, selection of propagative materials, and cultural practices involving monoculture, polycropping, crop rotation, accidental effects by herbicide application, level of sanitation, level of fertilizers, use of resistant varieties, and control measure activity, dispersal of pathogens, presence of alternative, transmitting, cultivated, or wild host, and host density as crucial to plant diseases (Zhu et al. 2000; Mitchell et al. 2002; Agrios 2005; Otten and Gilligan 2006; Condeso and Meentemeyer 2007; Jeger 2009; Ziegler 2016). These factors have been grouped mainly in four types of landscapes as physical, biological, cultural, and political. Those are to determine and fulfill the outbreaks and existence of disease in plants (Fig. 8.1). The physical landscape includes water sources like river, lake, pond, and glacier, and flooded and stagnant water, topographical features like lowlands that are a part of the vast Eastern Gangetic Plains in South Asia and hills and mountains that are continuum of the Himalayas, and valleys. In addition, it includes climatic factors like moisture, solar radiations, temperature, rain, wind, and humidity, land use and buildings. The biological landscape includes humans, animals, pathogens, and vegetation. Importantly, the cultural landscape includes site selection, selection of varieties, cultural practices like tillage, aeration, and application of mulch and fertilizers, and cropping methods like monocropping, polycropping, level of sanitation, and crop rotation. It possesses cultural properties that represent the combined works of nature and of man (WHC 2012). This type of landscape is said to be the organically evolved (past and continuing), to exist before major human-induced changes, to be designed and created intentionally by human, and is justifiable by virtue of religious, artistic, or cultural associations of the natural element (WHC 2012). The political landscape comprises health rights, insurance, sufficient funds, promotion, and awareness to the farmers and carriers of the plant diseases, as well as the role of small-and large-scale farmers and businesses and local communities in disseminating knowledge to others. It also includes how they control and guide the governance, existence, and change in the future in order to understand the consequences of host, pathogen, and environmental relations and to generate sustainable development. Thus, the landscape regarding agriculture or

Fig. 8.1 Powdery mildew in tomato

cropping is a dynamic and complex topic in nature because landscape influences disease dynamics through its structure as well as its own dynamics (Plantegenest et al. 2007; Ziegler 2016). Therefore, the landscape of the plant disease should be utilized to understand not only the disease mechanisms but also the management practices for wider public health issues. This is particularly true of some critical plant diseases that are crucial to humans as well as animals because they can destroy plants on which these primary consumers directly depend on plant products for food, medicine, clothes, and habitat. It has been highlighted that due to unfavorable climatic conditions, outbreaks of several diseases are the underlying causes of large-scale destruction in a very short period of time over a large cultivated areas and disappearance of certain varieties of crops (Chamy 2014). In addition, few diseases and their pathogens are so severe that they can even lead to a vast endangerment process in the plants. For example, the cactus moth (*Cactoblastis cactorum*) can be threat to a high diversity of both native and cultivated prickly pear cactus (*Opuntia* spp.) throughout the world (IAEA 2002). Similarly, Davies' waxflower (*Phebalium daviesii*) has been reported to result in the critically endangered plant in Australia by root rot fungus and other factors. Another issue is that few fungal species like *F. moniliforme, F. oxysporum* (Ortoneda et al. 2004) and *Aspergillus flavus* (St. Leger et al. 2000) are common aggressive etiologic agents that cause the infections in humans, animals, and plants. It is very important and helpful here to understand the Global One Health Concept in which health of plants, animals, and humans are considered and dealt with at a landscape level. Thus, it seems that the types and characteristic features of a plant disease, for example, the etiology, effects, distribution, and its epidemiology critically govern the health status of both human and animals. Essentially, the types and quantity of losses/effects caused by plant diseases depend on the plant or plant product, the pathogen, the locality, the environment, the control measure practiced and the summation of these factors (Agrios 2005). Understanding the landscape of disease in plants in the Himalayan nations is crucial, particularly because of the rich floral diversity and endangered and threatened flora due to many diseases. One of the principal Himalayan nations is Nepal where 282 species of flowering endemic plants, 248 non-flowering endemic plants, 701 medicinal plants, 16 protected plants, and 60 threatened medicinal plants are recorded (DPR 2012). The distribution of endemic species out of total flowering plant species is as follows:

in the tropical zone (0–100 m) (29 out of total 1500 endemic species)
in the subtropical zone (1000–2000 m) (50 out of 2028 endemic species)
in the temperate zone (2000–3000 m) (113 out of 2000 endemic species)
in the sub-alpine (3000–4000 m) (180 out of 1650 endemic species), and
in the alpine and Nival zone (>4000 m) (190 out of 1075 endemic species)

This indicates the vigorous richness of floral species all over the country (DPR 2012). However, a study explaining how these floral diversities are influenced by the landscapes of diseases have not been dealt with in the context of this small land-locked Himalayan nation. In order to deal with these aspects focusing on the incidence, distribution, and environment for a pathogenic agent and associated disease of plants at a landscape level all over the Nepal Himalaya (NH), we have used the primary data obtained from our field surveys (Boxes 8.1 and 8.2) and the secondary data like journals, books, theses, newspapers, and Online databases (Figs. 8.2, 8.3, 8.4 and 8.5).

Box 8.1: Field Experiences on Landscape of Citrus Diseases

Citrus decline is a complex problem but is not a specific disease of citrus tree which usually do not die and remain unproductive for several years. Agro-climatic conditions like sandy loam soil with poor organic matter of the mid-hills are often favorable for citrus. To evaluate and understand the citrus decline in some hilly districts of Nepal, the field survey was made. The fields were selected in Banskharka, Parbat (28° 22′ 57.5508″ N83° 36′ 5.1804″ E), Histan, Myagdi (28° 25′ 34.6476″ N83° 37′ 22.3356″ E), Sigana, Baglung (28° 14′ 59.4888″ N83° 33′ 8.352″ E), Chiti, Lamjung (28° 12′ 14.4144″ N84° 25′ 58.8756″ E). Evidences of citrus decline due to insect pests, diseases, poor cultural practices were collected during the field visit:

- Many insect pests like *Citrus psylla*, aphid, citrus leaf miner, and green stink bug have been observed in the country.
- Other evidences we found were those of foot rot, root rot, crown rot, gummosis, leaf fall, and brown rot diseases in citrus caused by *Phytophthora* species, greening disease by *Candidatus asiaticus* Liberibacter, and viral infections in limes by Citrus Trestiza Virus (CTV).
- Not only diseases, but also the lack of management practices and poor orchard growth is cultural factors. For example, practices of inter-crop involving unsuitable crops like maize, millet, potato, and mustard without extra manures, irrigation and planting trees on the edges of the beach terraces lead to malnutrition and moisture stress on citrus.
- Due to the use of raw wood, growth of fungus is possible in the store. Some areas like Chiti (Lamjung) used to grow citrus as a major crop few years ago, however, due to the attack of pest and diseases in old trees and high price of other short-term crops like tomatoes, cardamom, and other vegetables led the farmers to grow them.
- Few farmers had a lack of awareness about improved grafting techniques and safe and scientific nursery management system.
- Although Mandarin is a native citrus of the Nepal Himalaya, it is traditionally grown throughout the country. So are the cases of other citrus varieties. Farmers do not care and labor in enhancing the qualitative and quantitative production of citrus.

Box 8.2: Field Experiences on the Geographic Landscape of Major Diseases in Nepal

1. Lalbandi, Sarlahi (150 masL)
   - Fruit fly
   - Aphids
   - Yellow Rusts
   - Powdery mildew in tomato
   - Shoot-borer infestation in brinjal
   - Tomato Leaf Roll Virus infection
   - Cowpea mosaic virus.
2. Bharatpur, Chitwan (200 masL)
   - Aphids
   - Fruit fly
   - Clubroot of crucifers
   - Fruit worm of lychee
   - Late Blight of potato
   - Lychee mite infestation
   - Rusts in maize
3. Bardibas, Mahottari (220 masL)
   - Aphid
   - Fruit fly
4. Hetauda, Makwanpur (450 masL)
   - Fruit fly
   - Aphids
5. Purkot, Tanahu (590 masL)
   - Brown spot, blast, and blight in upland rice during tillering stage
6. Dhankuta (800 masL)
   - Mangostone weevil infestation
   - Clubroot of cauliflowers
7. Kharpa, Khotang (1000 masL)
   - Aphid infestation in crucifers
   - Fruit fly infestation in pomegranates
   - Mangostone weevil infestation
   - Rice weevil in maize and rice
8. Sundarbazaar, Lamjung (1150 masL)

(continued)

Box 8.2 (continued)

- Blast and blight in rainfed transplanted lowland rice
- Greening in citrus
- Rusts in maize

9. Kathmandu valleys (Kathmandu, Bhaktapur, Lalitpur) (1300–1400 masL)

- *Tuta absoluta* infestation in tomatoes
- Common rusts in wheat/maize/rice
- Yellow aphid of Avocado
- Late blight of tomato
- Bacterial wilt of tomato
- Damping off of tomato, cabbage, and cauliflower
- Club root of cauliflower, cabbage
- Black rot of cauliflower, cabbage
- Downy mildew, powdery mildew, and mosaic of cucumber
- Phytophthora blight of pumpkin
- Downy mildew and powdery mildew of pumpkin

10. Dhunche, Rasuwa (2050 masL)

- *Tuta absoluta* infestation in tomatoes
- Common rusts in wheat/maize/rice

11. Beni, Solukhumbu (3282 masL)

- Wooly Apple Aphid
- Tent Caterpillar on apple
- Collar Rot of apple by *Phytopthora* and *Fusarium* spp.

Fig. 8.2 *Tuta absoluta* infestation in tomato

Fig. 8.3 Shoot-borer infestation in brinjal

Fig. 8.4 Tomato Leaf Roll Virus infection

Fig. 8.5 Cowpea mosaic virus

8.3 The Impact of Landscape Properties on Viral Diseases

Viral diseases are predominant in the flora of the NH (Appendix). Among them, *Citrus Tristeza* Viral Disease (CTVD) is globally distributed in the citrus-growing areas of Africa, America, Europe, Oceania, and Asia including in the Himalayan regions like China, India, Nepal, and Pakistan (Jeger et al. 2017) although the viral isolates are genetically different with respect to geography (Roy and Brlansky 2004; Biswas 2010). The disease is disseminated to a large landscape by the transport of infected planting or propagating materials or to short landscape by aphids like *Toxoptera citricida* especially in a semi-persistent manner which has been evidenced to be widespread in the Himalayas including India and Nepal (Knorr and Moin-Shah 1971; Lama 1993; Yokomi 2009; Kishore et al. 2010; Dawson et al. 2013). These aphids are viviparous and develop into winged-forms. They seat mostly on young leaves, however, they leave colony after maturation and can travel up to 30 km geography (Jackson 2017) suggesting their critical role in CTVD dissemination. But, the wingless forms are usually large in numbers and occupy mostly on old and less nutritious leaves indicating their role in sustained viral infections (Jackson 2017). Importantly, the decline of different varieties of sweet orange trees in Kathmandu (Roistacher 1996) might be probably due to the favorable temperatures of the valley (DoA 2011) either for the growth of viruses or the aphids. Since first recorded in 1971, it has been evidenced that CTVD has been an underlying cause of acid lime decline all over the country (Lama 1993; Moreno et al. 2008; Regmi et al. 1999). The huge loss of various citrus fruits is associated with the cultural landscapes like poor orchard management, selection of low quality plant materials, unfavorable soil and climatic conditions (drought, and hailstones) (DoA 2011) and other landscape features that remain to explain (Figs. 8.6 and 8.7).

Fig. 8.6 Yellow aphid infestation in avocado leaf with other parasites

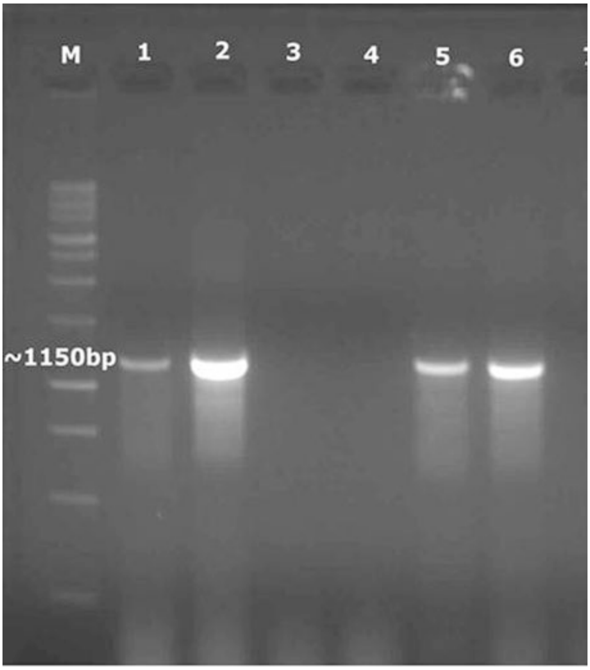

Fig. 8.7 Agarose gel electrophoresis of 16s rDNA PCR product with primers sets OI1, OA1, 012Cs. A PCR amplicon of ~1150 was seen in diseased samples. M:-DNA Marker.1,2,5,6: HLB samples; 3,4: HLB negative samples. (Photo kindly provided by Dr. Jyoti Maharjan, Molecular Biotechnology Unit, Faculty of Science, NAST)

8.4 The Impact of Landscape Properties on Fungal Diseases

Fungal diseases (FDs) are critically found in the flora of all over the Himalayan nations including Nepal, India, Bhutan, and others. They are caused by fungi which produce spores on the surface of the aerial parts from which they are disseminated by air breezes or strong winds over a range of spatial pattern leading most frequent and widespread epidemics. For example, fungi causing rusts, leaf spots, and mildews, spread from a few centimeters up to several kilometers. In these contexts, common rust or 'polio of agriculture' generally found in maize of subtropical climates in Bhutan, South China, and northern India (Subedi 2015), clearly shows a altitude biasness because it is critical in the hilly region, valleys, and mountains especially in the summer season and less important in the terai and inner terai of the country (Subedi 2015), although it can attack the winter and spring maize in the country (Kushalappa and Hegde 1970; Sharma et al. 1982). Rusts in wheat are disseminated long distances via air and rain-scrubbing, human, infected plant materials or in a step-by-step manner (Schumann and Leonard 2000; Singh et al. 2008). It should be noted that when hosts are absent, for example in temperate regions during the winter or summer, their spores can overwinter or oversummer and can colonize during favorable environmental conditions (Singh et al. 2008). Importantly, the stages of spore development can take place between wheat, a primary host and *Berberis*, an alternative host (Ali et al. 2014). Leaf rust is widespread and can oversummer on self-sown wheat in hills of Nepal (Mahto et al. 2015). Yellow or stripe rust is also a major disease in mid and lower hills, river basin, and valleys mainly at 600–1500 masL (Mahto et al. 2015). This is principally due to the high humidity caused by heavy dew in the winter months and cool temperatures during spring season creating conductive environment (Saari 1996). In addition, cultural landscapes involving the selection of cultivars may determine the severity of the yellow rust (Sharma et al. 2015b). Stem rust of wheat is a minor and sporadic disease in central, western, mid-western region late in the season (Mahto et al. 2015). Previous experiences show that Nepal served as a focal point of wheat rusts for further spread in the Gangetic plains of India due to presence of more than 25 species of *Berberis* in hills of Nepal (Mahto et al. 2015).

Another disease called the stem rust of the three-needled pine *Pinus roxburghii* has been recorded in the pine of the west-facing dry landscape at 2070 masL in the Rasuwa district in north central region of the country (Cotter et al. 1987). Although the etiologic fungus has been reported from northwest India, Pakistan, the Philippines, and Tibet, there are reports of a massive mortality of young *P. roxburghii* in India due to this fungus (Bakshi and Singh 1972). The dissemination is purely wind-borne and spermogonia and aecia from *Pinus canariensis* and *P. roxburghii* from the Himalayan region (Bakshi and Singh 1972) indicating its association with biological and physical landscapes along the Himalayan regions.

A leaf spot disease called brown spot needle disease, endemic to Himalayan region, of indigenous pine trees like *Pinus roxburghii, P. wallichiana*, and other several exotic species has been reported to cause most damage to nursery plants at the landscape of 400–2000 masL in the NH (Ivory 1990). Dissemination via infected seedlings or conidia of the fungus produced in sticky masses from conidial stromata. The conidia are carried by the wind or drops or splashes of rain during spring on diseased needles especially at high altitude are possible. Disease development starts at foliage on older parts and then, spreads to younger foliage. Another similar disease called dothistroma (red-band) needle blight on *P. wallichiana* at 2000 masL of this country (Ivory 1990) and now currently increasing in the northern hemisphere. In addition to the modes of transport of brown spot, it can be disseminated long range via the transport of contaminated plant tissue and by wind/cloud dispersal of spores in air currents (Bradshaw 2004). Other factors like humidity, temperature, and light and selection of various *Pinus* species are the climatic and cultural landscapes (Bradshaw 2004). As it is confused with brown needle disease during detection especially by landscape biologists, an expert laboratory confirmation of *Mycosphaelella gibsonii* should be required. Because the etiologic agent produces dothistromin, a toxin that acts as carcinogen, the forest workers are in risk groups of toxicity from the disease (Bradshaw 2004).

Notably, late blight disease of potatoes and tomatoes is critical in some high altitudinal areas like Kathmandu and Kavre where they are grown twice a year, in autumn and spring. It is particularly important for the remote and deprived people of hilly areas where they solitarily use potatoes for daily food. After 1883 and 1897 detection reports, several epidemics are observed at high hills, whereas sporadic cases are found in the low altitudinal landscapes of the NH (Shrestha et al. 1998) is particularly because of the wind-borne resistant oospores that survives for several years (Turkensteen et al. 2000) and revives at high humidity and temperature about 20 °C (Crosier 1934; Turkensteen et al. 2000). After the first identification of northern corn leaf blight in Nepal in 1964 (Khadka and Shah 1967), this disease has been widely reported throughout the country (NMRP 2013) although it is predominant in the cool and humid conditions of the foothills (Subedi 2015). Another leaf blight called the southern corn leaf blight is most common at the time of tasseling in the Terai region although it has been reported in some pockets of the mountains, the valleys, midhills, and inner terai especially in summer and winter maize since many years (Paudel and Koirala 1995). The spread and survival of the disease depends on the amount of rainfall, relative humidity, and temperature (Sumner and Littrell 1974), thus, a high humidity level and warm temperature (68–90 °F) is optimum for the fungi (DoCS 1997) suggesting both of these blights are regulated principally by physical landscapes in the NH.

Head smut and common smut of maize are sporadic diseases in Nepal and are highly prevalent with cases of epidemics in hilly regions including the Kathmandu valley (Pradhanang and Ghimire 1996; Ghimire and Harding 1997; PPD 2000; Subedi 2015). Similarly, *Leptosphaeria* leaf blight in maize is the major problem in hills and high hills and the minor issue in the terai and inner terai. Banded leaf and sheath blight in maize are critical problems in terai and inner terai and is less reported in hilly regions (Subedi 2015) indicating the predilection of cultural and physical landscapes in determining the distribution of blights. The disease is distributed in the inner terai landscape of the country and is probably associated with the cultural and climatic landscapes. The fungus survives for several years in the soil especially in high crop densities, humid conditions, increased temperature to 20 °C, frequent rainfall, irrigated fields, and a reduction of drainage of the soil followed by soil compaction. In addition, cultural landscape practices involving crop rotations and tillage have a very little effect on disease. Although the fungus does not produce asexual spores, and thus, it is not transmitted by insect vectors, infected plants are the main sources. However, sclerotia of this fungus can travel by means of wind, water, or soil movement between host plants which are possible in the summer and rainy seasons in the terai landscapes.

Since the first report of gray leaf spot in the Kavre district (Manandhar 2007), it has been recorded from other 22 districts in the eastern, central, and mid-western regions with its severity in the high hill regions depending on the maize varieties (Manandhar et al. 2009; Manandhar and Baidya 2010; Acharya et al. 2016). It has been reported to disseminate at a rate of 80–120 km per annum (Rijal et al. 2015). Similar diseases called brown (early) lesion leaf spot and black (late) lesion leaf spot in groundnut are also critical during rainy seasons at terai and mid-hill in Nepal (Thakur et al. 2013) because the pathogens probably love hot and wet conditions (Shew et al. 1988). Abundant rainfall with high mean temperature also favor the brown leaf spot of maize mainly in inner terai and hills, however, widely distributed throughout the NH (Subedi 2015) indicating its relation to climatic landscapes.

Spot blotch is widely distributed throughout the wheat growing countries including in terai and shows a true landscape of several factors such as geography, year, varieties and modes of transmission. Its etiologic agent is normally transmitted via infected seeds, crop residues, volunteer plants, secondary hosts, and free dormant conidia in the soil (Reis 1990). They lead to epidemics when there are high spore concentration, longer relative humidity, and higher temperature (Duveiller and Dubin 2002). The spreading of disease is favored when the temperature becomes more than 26 °C (Chaurasia et al. 2000) and that is why late-sown wheat is principally susceptible to the disease (Duveiller et al. 2005). Culturally, wheat is grown after the rice harvest in all the Himalayan nations including India, Nepal, and Bangladesh, thus, both spot blotch and terminal heat stress jointly lead to yield loss (Joshi et al. 2007). There will be polycyclic epidemics of conidia produced on the first leaves via rain splashes and wind (Duveiller and Dubin 2002). In years, when rain occurs late in the crop cycle, especially during grain filling, complete crop loss has been observed (Saunders 1988) suggesting a critical problem of climate change in the occurrence of the disease.

Few fungal diseases like Philippine downy mildew, are reported in northern India, Laos, northern Vietnam, and the Philippines and are the underlying causes of predominance and sporadic cases in maize in terai and inner terai, whereas less important in hilly region of the NH (Subedi 2015). The disease is critical in the country because the alternative hosts of this pathogen called *Saccharum spontaneum,* a delicious animal fodder, are traditionally and culturally planted as fencing around cultivated lands all over the terai areas. Although in the Himalayan area of northern India, brown-strip downy mildew is mostly found below 1500 masL, in Nepal, it is normally present all over the country without any altitudinal biasness, yet, it causes epidemics in the wet and humid weather (Manandhar 1972) especially in late seeded crops from June to July (Manandhar 1975).

When we explain the plant diseases in relation to water sources, the dieback of sissoo (*Dalbergia sissoo*) has been one of the most critical diseases found in the trees cultivated in forest plantations along with water canals, road sides, irrigation channels and railway lines by government, private land owners, and communities especially in the terai and lower valleys (Bakshi et al. 1976; Adhikari 1988, 1996; Acharya and Subedi 2000). The reports of dieback in sissoo plantations due to various landscapes like a large scale monoculture, lack of a quality seed, close plantations nearing the endemic regions of Indian border, diseased saplings from India, widespread vectors carrying fungi, widespread fungal spores via wind and water, lack of use of pesticides to apply in the cuts and wounds of sissoo, lack of an well-equipped task force in government and private authorities to control the disease, and the lack of proper management have been recorded since early nineties (Parajuli et al. 1999a, b; Joshi and Baral 2000). The geographic prediliction occurs because the dying back of sissoo in Kanchanpur, the far-western region, is due to land unsuitability; in Chitwan, the central region, due to an insect attack; and in Sunsari, the southern east region, due to seedlings grown from immature seeds or low quality seeds (FORESC 1997; Parajuli et al. 1999b). The topographic landscape partiality probably exists to govern the outbreaks of disease because in the lowland, water level is high and come to surface during rain, thus, sissoo suffers from wilting (Neil 1988). This principally occurs when snow-fed mountains melt increasing the numbers of glaciers with the increased volume of water that results in the outbreaks of flood all over the terai region of the country. As a result of flood and consequently the water logging, there will be enhanced pathogen activities and effects on root mortality, and development of stress to the trees (Bakshi et al. 1976). In this situation, *Ganoderma lucidum* is present in the old and rotten trunks, river areas, in root crevices of stump, especially in the bank of various rivers of the country and western region up to an altitude of 1700 m (Adhikari 1988, 1996) and has been reported to lead white spongy rot in the sapwood and to kill sissoo all over the country (Bakshi et al. 1976; Thapa 1990a, b; Karki 1992; Parajuli et al. 1999b; Thapa and Gautam 2017). Importantly, infection of the sissoo by a fungus, *Fusarium oxysporum* on water logged soil has been reported (Parajuli et al. 1999b), other several species like have been listed as etiologic agents in dieback of sisso in this NH (Manandhar and Shrestha 2000). This needs, however, evidences of further causal association of dieback with watershed and fungal species. Alternatively, few insects like borer larvae and adults of the order coleoptera (beetle), *Perissus dalbergia* and *Agilus dalbergia*, and bark and wood borers destroy the tissues leading the dieback disease outbreaks (Parajuli et al. 1999a, b). However, as fungal infection and insect invasions take place after sissoo becomes weakened by micro- and macro-environments (Negi and others 1999 in (Bashyal 2002) and the death of the trees even after treated with a systemic insecticide (Parajuli et al. 1999a) suggested that these biologic agents are the secondary underlying causes of dieback of sissoo.

Other types of fungi spread through the soil and generally cause slow-spreading local diseases. However, if they are present in the plant materials, or they produce wind-disseminated spores, they can lead to epidemics away from the usual places. In these contexts, rots caused by *Fusarium* spp. is critically common in the context of health of animal, human, and plant (Kriek et al. 1981; Morasas et al. 1981) indicating an essential step to study the concept of Global One Health. They are the most common destructive species diseases in maize and wheat caused by various fungi at different altitudinal gradients along the Himalayan countries (Desjardins et al. 2000, 2008). Although stalk rot is the most prevalent in the hot and humid areas, *Pythium* stalk rot caused by *Pythium aphanidermatum,* is common in the mountains and the valleys in the NH (Diwakar and Payak 1975). This type of rot is favored by waterlogged, low-lying or poorly drained field conditions at pre-flowering growth stage in a large maize population (Diwakar and Payak 1980). Another stalk rot called *Fusarium* stalk rot of maize, caused by *Fusarium verticillioides*, is favored by dry weather prior to silking and warm and wet weather after silking. It also leads to *Fusarium* kernel rot and gray ear rot of maize that is predominant in inner terai and terai, but is minor in hills and high hills of the country. *Fusarium* ear rot is a minor problem in terai and inner terai, but a major problem in hills and high hills under cool and humid climates. In contrast, *Gibberella* stalk rot, *gibberella* ear rot or red ear rot are critical in midhills and highlands, however, both pathogens *F. verticillioides* and *F. graminearum* can survive in crop residue or in overwintering structures in the soil for many years even in the absence of the alternative host (Jackson-Ziems et al. 2014). Survival in crop residue is particularly important to act as reservoir of the pathogens as corn stalk is stored for domestic fodder for several months or preparing hut in order to guard the maize-eating birds like parrots and domestic sparrows near cropping. Frequent rain or foggy weather prior to harvest enhances the ear rot disease, however, cases on harvested ears are present (Subedi 2015). In mountainous areas, the crop stands for 6–8 months in the field and the high rainfall provides favorable conditions for these disease (Subedi 2015). However, rhizoctonia ear rot led by *Rhizoctonia zeae* is critical in low altitude, but rarely critical in hilly areas. Lentil wilt is another important disease all over Pakistan, India, and Nepal. First reported in 1975, it has been reported from all the lentil-growing areas including terai, inner terai, valleys, and mid hills indicating its geographical predilection (Shrestha et al. 2011; Yadav et al. 2017).

The clubroot of crucifers is globally distributed including China, India, Nepal, and Sri Lanka (Dixon 2009). Although it was first reported in 1993 in Nepal, its severe and widespread epidemics have been observed since 2004 in the production areas around Kathmandu, Bhaktapur, and Palung/Daman Valleys (Timila et al. 2008) and this might be because of the use of pond water with resting spores for irrigation (Datnoff et al. 1984). These resting spores are also disseminated via the transport of infested soil by means of tools, equipment, animals, and humans and runoff from infected fields, or transport of reservoirs like cruciferous weeds.

8.5 The Impact of Landscape Properties on Bacterial Diseases

Bacteria produce their inoculums on infected plant parts in the soil, thus, spread of pathogen is via the help of vectors or via the transport of infected hosts, or via the wind-blown rain. Several bacterial diseases within NH show landscape predilection, for example, bacterial leaf blight is present in terai and mid-hills during hot and humid periods (Burlakoti and Khatri-Chhetri 2004) including Kathmandu valley (Khadka et al. 2014).

Bacterial wilt is a critical disease of tomato, brinjal, and potato in which it is widespread up to 1800 masL especially in terai, inner terai, and mid-hills under hot and humid conditions and in many seed production areas of the eastern, central, and western regions (Adhikari et al. 1997). Its pathogen can survive in the soil for long period with vast genetic variability (Hayward 1991). In winter tomato in terai, it is not a problem probably because of low air temperature and high soil moisture (Timila and Joshi 2014).

Huanglongbing (Greening) disease is widespread East Asia, South Asia, South and East Africa, the Arabic Peninsula, Mauritius and Madagascar in the Indian Ocean (Jagoueix et al. 1996; Bove 2006) is one of the serious problems of citrus in Nepal. The disease possesses a true nature of well-explained landscape factors within the NH. After it was first reported in Pokhara valley, Knorr et al. (1970) suspected that the decline was caused by greening disease entered with the rootstocks introduced to Horticulture Research Station (HRS), Pokhara from Saharanpur, Uttar Pradesh, India (Catling 1970; Knorr et al. 1970). Citrus decline in many areas of the country was evidenced by this disease and even molecular data show the widespread HLB in many hilly areas like various districts including Kathmandu valley (Roistacher 1996; Shrestha et al. 2003; Bove 2006; Regmi and Yadav 2007). Regarding molecular methods in the NH, Dr. Chiranjivi Regmi had established and initiated the polymerase chain reaction (PCR) techniques to provide HLB analytic services for farmers and researchers at Nepal Academy of Science and Technology (NAST), one of the author's current affiliations (Dr. Chiranjivi Regmi pers. comm.).

HLB is critical because it is also transmitted by vectors. The vectors, Asian citrus psyllid (*Diaphorina citri*), have been recorded in 15 districts including Kathmandu valley at 1350 masL suggesting its adaptation in cooler areas and higher altitudes (Lama et al. 1988). These vectors commonly flourishes during late spring through mid-summer with the determining role of both humidity and temperature in the development of each stage, from egg to adult and the complete lifecycle, outbreaks of the psyllid can occur at any time of the year depending on environmental factors and the availability of young shoots and yellow colored ones (Hall et al. 2008; Beloti et al. 2013; Wu et al. 2015). The adult psyllid population decreases during the rainy season because heavy rains can eliminate eggs and nymphs; however, adults can hide on the abaxial surfaces of leaves and on the twigs of the lower and inner portions of the trees (Regmi and Lama 1988). Geography-wise results regarding the flight distance vary (Aubert and Xia Yu Hua 1990; Sakamaki 2005; Arakawa and Miyamoto 2007; Boina et al. 2009; Hall and Hentz 2011), however, flight is purely wind-dependent because they have weak flight muscles relative to the size of their wings (Aubert and Xia Yu Hua 1990; Sakamaki 2005) and they show very short flight indicating it is not easily transmitted from diseased tree to healthy one in a steep landscape or terrain that is normally found in the hilly region of Nepal. However, repeated short-distance flights may enhance the long-distance dispersion of these insects (Arakawa and Miyamoto 2007) suggesting the problem in the high altitude in a time-dependent manner.

Bacterial stalk rot of maize generally attacks at the time of tasseling, however, it can affect both the growing and harvested crops (Baz et al. 2012) and is confined to the terai and inner region (Sharma et al. 1993; Burlakoti and Khatri-Chhetri 2004). Intensity of infection increases as weather conditions become warmer and humid. Although it is found in low rates in some pockets of the mountains and the Kathmandu valley, geographic predilection at terai occurs which probably depends on the use of sewage water for irrigation with high temperatures (≥28 °C) and high relative humidity, which prevails in most maize-growing areas 3–4 weeks after sowing (Subedi 2015).

8.6 The Impact of Landscape Properties on Arthropod-Borne Diseases

Arthropods affect the plants and their parts by the direct attack and indirectly via the transmission of various pathogens. Fruit flies are one of the most critical pest problems in horticultural crops (citrus and cucurbits) causing severe qualitative and quantitative yield loss even up to 100% in Nepal (Sharma et al. 2015a, b). They have a wide range of hosts with very complex micro- and macro-environment exist to govern their distribution along various landscapes. Few arthropods like the shoot and fruit borer are the prominent insect pests in Terai, Low and Middle mountains of Nepal (Neupane 1993; Joshi 2003). South American tomato leaf miner, *Tuta absoluta* has been a destructive pest of tomato associated with solanaceous crops (Desneux et al. 2010). The pest has hit the mid-hill region of Nepal including about various districts principally the Kathmandu valley and Kavre (personal observation) and has been distributed both in field and greenhouse conditions (Desneux et al. 2010). After the pest was first of all identified at the laboratory of Entomology Division, Nepal Agricultural Research Council (NARC) (Bajracharya et al. 2016), its studies related to a wide landscape features including distribution, modes of transmission, and other features are undergoing at NAST, NARC, and other institutes in the NH.

Interestingly, both adult and larval stages of white grubs are highly destructive in nature (Maharjan and Khanal 2016). Root grubs prefer plants with a fibrous root system such as rice, millet, sorghum, sugarcane and various grasses. Several species involved in crop damage are reported along the eastern and western Himalayan regions by Stebnicka from Polish Academy of Sciences in Poland (Stebnicka 1981, 1986; Pandey et al. 1993; GC et al. 2009; Chandra and Gupta 2013). Yubak Dhoj GC describes that the species of scarabaeid beetles depend on various agro-ecologic landscapes like rainfall, geology, geography, season, temperature, cropping pattern, host crop, soil types, and others (GC 2006). Notably, the adult beetles emerge after the first rain in May and infests the field till heavy monsoon (GC 2006) indicating their lives in causal association with climates.

8.7 Conclusions and Research and Management Recommendations

It has been a well-known fact that Nepal is rich in floral diversities present in land, aquatic, agricultural, and forest ecosystem at various landscape levels. However, the floral richness of the NH has been threatened by either introduction or existence of many species of pathogens like viruses, bacteria, fungi, and arthropods. This threatening situation has been augmented by the geographic location of the NH because it is a landlocked country with the open border due to which several pathogens can enter via different modes of dissemination, for example, via transport of good, plants, and plant materials, air, water sources, and migratory behaviors of animals and humans. That is why several endemic, epidemic, and sporadic diseases have caused the loss of several million dollars and hampering the economic and agricultural development along various landscapes. However, many landscape properties or factors have yet to be understood and elaborated. In conclusions, the following points related to research and management should be considered further:

- Investigating the effects of pathogens and their diseases in sustainable development of the local and small-scale farmers and large-scale business in various landscape levels should be conducted.
- Research on the effects of climate change, glacier melting, and increased flood and their effects on trees like pine and sissoo at a defined landscape should be well-investigated.
- Documentation of past, existing, and predicted floral (trees, herbs, and crops) pathogens within the NH should be compiled.
- Documentation of different plant varieties like local and improved ones and their mechanisms in generating resistivity to various pathogens along different landscape levels should be prepared.
- Further elucidation of Global One Health System involving diseases common to plants, humans, and animal should be done.
- How climate change has/not affected the landscape factors of diseases like pathogens and vectors survival, genotypes, dissemination, and existence should be evaluated.

Appendix: Various Diseases of Different Hosts, Their Etiologic Agents, and Their Characteristics in the Nepal Himalaya

Diseases	Etiologic agent	Hosts	Disease characteristics and incidence in Nepal	References
Citrus Tristeza viral disease (CTVD)	Single-stranded positive-sense ribonucleic acid (RNA) virus transmitted by aphids like *Toxoptera citricida*, *Aphis gossipii*, and *Toxoptera aurantii*	Lemon, lime, sweet and sour orange, tangerine, mandarin, grapefruit, and Kumquats, *Poncirus* spp., *Aegle, Microcitrus, Pamburus*, and *Pleiospermium*	Sudden and robust death of plants with 'stem-pitting' (an aberrant phloem development and visible pit in the wood with the reduction in vigor and sweetness of fruits) and 'seedling yellows' (stunting and leaf chlorosis) resulting in the complete cessation of growth	Karasev et al. (1995), Moreno et al. (2008), Pedro et al. (2008), DoA (2011), Dawson et al. (2013), and Kaini (2013)
Common rust	*Puccinia sorghi* (Class: Teliomycetes, Family: Pucciniaceae)	*Oxalis*, maize, *Berberis,* and other plants	Yield loss up to 6–32%	Subedi (2015), Sharma et al. (1982), and Mahto et al. (2015)
Yellow rust	*Puccinia striiformisf* sp. *tritici (Pst)*	Wheat	Zero grain formation, 15–95% grain yield loss	Karki and Sharma (1990) and Upreti and Karki (1999)
Leaf rust	*Puccinia triticina*	Wheat	14–20%	Mahto et al. (2015)
Stem rusts of wheat	*Puccinia graminis, P. triticina* and *P. striiformis*	Wheat, *Berberis, barley, triticale*	Predominant at the lowland border region of India	Mahto et al. (2015)
Stem rust of pine (SRP)	*Cronartium himalyense* (Class: Urediniomycetes, Family: Cronartiaceae)	Pine *(Pinus roxburghii)*	Predominant at high altitude	Cotter et al. (1987)

(continued)

Diseases	Etiologic agent	Hosts	Disease characteristics and incidence in Nepal	References
Brown Needle Disease (BND)	*Mycosphaerella gibsonii* (Class: Dothideomycetes, Family: Mycosphaerellaceae)	*Pinus roxburghii, P. wallichiana P. ayacahuite, P. canariensis, P. caribaea, P. clausa, P. densiflora, P. elliottii, P. greggii, P. halepensis, P. kesiya, P. luchensis, P. massoniana, P. merkusii, P. muricata, P. oocarpa, P. patula, P. pinaster, P. pseudostrobus, P. radiata, P. roxburghii, P. rudis, P. sylvestris, P. taeda, P. thunbergii* and *P. wallichiana*	Early needle drop with the eventual death of young trees	Ivory (1990, 1994)
Dothistroma needle blight or red band needle blight	*Mycosphaerella pini*	60 species of conifers especially pine like *P. wallichiana*	A total defoliation and death of trees	Ivory (1990), Bradshaw (2004), and Barnes et al. (2008)
Late blight potatoes and tomatoes	*Phytophthora infestans* (Class: Oomycota, Family: Pythiaceae)		75%: High hills, 50–90%: terai	Shrestha (2005, 2000)
Head smut of maize	*Sphacelotheca reiliana* (Class: Microbotryomycetes, Family: Microbotryaceae)	Maize	–	Subedi (2015)
Common smut of maize	*Ustilago maydis* (Class: Ustilaginomycetes, Family: Ustilaginaceae)	Maize	–	Subedi (2015)
Leptosphaeria leaf blight in maize	*Leptosphaeria zeae* and *Leptosphaeria michotii* (Class: Dothideomycetes, Family: Leptosphaeriaceae)	Maize	Problem in hills and high hills	Paudel and Koirala (1995), and Subedi (2015)

Banded leaf and sheath blight in maize	*Rhizoctonia solani* (teleomorph *Thanatephorus cucumeris*) (Class: Agaricomycetes, Family: Ceratobasidiaceae), a ubiquitous soil-borne pathogenic fungus. *R. solani* is classified into 13 anastomosis groups (AGs) and AG2-1 and AG4 lead to stem and root rot diseases in dicotyledonous crops of Brassiciacea family. In contrast, AG8 causes bare patch or root rot on monocotyledonous crops of Poaceae family	Maize, rice, corn, sorghum, bean, cabbage, carrot, flax, pine, crucifers, strawberry, tulip, turf grass, sugarbeet, konjak, Chinese yam, brinjal, onion, potato, pea, and others	10–90% losses of different varieties or cultivars of maize	Singh and Sharma (1976), Gugel et al. (1987), Sneh et al. (1991), Paulitz et al. (2002), Tewoldemedhin et al. (2006), and Sharma and KC (2007)
Gray leaf spot (GLS) disease in maize is caused by)	a cercosporin-producing fungus called *Cercospora zeae maydis* (Class: Dothideomycetes, Family: Mycosphaerellaceae	Maize	18% and 19%	Manandhar and Baidya (2010)
Brown (early) lesion leaf spot in groundnut	*Cercospora arachidicola*	Groundnut	Early and late both: 10–50%, up to 50% or more, commercially grown varieties of groundnut like Jyoti and B-4: 20%	McDonald et al. (1985), Shew et al. (1988), Smith and Littrell (1980), and Chaudhary (2010)
Black (late) lesion leaf spot in groundnut	*Cercosporidium personatum*			
Spot blotch (SB	An aggressive fungus called *Bipolaris sorokiniana* (teleomorph *Cochliobolus sativus*) (Class: Dothideomycetes, Family: Pleosporaceae)	Wheat, barley, and others	cv-RR-21in terai belt: RR-21: Up to 90%, RR-21: 23.2% to 23.88%, Nepal-297: and 15.2%	Shrestha et al. (1998), Duveiller and Dubin (2002), and Gupta et al. (2018)
Philippine downy mildew of maize	*Sclerospora philippinensis*	*Saccharum spontaneum*	50%	Subedi (2015)

(continued)

Diseases	Etiologic agent	Hosts	Disease characteristics and incidence in Nepal	References
Brown-strip downy mildew	*S. rayssiae*	Maize	The wet and humid weather: 10–20%, epidemics: 30–60%	Manandhar (1972)
Dieback of Shisham (*Dalbergia sissoo*)	*Ganoderma lucidum* (Class: Agaricomycetes, Family: Ganodermataceae), *Alternaria, Aspergillus, Botryodiplodia, Cladosporium, Colletotrichum sissoo, Fusarium solani, Fusarium, Ganoderma, Maravalia, achora, Phoma, Phyllachora dalbergiae, Phyllactinia dalbergiae, Polyporus*, *Fusarium oxysporum,* and *Uredo sissoo, Xyleria sp, Schizophyllum communi, Uredo sissoo, Phyllactinia dalbargiae, Ganoderma lucilium, Coriolus versicolor, C. tephroleucus and Polyporus* sp. *Maravalia achroa and Phyllactinia coryle, insect borers belonging to the families Scolytidae, Buprestidae, Cerambycidae of the Order Coleoptera (beetles). Perissus dalbergia* and *Agilus dalbergia*, and bark and wood borers	Shisham (*Dalbergia sissoo*)	–	Bakshi et al. (1976), Parajuli et al. (1999a, b), Joshi and Baral (2000), and Manandhar and Shrestha (2000)
Stalk rot in wheat	*F. graminearum*	Wheat and other hosts have 600 diverse strains	–	Desjardins et al. (2000, 2004, 2008)
Stalk rots in maize	*F. monoliforme, F. graminearum, Pythium aphanidermatum, Diplodia maydis, Macrophomina phasiolina*, and *Cephalosporium acremonium*	Maize and other hosts	Minor	Subedi (2015)

Red Ear Rot disease or Gibberella disease	*F. graminearum*	Maize and others	40% at high hills to less than 5% at terai	Manandhar and Gurung (1982)
Fusarium Ear Rot	*F. moniliformes,* a soil and grass fungus called *Fusarium moniliforme* or recently modified into *F. verticillioides* (Class: Sordariomycetes, Family: Nectriaceae)	Maize, bananas, watermelon, and sugarcane	30–40% at mountain, 5–10% at Kathmandu Valley, 80–90% in improved varieties	Shah and Manandhar (1978)
Clubroot of crucifers	A soil-borne obligate intracellular parasite *Plasmodiophora brassicae* (Class: Phytomyxea, Family: Plasmodiophoraceae)	Turnip, rutabaga, cabbage, cauliflower and broccoli, Brussels sprouts, kohlrabi, Chinese cabbage, and radish, cruciferous weeds	100% yield loss 40% with overall loss of cauliflowers	Bulman et al. (2007) and Ferreira and Boley (1993)
Bacterial leaf blight	Gram-negative bacteria with encapsulated rod with a single polar flagellum *Xanthomonas oryzae* pv *oryzicola* (*Xanthomonas campestris* pv *oryzae*)	Rice	5–60% in terai and mid-hills during hot and humid periods	Burlakoti and Khatri-Chhetri (2004)
Bacterial wilt	*Ralstonia* (*Pseudomonas*) *solanacearum*	44 families of plants alternatively including banana and tomatoes	Tomato: 80–100%, potato: 70–100% and brinjal: 32.5–40%	Burlakoti and Khatri-Chhetri (2004), Hayward (1991), Timila et al. (1997), Gurung and Vaidya (1997), and Adhikari et al. (1993)

(continued)

Diseases	Etiologic agent	Hosts	Disease characteristics and incidence in Nepal	References
Huanglongbing (greening) disease	A gram negative phloem-restricted bacterium (Class: Protobacteria, Family: Rhizobiaceae) called Candidatus *Liberibacter asiaticus,* the African Candidatus *L. africanus* (Laf) and the Brazilian Candidatus *L. americanus* (Lam), *Candidatus Liberibacter asiaticus* transmitted by the sap-sucking insect vectors called the Asian citrus psyllid (*Diaphorina citri*) (Order: Hemiptera, Family: Liviidae)	All citrus trees	39–100% in mandarin trees	Garnier et al. (2000), Teixeira Ddo et al. (2005), Regmi (1982), and Knorr et al. (1970)
Bacterial stalk rot	A non-spore forming, facultative gram-negative rod-shaped anaerobe called *Dickeya dadantii* (formerly known as *Erwinia chrysanthemi*) (class: *Gammaproteobacteria,* family*: Enterobacteriaceae*)	Potatoes, carnations, chrysanthemums, Dahlia, Dieffenbachia spp., *Euphorbia pulcherrima, Kalanchoe blossfeldiana,* maize, *Philodendron* spp., potatoes, *Saintpaulia ionantha, Syngonium podophyllum,* carrots, bananas, cucumbers, onions, tomatoes, maize, and lettuce	Up to 80% in maize in (the low altitude)	Nazerian et al. (2013), Akbar et al. (2015), and Burlakoti and Khatri-Chhetri (2004)
Fruit Fly Rot	Chinese citrus fly (*Bactrocera minax*) (Order: Diptera, Family: Tephritidae) was the species affecting in that area, however, *B. cucurbitae*, *B. dorsalis*, *B. zonata*, *B. tau*, *B. scutellaris* and *B. yashimotoi*	Citrus and cucurbits	Citrus and cucurbits: 100%, Mandarin: 15%, Bittergourd: 42–68%	NCRP (2012), Sharma et al. (2015a, b), GC (2001), and Shrestha (2006)
Shoot and fruit borer in brinjal	Shoot and fruit borer (*Leucinodes orbonalis*), white fly, red spider mites, spotted beetle		40–45%	Neupane (1993), Joshi (2003), and Gyawali (1999)

Tomato leaf miner infection	South American tomato leaf miner, *Tuta absoluta* (Lepidoptera: Gelechiidae)	Solanaceous crops including weeds *Solanum nigrum*, *Datura stramonium*, *Solanum melongena, Capsicum annum*, and above ground parts of *Solanum tuberosum*, *S. elaeagnifolium*, *Lycopersicum puberulum*, *Datura ferox*, *D. stramonium*, and *Nicotiana glauca*	80–100% both in field and greenhouse in newly invaded areas	Desneux et al. (2010), García and Espul (1982), and Pereyra and Sanchez (2006)
White grub infection	White grubs (Coleoptera: Scarabaeidae) *Hybosorus orientalis, Aphodius moestus, Gymnopleurus cyaneus, Paragymnopleurus sinuatus, Catharsius molossus, Onthophagus gazella, O. spinifex, O. pactolus, Onitis philemon, Onitis subopacus, Oniticellus cinctus, Tiniocellus spinipes, Tibiodrepanus setosus, Clinteria klugi, Phyllognathus dionysius*, and *Phyllophaga*	Most of the crops in the NH	12–80%	Pokhrel (2004), Chandra and Gupta (2013), Prasad and Thakur (1959), Raodeo et al. 1974, Stebnicka (1981, 1986), and GC et al. (2009)

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Chapter 9
Showing True Change of the Hindu Kush Himalaya Region Through the Power of Photo Monitoring as a Visual Memory of Change

Fritz Berger

9.1 Introduction

The visual memory of most modern humans is rather weak and short-minded, specifically when it comes to details of our surroundings, nature and in vast landscapes: we usually don't remember well how it looked months back or in the past decades; we cannot relate well. To tackle this problem Photomonitoring (FM) in short; as taken from the German language where the author developed it) makes for an ideal tool. Photomonitoring is among the best means to document changes in landscapes over time. The series of two or more pictures helps in planning but also to evaluate and discuss already executed programmes in hindsight for impacts. Further, taking more photos can support oral and written analysis and statements even further.

Whereas words tend to stimulate our intellect first, photos actually touch immediately our emotions. To illustrate this: For a women collecting firewood, a road worker, or a farmer it will be quite difficult to read and understand a quantitative written analyses on erosion and regeneration; but if you show them a photo they will immediately start telling stories coming from their own experiences. As one visitor of my Photomonitoring exhibition titled "*A new tree in Charikot*" wrote in the guestbook: "*Changes are inevitable, but the photographer has presented a vivid picture of the changes that have taken place in our surroundings. This we could have noticed only through photo monitoring.*"

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F. Berger (✉)
Transhumana, Bern, Switzerland
e-mail: fritz@transhumana.ch

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Here we can only show the value and concepts. To introduce this unique technique as a general tool – a science – on a larger scale, and with sound methods, the creation of a Centre/Institute for Photomonitoring is necessary (Suggestions are welcome, please contact the author).

9.2 Background, Context and Bio Data of the Photographer

Fritz Berger was born into a farming family south of Bern, Switzerland in 1938, as the third of eight children. After primary school, he earned an apprenticeship in horticulture, starting a life-long fascination with plants and agriculture. At 24, he started working as an adviser to development projects abroad, initially in Greece, but later in Nepal and Pakistan. Berger took a camera with him on every field excursion, developing this initial hobby into a passion for photography with a professional outcome.

In 1987, Fritz returned to Bern and began working as a freelance photographer. His assignments took him far afield once again, documenting activities in Nepal, Pakistan, Palestine, and ex-Yugoslavia (today knows as the Balkan region). He particularly enjoys documenting people, their work, and their struggles to make it through life.

Fritz speciality is Photomonitoring. He conducted trainings on this subject, wrote articles and conducted exhibitions. In 2010, Berger performed some of this work for ICIMOD, SDC and HELVETAS travelling to many sites in remote Nepal to record the impacts of natural forces and human activities.

The following photo series come from this work and present a unique combination of luck and determination allowing to determine landscape changes in the HKH region and with full background stories. That's what these following series allow for; these are now documented stories and landscape tales not to be forgotten:

FM Series for the Hindu Kush-Himalaya region

1. Observe Landscapes for Changes

a

Photo 9.1a Buju 2100 m, Swat, Pakistan August 1985 and August 2005
There are two details that are interesting in these FM pictures from Buju: the field crops and the forest opening in the background. As the photo from 1985 shows corn dominates (yellow green) next to it there are dark green fields with potatoes. Whereas in 2005 only potato fields can be seen later and corn has completely disappeared. Cabbage grows in the bright green field behind the mosque. After a road was built to Buju, the farmers have switched to cash crop

Avalanches are the cause of the broad forest opening. In 1985, young firs grow in the lower part of the opening. In the snowy winter of 2014 another avalanche broke down, which destroyed the young trees and penetrated the area almost to the mosque, as people told me. The avalanche destroyed two houses, and more than ten people died b

Photo 9.1b Gayal a village in Manang valley, Nepal July 1978 and July 2010
At first glance, it seems like nothing has changed in the 32 years between those photos. But let's first look at the farming village of Gyal: Noticeable are the Gumpa in the center and the new building with a blue roof on the right edge of the village. By building new houses, the village has actually expanded. When we look at the white prayer flags, we find that there are fewer of them in 2010, suggesting that many houses are empty by then. People either died or emigrated. Also, looking closely at the 2010 photo, we notice that only about one half of the fields are cultivated (=only on those who have a uniform green) On my first visit in 1978, buckwheat, peas and barley were grown, in 2010 it was only peas. Has diversity changed to monocultures?

2. **Deforestation**

(a)

Photo 9.2a Urbanization of Gula Bad, in Kalam valley, Pakistan, 1983 and 2014
The photo from 1983 shows the thinly wooded pastures of Gula Bad. A year later, a road was built there and the valley on both side of the river slowly converted into fields to grow potatoes as cash crop. Farmer huts were built and for their construction most of the trees were cut down. The little river on the left side, has changed its course slightly (Photo taken 2010) (Photo 2014 by M. Zaman Sagar)

(b)

Photo 9.2b Hill over Simikot in Humla, Nepal 1999 and 2010
In just ten years, all the pine trees were felled on this stony hill. Buckwheat, initially just grown behind the stone wall in 1999, is planted on the steep slope in 2010

3. **Landscape healing**

(a)

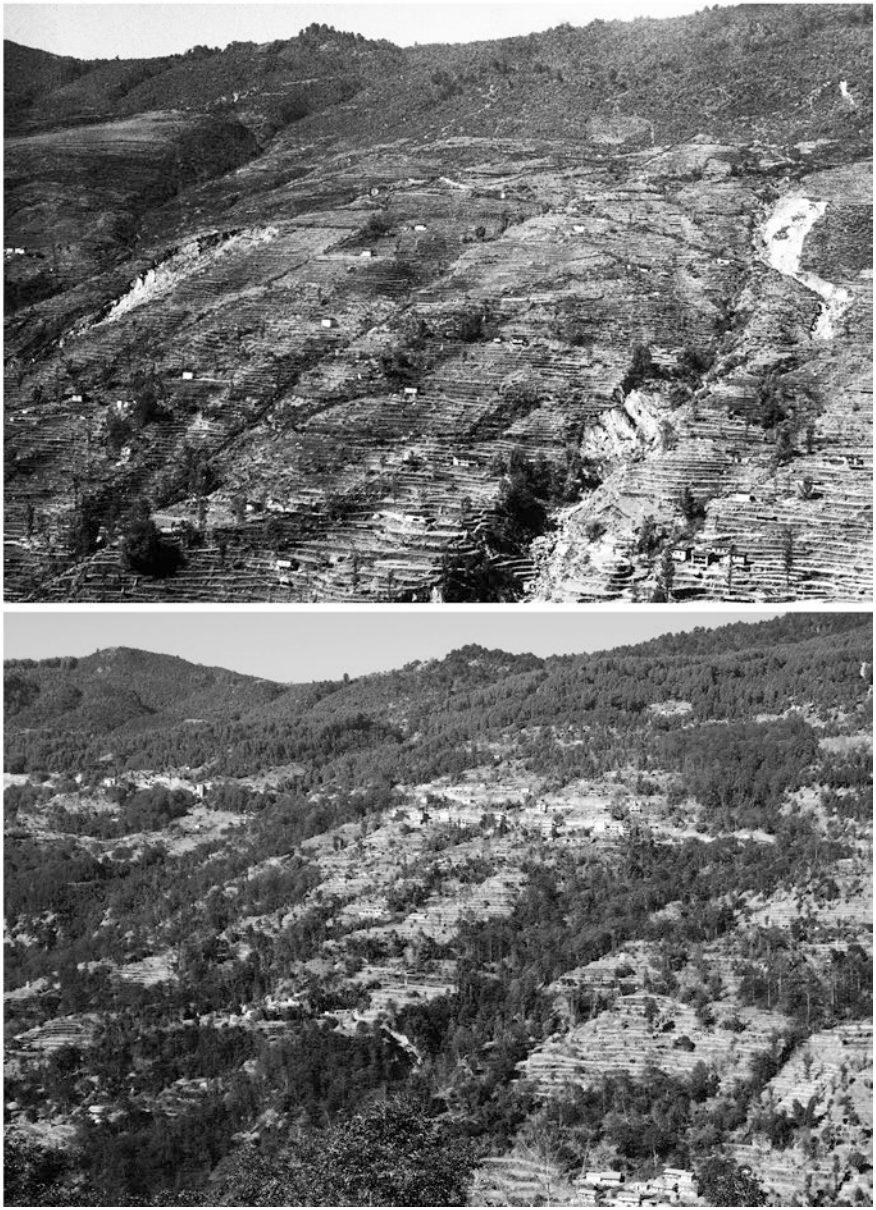

Photo 9.3a Boch in Nepal 1977 and 2018
In 1977 the slope has deeply eroded gullies and the hill looks barren without trees. For the construction of new road the water was drained through a safe runoff, and Utis were planted in an eroded gullies. In the nineties the community of Boch started some larger replanting activities on the hill above; protecting them from grazing helped to reduce the surface water and the deep gully healed slowly. In 2018 the slope looks stable and is covered with a lot of trees and new houses with a new road to reach their homes

(b)

Photo 9.3b Charnavati valley in Nepal, 1974 and 2010
Unstable terrain in the valley below the ridge of Seilung 1974. Back then, the new forest law asked villagers to engage in taking care of their forests. This measure helped to regenerate big parts of the hills in Nepal as seen here in the photo of 2010; the eroded surfaces on the hills are now covered with forest and the riverbed is stabilised

4. **Forest planting**

(a)

Photo 9.4a Dandapakhar, Nepal, 1975 and 2010
The 1975 photo shows villagers planting pines trees in a barren slope. In 2010, the entire slope is well covered with a dense forest, from which lumber can now be harvested for local demand and sale (Photo 1975 by Samuel Mauch)

(b)

Photo 9.4b Tree planting after the old road-widening construction, Dolalgath, Nepal, 1998 and 2010

When the old road was widening into the steep slopes of the narrow river valleys, there are always new landslides occurring as the photo from 1998 shows. Professionally executed measures with the help of plants (bio engineering) can ensure though a permanent stabilization of the slopes, photo 2010

5. **Damages by river floods**

(a)

Photo 9.5a Kalam bazaar in 1997 and 2014, 4 years after the flood disaster
As one can see on the first photo, the old river bed was initially located in front of the mosque (blue roof) which was used for tourists to enjoy the cold water from the canals. At the footpath over the bridge shops were erected
The actual flood that devasted large parts of Pakistan in the summer of 2010 had its origins in the foothills of the Hindukush. It was caused by extreme thunderstorms and precipitation, which then caused great damage, as shown here in Kalam. (Photo 2014 by M. Zaman Sagar)

(b)

Photo 9.5b Kali Gandaki at Kagbeni, Mustang in Nepal, 1978 and 2010
The photos of 1978 and 2010 show how the river slowly erodes away the irrigated fields and soils below the village. Even walls built by farmers to keep back the river cannot prevent that

6. **Urban growth**

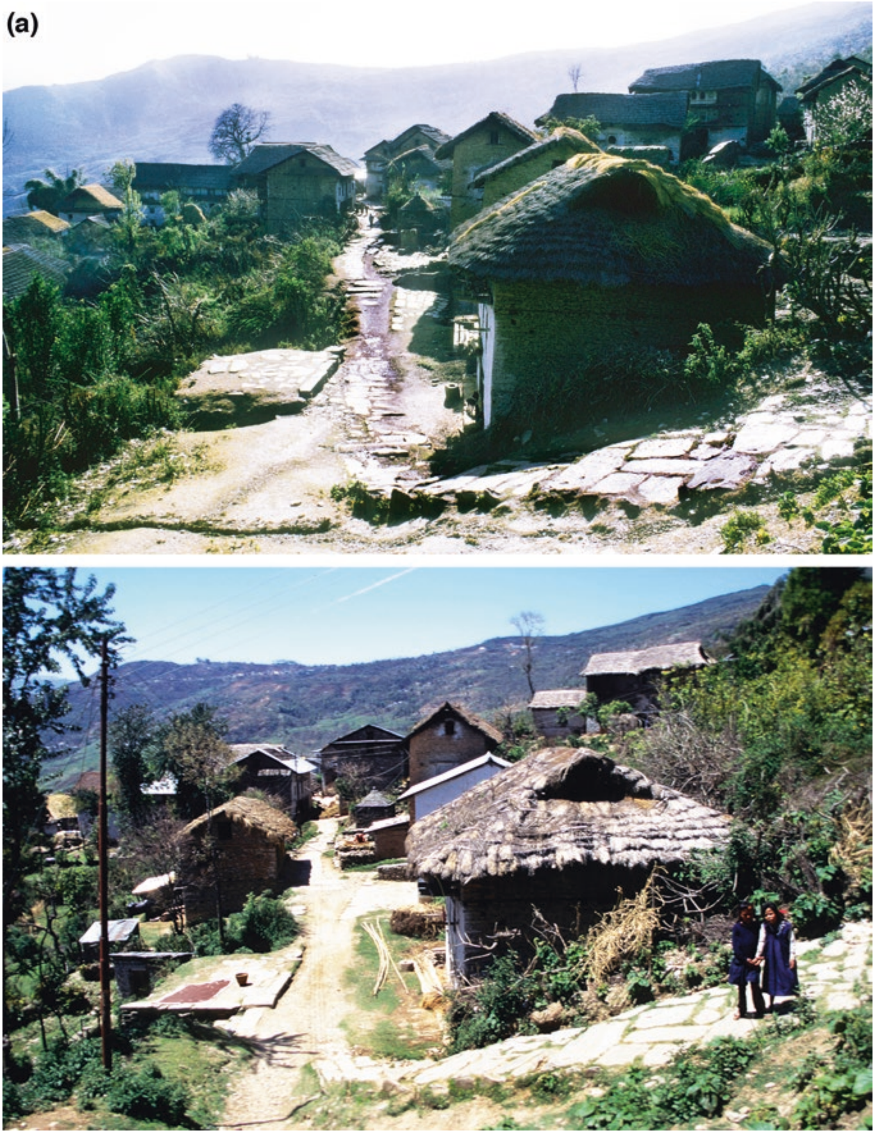

Photo 9.6a A street in old Dolakha, Nepal, 1974, 1998, 2005 and 2016
This series of 4 photos shows the changes in the old Newar town of Dolakha during 42 years. Thatched roofs could still be seen until the turn of the century, but after that all the houses were covered instead with corrugated sheet. In 2016 the damages of the earthquake 2 years earlier, is still evident. This street is not passable by cars and therefore it has not changed much. The village centre moved to upper Dolakha where now a new road connects from Charikot

Fig. 9.6a (continued)

(b)

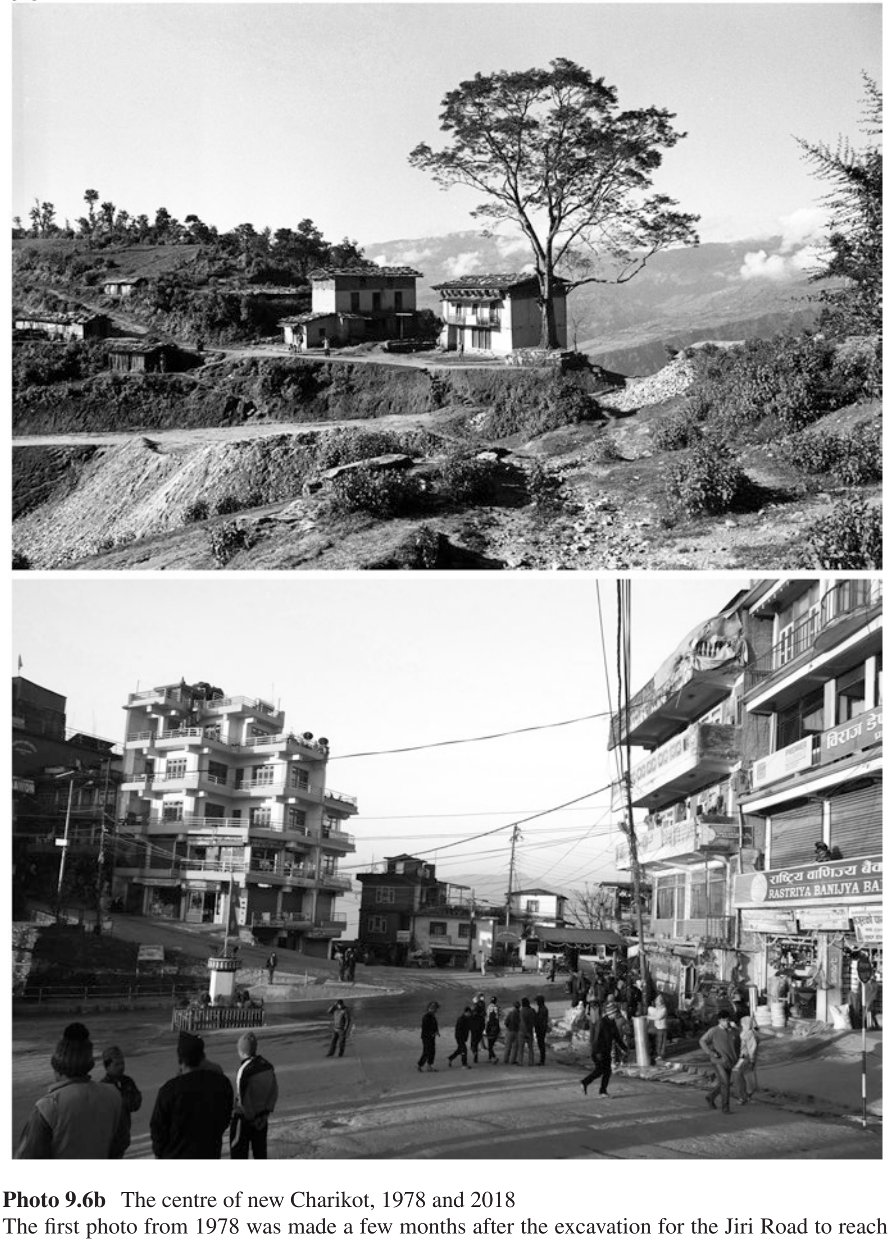

Photo 9.6b The centre of new Charikot, 1978 and 2018
The first photo from 1978 was made a few months after the excavation for the Jiri Road to reach Charikot. The place had been named the capital of the Dolakha district several years earlier and it consisted of a small bazaar and just a dozen of office buildings. With the new connection to Kathmandu, Charikot grew during the following decades to a small town with modern buildings and facilities, as the photo of 2018 shows

7. **The power of roads**

(a)

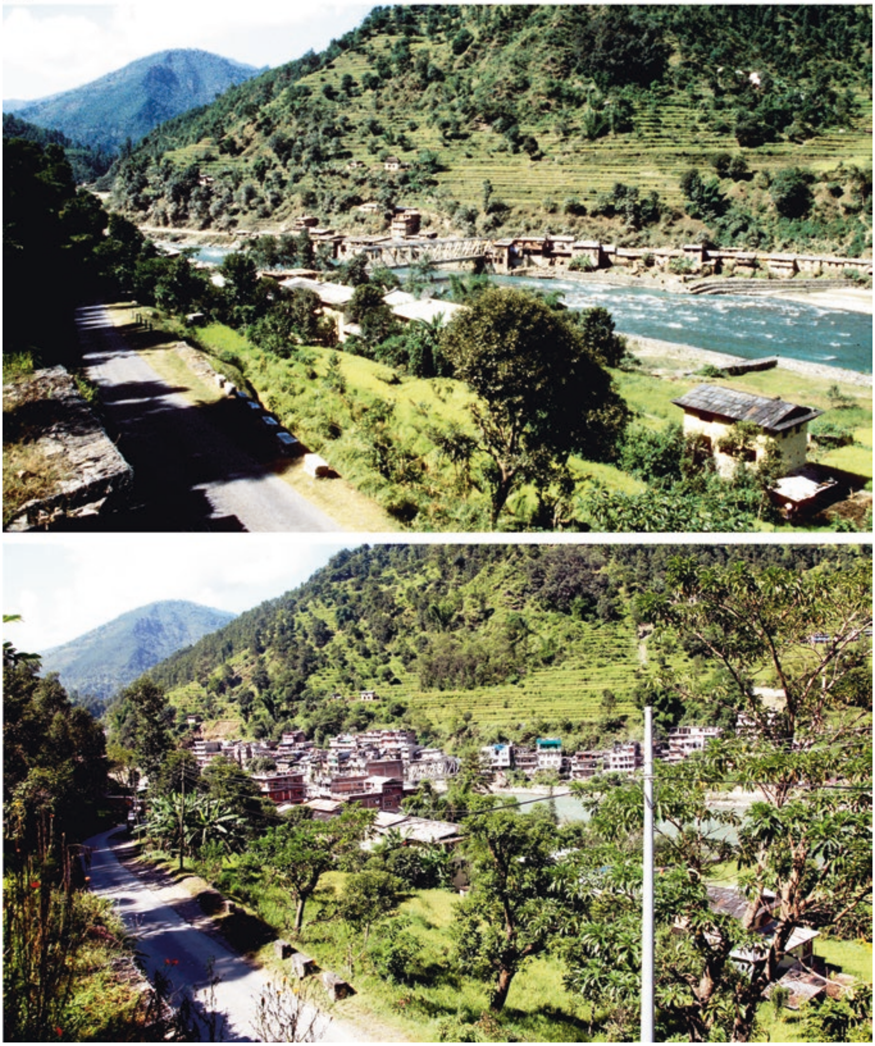

Photo 9.7a (a) Kalichor, Sunkosi, Nepal 1996 and 2010
These photos impressively show the dynamics that result from the construction of a new road and highway. In Kalichor, near Lamosangu, the road to Chrikot and Jiri leaves the Arniko Highway. When the picture was taken in 1996, the bridge existed for 15 years. On the narrow ground between the road and the river are already a number of houses
But in the photo from 2010 we see a lot of new multi-storey buildings on both sides of the Sunkosi. On the other side of the street, construction sites were carved into the steep slope to build new houses. In Kalichor today thousands of bus passengers eat-in, and they shop in the many new shops the cheap goods imported from China

(b)

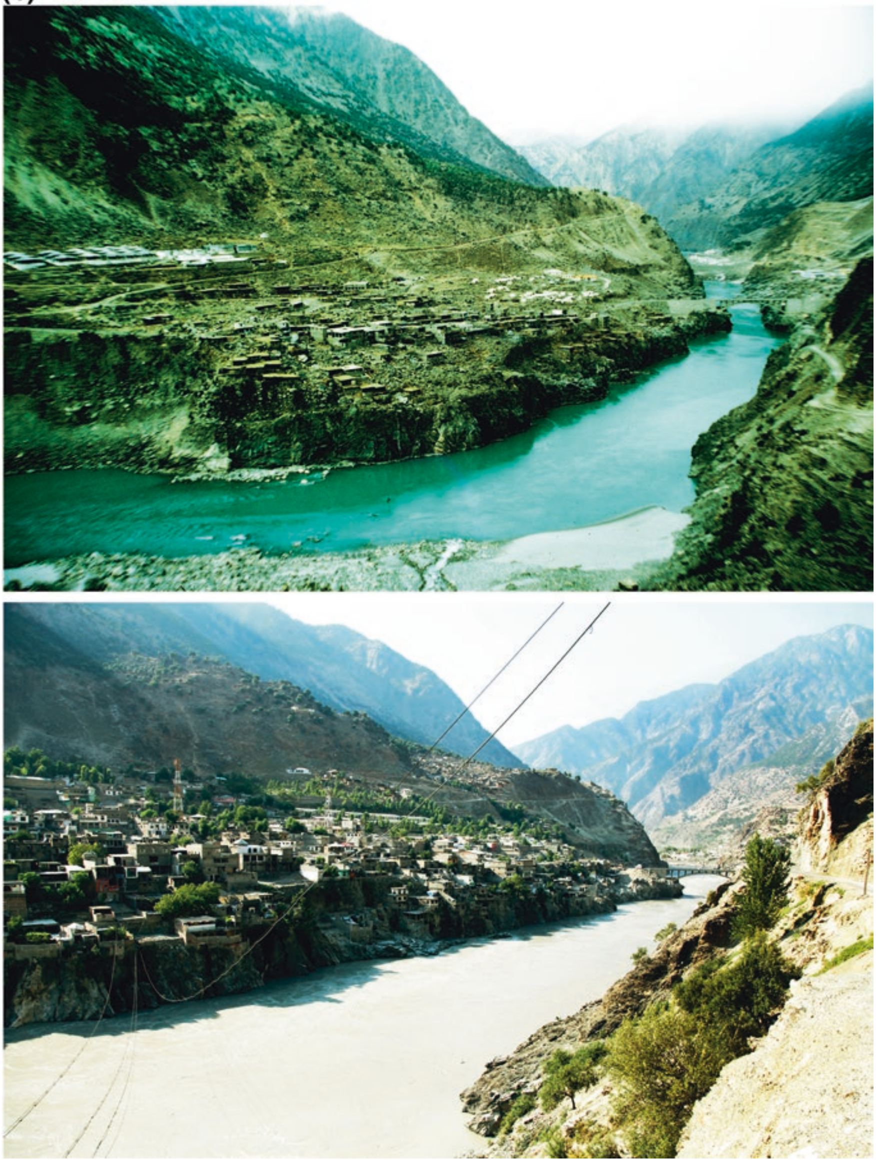

Photo 9.7b Kamila in Indus Kohistan, Pakistan 1984 and 2011
Until the construction of the Karakorum Highway after 1960, there were virtually no traffic routes and settlements in the Indus Gorge. But in 1984, Kamila became the administrative capital of the district of Kohistan. There are many barracks and simple houses. On the right side of the picture, the bridge over the Indus River is visible
In 2011 then, the settlements between the river and mountain slope has become a small town. Kamila is now an important trading centre for the surrounding valleys, which are already electrified as the high voltage power line shows

8. **Divers infrastructure**

(a)

Photo 9.8a A dam is being built at Lamabagar, Nepal 2010 and 2016
The photo from 2010 was taken shortly before the new road Lamabager arrived. In 2016, during the work on the dam (visible in the back of the valley) was interrupted due to the heavy earthquake of 2015. There are new houses in the village (some of the old ones are damaged) and a road is passing in the riverbed. It will be interesting to see how Lamabagar develops in the future. It is now planned to expand this place as a tourist destination

(b)

Photo 9.8b The airfield expansion of Simikot, Humla, in Nepal 1999 and 2010
The photo of 1999 shows the narrow unpaved runway. It is surrounded by new buildings in a fertile plateau. At the end of the runway, the old village of Simikot is visible
2010 shows a now-paved runway under construction. Simikot has greatly increased on both sides of the runway. The place now has electricity, which is visible through the line that leads across the fields

(c)

Photo 9.8c The magnetite mines of Karidungha 1973 and 2018
In the years when the first picture was taken, Nepal awarded a license to remove magnesite to one Indian company. Eight years later, the road to Jiri was built right through the mine grounds. Soon, however, the exploitation was unprofitable and it was all given upp. The remaining deep wounds on the mountain can be seen in the photo of 2018

(d)

Photo 9.8d Hotel in Kalam, Pakistan 1986, 2005 and 2014
The mass tourism of the past decades has visibly changed the valley of Kalam, as clearly shown in the photos of 1986, 2005 and 2014. Whereas in 1986 it is located next to the road, some of the remaining farmland, a cemetery and some houses and the first hotel can be seen; a new tourist destination starts to emerge. As the photo from 2005 documents many new hotels and shops got built along the road and near the river. As the photo from 2014 shows, the flood of 2010 washed away several hotels that were build too close to the river. (Photo 2014 by M. Zaman Sagar)

Fig. 9.8d (continued)

9. **Air and river pollution at Kathmandu**

Photo 9.9a Baharatar 1998 and 2016
The two photos clearly show two main problems of Katmandu: the wild, unplanned expansion of the city as well its enormous air pollution! The traditional small town has expanded into a city in just 20 years, with huge areas of valuable cultural land being simply built over

(b)

Photo 9.9b Bagmati at Pashupatinath 1974 and 2016
The Bagmati is a sacred river in which people – at least until two decades ago – bathed in Pashupatinath (a World Heritage Site), one of the most venerable sanctuaries on its shores. Because of the poor water quality and the contented waste, it is currently not only repulsive but also a health risk to bathe in Bagmati

Textbox: Looking at a Lost World – Nepal, March 1978
Textbox by Prof Josef Glowa

My trip to Nepal actually began in Paris. In late fall of 1977, I strolled through the Quartier Latin and stopped at a travel agency's shop window. It was cold and rainy, and Paris wasn't very inviting at the end of November. A poster advertised cheap flights with Bangladesh Airlines from Amsterdam to Kathmandu, probably just $800 at today's exchange rates. I walked inside and gathered more information, and afterwards, I called my old school friend in Germany in order to suggest that we fly to Nepal together. We had considered doing something like this for a long time, and this flight was THE chance to realize a dream within our tight budgets. So we prepared for the trip for several months before our departure, and I even managed to find a Nepali-English dictionary with helpful phrases for travelers. We were all ready to leave and we planned of staying in Nepal for 4 weeks.

Ten years earlier, I had met some Hippies who had visited Kathmandu. They traveled across the entire continent and back simply by VW bus, and impressed us with tales of a Shangri-La-like. Mythical Himalayan happy land on their return.

The Nepal flight was actually my first trip by plane, and it was long and adventurous. The plane seemed very old--after take-off, one of my armrests even broke off. We flew out of Amsterdam with stopovers in Athens, Dubai, Bombay to Dacca. From Dacca, we boarded a commuter plane to Kathmandu. The airport in Nepal was small, and we had to walk through hazy, yellowish air on our way to the customs control building. From the start, the town of Kathmandu felt shrouded in exotic, fairy-tale mystery.

An intoxicating scent enveloped us; a mixture of woodsy smoke from indoor cooking fires and dust, along with fumes from old buses emitting black smoke. The town was amazing though. The streets were full of pedicabs with hardly any cars to be seem. In fact, Kathmandu seemed to be an entirely pedestrian town. There were no modern stores or advertisements. Instead, life took place in the streets. Public spaces bustled with vendors selling fruits and vegetables; barbers plying their trade; traditional healers selling herbs, powders, and Ayurvedic liquids; and women washing clothes in buckets outside their houses in the streets. Everything was out in the open air. We sought out lodging and found a small hostel run by Tibetan exiles. The hostel had a makeshift restaurant and a bar with photos of the Dalai Lama everywhere. The other guests at the hostel weren't part of any organized tourist groups. Rather, the clientele consisted of only individual backpackers, and most of them seemed to be American.

After sunset, the downtown area avoided complete darkness with a few dim street lights. In comparison to the noisy daytime, Katmandu was beautifully quiet at night, interrupted from time to time by the sound of music.

(continued)

Every night, musicians were busy, and one could find ensembles in public locations playing traditional instruments, like the *tablas*, the harmonium (a small hand-pumped reed organ), and *sarangi* (a small stringed instrument). The music venues were often lit by only one lightbulb hanging from the low ceiling of a temple entrance, which was adorned with photographs of King Birendra and Queen Aishwarya on the walls. These concerts were obviously aimed at local audiences, and I saw hardly any Westerner listening.

Throughout the cityscape, the ornate carvings and intricate details of temples and other buildings in public spaces were sights to behold. Even back in 1978, the medieval towns of Kathmandu and Bakhtapur seemed fragile with their marvelous art, as loosely stacked bricks foreshadowed the destruction by earthquakes to come.

From Kathmandu, we intended to hike into what is today the Shivpuri Nagarjun National Park, towards the high peaks of Langtang National Park. However, we had to obtain and pay for a special permit for a self-guided trekking tour before we were allowed to depart. We got the permit and set out on foot. We followed trails that were hundreds of years old, and sometimes they were so narrow that we had move to the inside (away from any cliff) or walk back several minutes to get to a wider spot in order to allow oncoming traffic pass. We often came face-to-face with women carrying conical baskets full of firewood, tea leaves, or leaves for animal feed on their backs. And from time to time, we had to get out the way of ferocious looking men with large Gurkha knives or kukris attached to their belts.

Life in the mountains and valleys seemed picturesque. We often saw women and children washing clothes in glacial rivers, and along the trails, we stopped a small village squares where mostly men gathered around a central fireplace topped by a big tea pot.

As we traveled across mountain ranges and valleys, we sought out places to stay with locals in exchange for money or goods. People were happy to put us up, and we stayed many nights in their stone farm houses with thatched roofs. We typically ate with the family, mostly rice and lentils. The simple houses were divided in two sections: the lower level was occupied by livestock, and the upper section under the roof was for sleeping and cooking. This upper level was reached via a ladder. One night, after eating in half darkness, an old farmer's wife generously offered me a pillow, in the form of a nicely shaped stone. I had to accept it. Next day we bathed in a river, and when we shed our clothes, we found out that our bodies we were lined and crisscrossed with lice bites rows. It took almost 5 months to get rid of the scars.

In small villages, locals often offered us one bedroom houses for short-term lodging, and they were pleased to earn a few extra Rupees for the lodging. I recall one interesting event from the trip in particular. In one village, a

(continued)

middle-aged man approached us. He spoke some English and told us that he had learned the language when he lived and worked in Calcutta many years earlier. The man seemed unhealthy and his yellowish eyes and skin tone suggested that he suffered from jaundice. He said there were a few sick people in town, and he asked us for modern medicine, particularly for some Aspirin. Then he led us to a young man whose right face side was covered dried blood and dirt. The wound looked pretty bad. We did have a first aid kit with us, and we set to work on him. First, we cleaned his face with alcohol, and we discovered that the wound was, in fact, not that bad. After putting triple antibiotic cream on the cut and covering it with a large band aid, the fellow looked good. Indeed, he was so happy that he followed us for a whole day, helping us by carrying our backpacks. During last days of our long trek, we walked along the Indrawati River back to a bus stop, where we could hop the bus back to Bakhtapur and Kathmandu.

Altogether, we had a wonderful time in Nepal 41 years ago. However, even then we were aware of poor natural resource management: widespread forest degradation, inefficient irrigation, and lack of drinking water were obvious even to non-specialist. Back in 1978, the population of the Kathmandu valley was around 400,000, but already by the 2011 census, it had risen to roughly 2.5 million! Urbanization and industrialization has taken a toll on Kathmandu. Moreover, no one at that time could have or would have predicted the 2001 Nepalese royal massacre, the civil war, or the devastating 2015 earthquake, events that have shaped recent history and culture. Time gone, what new times are coming?

Chapter 10
A First-Hand Narrative Account on Tibet's Paper Parks: How China's Greenwashing in Tibet Flies Under the Radar

Michael Buckley

In the book *Yeti: The Ecology of a Mystery*, I came across a stunning statistic. On page 382, author Daniel Taylor cites the extraordinary figure that 54% of the land area of "China's Tibet Autonomous Region" (TAR) is now classified as "nature reserves." In fact, Daniel Taylor says he has been instrumental in the creation of Mt. Everest National Nature Preserve and 18 other nature reserves within the TAR. This sounds like an admirable achievement, but let's also take into account the fact that Daniel Taylor spent close on 60 years searching for a chimera–the legendary Yeti. In his book, he finally concludes the Yeti is a species of Tibetan bear, with large footprints left in the snow being serial steps of a mother followed by cubs. The same conclusion was drawn by others decades ago—including climbers Reinhold Messner and Edmund Hillary, both setting off on expeditions in search of the mysterious Beast of the Snows.

Call me skeptical, but Daniel Taylor's other quest—to establish a series of national parks—is just as strange a tale. The book's subheader is: *The Ecology of a Mystery*. For me, the big mystery here is not the Yeti, but that figure of 54% of Tibet's land area set aside for nature preserves. The land area of the TAR is 1.2 million square kilometres, which means about 600,000 square kilometres have been set aside as "nature reserves." Changthang Nature Reserve alone encompasses over 334,000 square kilometres, qualifying as the second biggest in the world, after Northeast Greenland National Park. That is, if Changthang is a genuine park.

Already the Changthang Nature Reserve is bigger than many nations around the world. If Tibet were a nation (as it once was), the TAR's 54% nature ratio would make it the greatest environmental innovator on the planet. The only nation that

M. Buckley (✉)
Independent Researcher, Vancouver, BC, Canada
e-mail: himmies757@gmail.com

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comes close is Bhutan, lying just across Tibet's southern border. Bhutan has set aside 51% of its total land area for nature reserves, wildlife sanctuaries and biological corridors. In fact, Bhutan is the first and only nation in the world to realize famed biologist Edward Wilson's vision of setting aside half the planet for nature to regenerate and for biodiversity to thrive. The next nation to get even remotely close to that vision is Costa Rica (Fig. 10.1).

Having travelled extensively on all sides of the borders through the years—in Tibet, in Bhutan, in India and in Nepal—I can tell you there are major red flags to raise concerning the Chinese narrative on nature preservation in Tibet. Mao Zedong pushed the slogan that "*Man must conquer Nature*." This had mixed–sometimes devastating–results. China has a sorry history of destroying its own ecosystems and its wildlife—causing species like the tiger to go extinct. Tigers in China were hunted to extinction to feed demand for bogus Traditional Chinese Medicine practices. Meaning the demand for tiger bones, penis and other parts—to be consumed in soups and other concoctions, touted to boost the male libido (remedies that have never been proven to actually work).

British mountaineering expeditions to Tibet in the 1920s and 1930s remarked on the huge herds of wild antelopes, wild asses and yaks that roamed the grasslands. In the 1960s and 1970s, the decades after China forcibly took over Tibet, its wildlife was decimated—hunted for food, medicine, or sport. In a sense, Tibet was the first place in the world to create national parks—because they set aside regions as sacred landscapes—sacred lakes, peaks, valleys—to be left totally untouched. So the Chinese actions in Tibet have deeply offended Tibetans. However, Tibetans have no say over what happens to their land, their resources—and their wildlife. There is nothing "autonomous" about the Tibet Autonomous Region. This is meaningless Chinese doublespeak. Likewise, setting aside a nature reserve is meaningless unless the reserve is patrolled and policed, to keep poachers and opportunists at bay. That type of needed policing simply does not happen in Tibet. But it certainly does

Fig. 10.1 Tibetan antelopes in Changtang, northern Tibet. The areas of Changtang (TAR) and Hoh Xil (Qinghai) are the last great refuge of the Tibetan antelope, which was decimated in the 1980s and 1990s by poachers seeking its valuable underwool—the finest in the world, used to make shawls for celebrities in the West. (Photo credit: Matteo Pistono)

happen in adjoining Bhutan, India and in Nepal, which all appear to take wildlife preservation more seriously.

10.1 Nature Reserves and Nomad Resettlement

Examining the "math" of ecology in Tibet reveals some bizarre statistics. In 1990, according to official figures cited by People's Online Daily (China Daily 2013), nature reserves accounted for just 4% of the land area of the TAR. By 2012, that figure jumped to over 33% of total land area. Then, according to Taylor, by 2016 around 54% of the TAR had been set aside for parks. And that is just the TAR. Outside the TAR, in ethnic-Tibetan parts of the provinces of Qinghai, Sichuan, and Yunnan, more vast nature reserves have been established, such as Sanjiangyuan National Nature Reserve, which started off covering 20% of the land area of Qinghai Province, but later was boosted to over 50%. So this creation of vast national parks appears to be an ethnic-Tibetan-area phenomenon (Fig. 10.2).

Why such a meteoric rise in the number of nature reserves? Why such big reserves? And why on the Tibetan plateau in ethnic-Tibetan regions? There's no clear answer, but the timing—from 1990 to 2017—coincides with large-scale Chinese removal of Tibetan nomads from their grassland habitat. This nature park creation agenda appears to be justification for evicting upwards of two million Tibetan nomads– the stewards of Tibet's immense grasslands—and resettling them in concrete urbanized ghettoes.

Along with the establishment of these national parks come coercive laws that severely limit the rights of people in and around the designated areas—usually Tibetan nomads. Yet within the boundaries of these reserves, there seems to be very

Fig. 10.2 The vast Changtang Nature Preserve (TAR) has some WWF and Conservation International involvement. (Photo credit: Matteo Pistono)

little in the way of protection going on: nomads are pushed out, grasslands are mismanaged, herbs are harvested unsustainably, wildlife is poached, trees are felled, and illegal mining takes place. And creeping desertification plagues the land further. Desertification is a huge problem within Tibet and across China. The grasslands provide a buffer against desertification—but only if the grasslands are taken care of. The stewards of Tibet's vast grasslands are the Tibetan nomads, who rely on these grasslands to graze their yaks—and have done so for over 4000 years, co-existing in harmony with nature for four millennia fine (Fig. 10.3).

The strategy of using the creation of nature reserves to oust indigenous populations is not new: it has actually been used by unethical rulers around the world. A prime instance of this is the ousting of the hunter-gatherer Bushmen in Botswana through the creation of Central Kalahari Game Reserve, coincidently located between two of the largest diamond mines in the world.

The fact is that the Chinese overseers of Tibet have virtually no experience with grassland management. They claim that the nomads are degrading the grasslands by over-grazing their yaks and sheep and goats. Which is a decidedly odd claim, since the grasslands have remained sustainable for four millennia. More likely, the problem is the Chinese policy of mandatory fencing, introduced in the 1990s. The forced fencing pits nomad clans against other clans, vying for territorial rights—and it undermines the entire principle of nomadism, which is moving around, rotational

Fig. 10.3 Nomad tent faces off with Chinese mining venture on the grasslands. All too often, this happens within the boundaries of a so-called "nature reserve"

grazing, sharing land with others, keeping the yaks moving from pasture to pasture. With grassland pasture fenced in, of course the yaks are only grazing in a confined area, so no wonder that area becomes rapidly degraded under such a governance regime (Figs. 10.4a and 10.4b).

Environment writer Emily Yeh notes (Yeh 2014) that Chinese managers of so-called nature reserves are more interested in generating revenue through exploiting the reserve than in their protection: "Many protected areas are 'paper parks,' with at least one-third lacking staff, management and funding. The Nature Reserve Law of 1994 did nothing to remove control of the land under protection from the government that was managing it when it became a reserve. Moreover, except for national-level reserves, it failed to provide a guaranteed source of funding for reserve administration and staffing. This has led to a situation in which reserve managers' primary goal has become revenue generation rather than biodiversity conservation" (Fig. 10.5).

Henan-based environmental activist Huo Daishan, quoted in an article by Radio Free Asia (2014), claims that designation of national parks or nature reserves is tied up with vested interests that often propose the parks in the first place. He says that local governments are adept at retaining control over areas given nominal protection under central government laws. "According to what we are seeing on the ground, and from what the NGOs are able to observe, there is a huge gulf between [laws protecting parks and reserves] and the local government's implementation of them," Huo says. "There are always local interests bound up with protected areas. In the end, this entanglement…this conflict between the designation of a protected area and local development interests, destroys the protected area."

Fig. 10.4a Chinese wire fencing being staked out in eastern Tibet. The introduction of wide-scale fencing by Chinese authorities has destroyed large swathes of grassland because nomads previously relied on rotational grazing

Fig. 10.4b Fencing division in Damshung results in two very different fields of grass

Fig. 10.5 A settlement for Tibetan nomads, who have been shuffled off to concrete ghettoes like this, with no facilities like schools or medical clinics

10.2 Hoodwinking the UN World Heritage Committee

These so-called parks often do not cover a single area with clear boundaries: they are broken up into different zones, making protection vague. The Three Parallel Rivers region in Yunnan, a declared UNESCO World Heritage Site in 2003, consists of eight geographical clusters divided into protected nature zone areas and scenic areas. No sooner was this region declared a World Heritage Site than megadam building started up on these same river stretches, thus endangering the riverine ecosystem that supports the incredible biodiversity of the region. The mighty rivers and canyons that give the site its name are peculiarly enough not part of the World Heritage site, it seems. There have been calls to change the status of Three Parallel Rivers to a 'World Heritage in Danger' site. In 2013, when World Heritage personnel revisited the area, they noted there was a string of megadams on the rivers–and then did nothing about it (Fig. 10.6).

Within the Three Parallel Rivers World Heritage Site lies Mount Kawakarpo, a highly revered mountain with a pilgrim path around it. In February 2011, a Chinese gold-mining operation started up close to the pilgrim circuit. Infuriated Tibetans pushed equipment worth hundreds of thousands of dollars into a river far below. The mining operation was shut down. But protests against dam construction on the rivers running close to this nature reserve have not been successful.

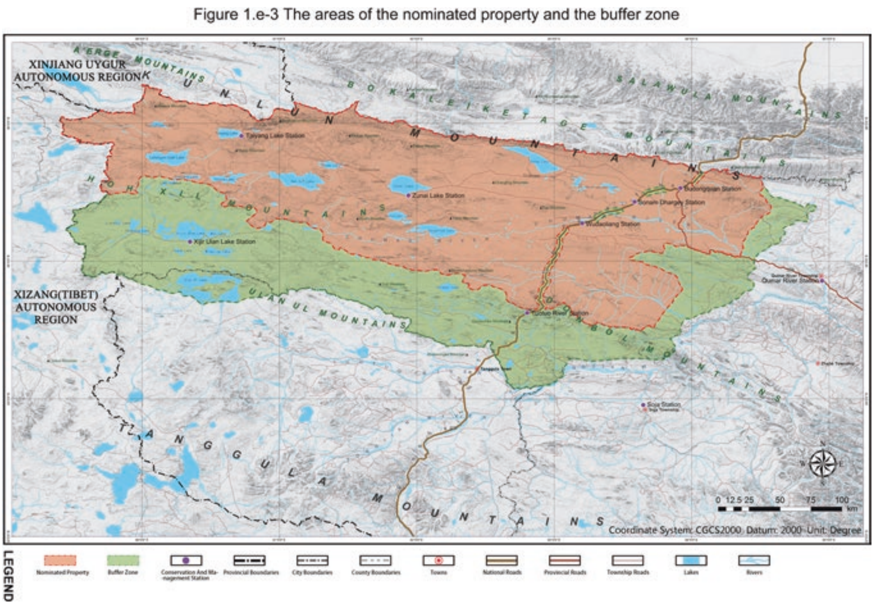

Fig. 10.6 Hoh Xil World Heritage Site, in Qinghai, north side of Tibetan Plateau. Note the core zone, and the buffer zone–which can be redrawn if a conflict of interest arises with mining ventures

China was a late starter in joining UNESCO World Heritage listings. Its first site was inscribed in 1987. Since then, China has raced up the rankings, registering 52 sites of cultural and national importance, trailing only Italy by a whisker (Italy has 53 sites listed). In its efforts to become the top World Heritage nation, the Chinese government has thrown money, marketing and manpower at the project. Among the strangest World Heritage sites in China is the ensemble of the Jokhang Temple, the Potala Palace, and the Norbulingka (summer palace). The palaces are both strongly associated with the lineage of the Dalai Lamas. Official Chinese sources vilify the exiled 14th Dalai Lama as a "wolf in monk's robes" and "a splittist," and yet they claim to preserve Tibet's cultural heritage at his former palaces. Every single photograph of the 14th Dalai Lama has been removed from these sites, leaving only a large historic painting of him and other figures on a wall at the Norbulingka. Around the Jokhang Temple, many ancient Tibetan buildings at the Barkor have been fully demolished and replaced with Chinese copies—all in the name of cultural preservation.

When a serious fire broke out at the Jokhang Temple in February 2018, Chinese authorities imposed a blackout on all news about the incident, refusing to reveal the extent of the damage (Fig. 10.7).

The latest addition to China's World Heritage haul is Hoh Xil Nature Reserve, in Qinghai Province. Hoh Xil (aka Kekexili) covers a region of 45,000 square kilometres in extent: it was inscribed to the World Heritage site in July 2017, despite fierce opposition from Tibet-support groups abroad. Originally established in 1995, Hoh Xil is prime habitat for the highly endangered Tibetan antelope, and for other rare wildlife. The region became famous in China through the showing of the film

Fig. 10.7 Illegal coal mine in Qinghai, on grasslands inside a so-called nature reserve. Note the fox in foreground. Photo by Greenpeace East Asia

Mountain Patrol, made in 2004. This gritty film shows Tibetan volunteers taking on Chinese poachers in the reserve, and confiscating thousands of antelope skins. However, the Tibetan volunteer band, dubbed the "Wild Yaks" was eventually disbanded, after its leaders were actually killed by poachers. This region is home to some 90,000 Tibetans—mostly nomadic.

Conservation International (CI) proposed the creation of a Sacred Natural Site, managed by Tibetans, allowing for community access to the zone. The NGOs CI and the WWF worked with nomadic families in this and adjacent regions to employ Tibetans to patrol wildlife areas, though not much is known about the success of this initiative, which seems to have since vanished. Certainly, this solution could work well if given half a chance. I have trekked through Bhutan's Sakteng Wildlife Sanctuary, at the eastern side of the country. This wildlife sanctuary is home to the Brokpas, nomad herders of Tibetan origin. They get along fine with the wildlife, though occasional conflict happens with a wild predator going after a baby yak or sheep in a nomad herd (a generic scheme found throughout all of the Hindu Kush-Himalaya, if not the world even).

What is transpiring at Hoh Xil is exactly what protesters warned the UN World Heritage Committee about: the removal of nomad families *en masse*, despite Chinese promises that the nomads would not be disturbed. The World Heritage listing unequivocally supports the rights of the Tibetan pastoralists in the area. But just 5 months after the inscription of Hoh Xil as a World Heritage site, Chinese officials imposed an ominous ban on access to the new reserve, except to a few authorized Chinese personnel.

10.3 When Miners Happen to Venture into Nature Reserves

More than half of Qinghai Province is set aside for nature reserves, so what about the other half? Well, that is somewhat darker in nature. The region, previously known as Amdo, was once part of the Tibetan realm-but in 1965 it was carved off and donated to the neighbouring province of Qinghai. Qinghai's massive Tsaidam Basin is a wasteland of mining—the total opposite of a national park. The Tsaidam Basin is heavily exploited for oil extraction and rampant mining of minerals. Upcoming is tar-sands oil extraction, the dirtiest form of obtaining oil ever devised. North of Golmud lies Chaerhan Salt Lake, home to huge lithium salts deposits-which are extracted by Chinese electric-vehicle giant 'Build Your Dreams.' Build whose dreams? Powering the Chinese dream, but certainly not the Tibetan dream. That's because this industrial activity sometimes spills over into regions revered by Tibetans, such as sacred peaks. And it spills over into so-called "nature reserves." A conflict of interest? No—because China uses its time-tested trick of dividing the place up into "core zones, buffer zones, and experimental zones." And the rules for each zone will shift around like the desert sands. The map is redrawn to suit the miners, so that they actually can access nature reserves (Fig. 10.8).

Fig. 10.8 Chinese mining ventures have sprung up in numerous locations on the grasslands of Tibet

Obviously, the creation of paper parks in Tibet paves the way to exploit pristine regions for vast mining and dam-building ventures.

Case in point: Sanjiangyuan National Nature Reserve, in Qinghai.
Sanjiangyuan was created in 2000, supposedly to protect the headwaters of the Yellow, Yangtse and Mekong rivers.

Sanjiangyuan initially covered an immense area of 150,000 square kilometres—greater in size than England and Wales combined. Later, that extent was more than doubled. A map of Sanjiangyuan did not appear in any official source until early 2009. That's because the whole exercise appears designed to bamboozle not only Tibetan nomads but also watchful foreign outsiders. The official map of Sanjiangyuan that finally surfaced is a chaotic jumble of zones: core zones, buffer zones, and experimental zones. The latter two allow for "development" and "green industries." This seems to refer to options for mining and for building of hydropower stations (in Chinese references elsewhere, dams are considered "green").

In 2005, part of a core zone at Sanjiangyuan was adjusted to a buffer zone to allow gold-mining company Inter-Citic to start up operations. The company alluded to the region as being "uninhabited." What they failed to mention is that all the nomads of this region were forcibly shifted off the same grasslands to make way for mining exploitation, which caused extensive damage to the region.

In mid-August 2013, Tibetans from Dzatoe County staged a 3-day sit-in protest against an illegal mining operator in Sanjiangyuan National Nature Reserve. The operator's license to mine turned out to be fake: he obviously paid off corrupt officials. Protesters put up a gate flying Chinese flags and bearing posters of President Xi Jinping, quoting from his May 2013 speech about the importance of guarding the environment for future generations. The protest in Dzatoe was broken up by over 400 military and paramilitary troops using tear gas and electric batons as well as firing machine guns in the air. At least one protester was killed. Fourteen protesters were hospitalized, and a large number arrested. Video footage of the protest was taken by Tibetans using smartphones: this was smuggled out of Tibet and posted to YouTube—confirming that gunfire was used against unarmed protesters. The video is actually a rare chance for the outside world to see what actually happens at a mining protest within a so-called Nature Reserve. Against all the odds, the Tibetans of Dzatoe later achieved a rare victory: they took their case to Beijing and argued that the mining was illegal. The credentials of the miners were found to have been forged, and the mining was shut down (Fig. 10.9).

Over 400,000 nomads have been forcibly resettled in Qinghai, with a significant number of those coming from the Sanjiangyuan area. This is being done under the cloak of conservation. Fiercely independent and reliant on their own resources—their yaks, goats, sheep and horses—the Golok nomads, the toughest and most stubborn of all Tibetan nomads, have now become beggars in their own land. Shifted into the concrete urban ghettoes, they have been deprived of their regular food sources, and live off Chinese government subsidies—which are not enough to buy the tea, cheese and other commodities they once had in abundance. This is a form of cultural genocide (Fig. 10.10).

Installed in such ghetto-housing, former nomads even have to buy bottled water: before they got abundant water for free from rivers. These former nomads have been offered no job retraining, and as they cannot speak or read Chinese, they are unlikely

Fig. 10.9 Starting up in 2006, the Golmud-to-Lhasa railway has opened up Tibet, making large-scale mining and megadam-building economically viable for the first time

Fig. 10.10 Family of nomads, who are fast disappearing in Tibet. What does the future hold for their children?

to be employable in towns and modern industrial society. However, during the spring, a number of ex-nomads venture into the high-altitude mountains to collect rare mushrooms and exotic herbs (like Chinese caterpillar fungus, highly valued for medicinal properties and as an aphrodisiac), thus generating decent income.

Meanwhile, state-run mining companies have moved into the so-called nature reserve; also moving in are hydropower consortiums building a bevy of small dams within the region in support of mining and new energy needs. Sanjiangyuan may become the starting point for the ambitious water diversion of the Yangtse River headwaters to the Yellow River headwaters so that more water will flow to water-starved Beijing. This harebrained plan embraces three mega-dams—with wall heights of 175 m, 302 m and 296 m—linked to a series of tunnels totalling hundreds of kilometres in length. That does not sound like conservation. Is the vast Sangjiangyuan National Nature Reserve protecting the headwaters of the rivers, or opening the door to their exploitation by state-run companies and their leaders? (Fig. 10.11).

In December 2013, it was announced that Sanjiangyuan's area would double in size for the purposes of "rehabilitation" of the land. That size represents over 50% of the land area of Qinghai Province: the real target of this "rehabilitation" appears to be the last remaining nomad strongholds. By more than coincidence, at the same time that expansion of Sanjiangyuan was announced, another official site said that 90% of nomads in Qinghai would be resettled.

Fig. 10.11 "Development" is being pushed by this Chinese propaganda poster, featuring a Chinese engineer and a PLA officer. At upper left, on the grasslands, is a newly built Chinese dam. At lower left, Chinese PLA troops are shown riding alongside armed Tibetan Khampas on horseback. This is pure fiction. In the 1960s, Khampas were waging a guerrilla war with Chinese troops

10.4 Eco-Babble

In June 2008, a Reuters article reported a story from Lhasa on a proposed "ecological security plan" to counter the impact of receding glaciers and shrinking grasslands in Tibet (Buckley 2008). The report quotes Mr. Zhang Yongze, director general of Tibet's Environmental Protection Bureau. According to Reuters, the plan, which could initially cost 10 billion yuan (US$1.5 billion), would involve turning grasslands into protected forests, restricting grazing, and creating "green jobs" for Tibetans that would ease pressure from population growth and development. "*The solution to problems like global warming is out of our hands, but this document will give us a framework to work in,*" Zhang says. Tibet would also have to develop more hydroelectric power stations on the region's many rivers—an option opposed by some conservationists—to provide enough power, he says (Figs. 10.12 and 10.13).

The rhetoric gives an idea of Chinese doublespeak on the environment. Creating green jobs for Tibetans? Chinese officials have actually taken away over a million "green jobs" from Tibetans by removing nomads from the grasslands. If you want to save the grasslands and keep Tibet green, the nomads are best left alone and within their own governance. If you want to ease pressure from population growth and development, that's simple: stop such type of development and waves of Chinese miners and immigrants from flooding into Tibet on the railway. Turning grasslands into forest? That's not feasible as large areas of the Tibetan Plateau lie above the tree-line. The plan calls for the building of dams to "provide enough power." Power for what exactly? Why is dam building mentioned in connection with environmental plans? Zhang Yongze goes on to cite the usual Chinese take that dams are green, and thus better for the environment than burning coal, but he fails

Fig. 10.12 The Salween—one of the last wild rivers of Asia—is part of the Three Parallel Rivers World Heritage site. The other two rivers are the Mekong and the Yangtse. Megadam-building is now under way on the Salween

to mention that Chinese mining and industry need power from megadams, not Tibetans. Meaningless eco-babble like this is regularly churned out by Chinese official sources to make everything sound clean and green in Tibet. Plans for establishing an "ecological security barrier" in Tibet speak about pouring billions of yuan into setting up more national parks and protected reserves—which may exist only on paper.

And that is the trouble with China's approach generally. The government has environmental laws that exist only on paper; they do not seem to be enforced. China is signatory to the UN Convention on Biodiversity, and signatory to the UN Declaration on the Rights of Indigenous Peoples. But these appear to be quite worthless scraps of paper: China signs international agreements protecting the rights of indigenous peoples—and then turns around and sets about snuffing out their culture by taking them off their traditional lands. The real stewards of Tibet's grasslands are the nomads—they are a major part of the solution, not part of the problem.

The nomads are under more resettlement threats as Beijing unveils its grand plan to establish ten huge national parks in 2020. Four of those will be located in regions inhabited by Tibetan nomads: these sparsely inhabited zones, well away from prying eyes, are the easiest places to set up vast parks, whether genuine or not. The ever-expanding Sanjiangyuan National Park (already referenced in this article) serves as the pilot project for this ambitious plan. In 2017, it was announced that over 60,000 people would be relocated here. That likely refers to forced relocation of Tibetan nomad herders.

Other vast national parks upcoming in Tibetan regions are Paducuo National Park in upper Yunnan, Giant Panda National Park (straddling Sichuan, Shaanxi and Gansu provinces), and Qilianshan National Park, straddling Qinghai and Gansu.

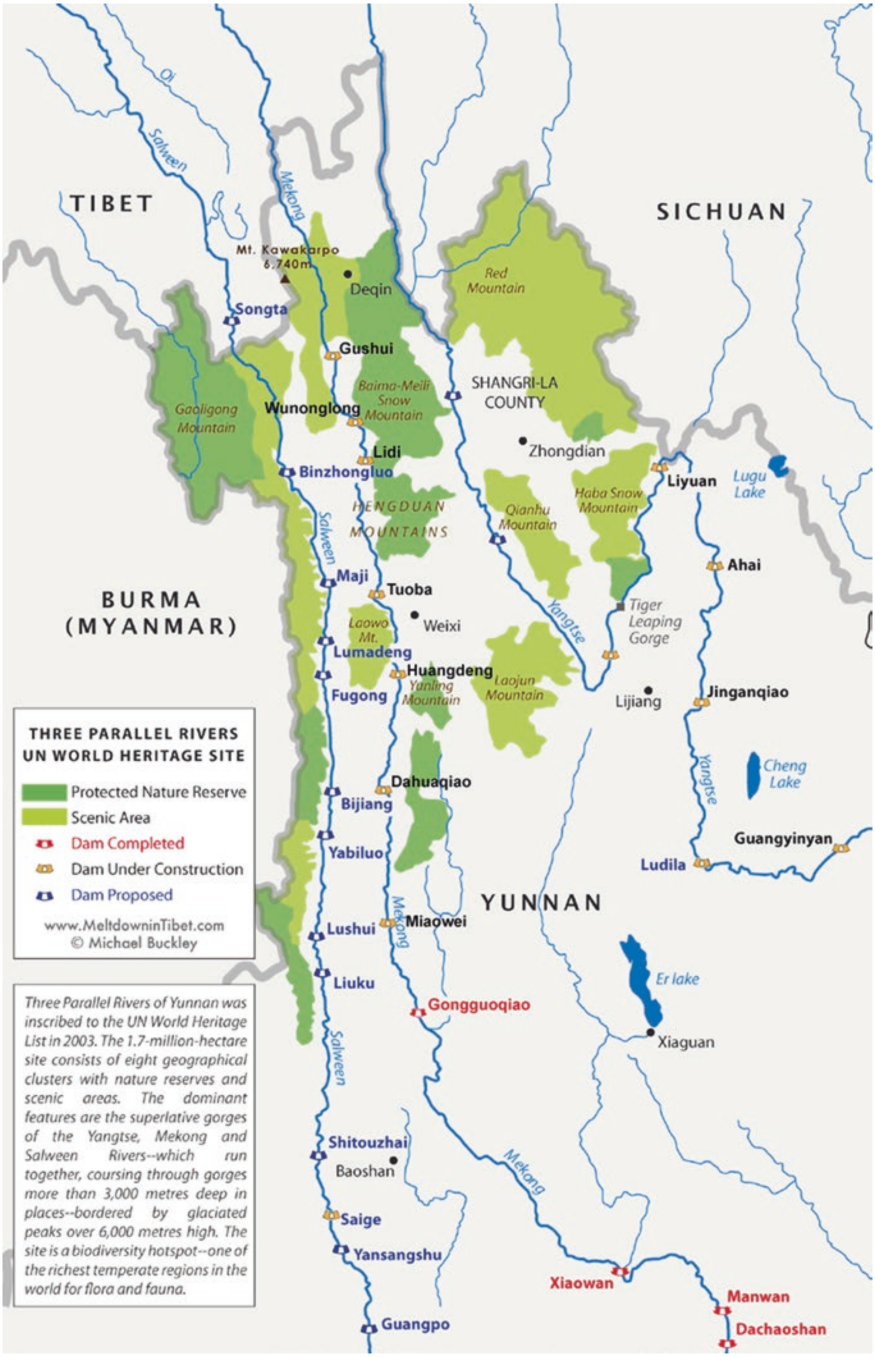

Fig. 10.13 Three Parallel Rivers World Heritage Site, with core zones, buffer zones and mixed-use zones. The three rivers themselves are not protected—and cascades of megadams have popped up on those rivers

Coming under control centralised from Beijing may or may not mean closer monitoring. Qilianshan National Nature Reserve was criticised in 2016 by both the Party Central Committee and the State Council for excessive commercial activity. "Excessive" refers to 52 illegal mining operations found there.[1]

Because of lack of free press in China, it is near-impossible to work out what goes on in these parks and how they operate. Green glove or iron fist? It remains to be seen how conservation will play out under China's authoritarian regime. One thing remains very clear: Tibetan nomads, the guardians of Tibet's grasslands, will be shuffled off to concrete ghettoes—under the cloak of conservation.

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[1] https://www.chinadialogue.net/article/show/single/en/10152-China-overhauls-its-national-parks-. An inspection of the same park in 2017 revealed that in addition to rampant mining, there was illegal construction and operation of hydropower facilities, as well as "excessive" emissions by local enterprises.

Chapter 11
Forestry Management in Nepal: An Example and a Review of Growth & Yield

Sakar Jha, Apsana Kafle, Ganesh Puri, and Falk Huettmann

11.1 Introduction

Land spanning more than 0.5 ha with trees higher than 5 m and a canopy cover of more than 10%, or trees able to reach these thresholds in situ is called Forest (FAO 2015). A number of such definitions for forests are used around the world, however to get a basic view about it, the Government of Nepal defined Forest as any land area that is partly or completely covered by trees or grasslands. Forests and shrublands cover 44.74% of total land area of Nepal of which forest cover 40.36% and shrublands cover 4.38% of the total land area (DFRS 2015) (See Fig. 11.1). Forests play a significant role in supporting the livelihood of the forest dependent communities and support the economy of the country in a tremendous way. Recognizing that forests can help the country to develop with a sustainable approach, the government along with support from international agencies has worked rigorously for past few decades to develop the forestry sector of Nepal. This chapter reviews the implementation and success of forest management practices in Nepal.

S. Jha (✉) · A. Kafle
Institute of Forestry, Tribhuvan University, Pokhara, Nepal
e-mail: sakarjha299@gmail.com

G. Puri
Department of Forests, Ministry of Forests and Environment, Government of Nepal, Kathmandu, Nepal
e-mail: gpuri.forestry@gmail.com

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA

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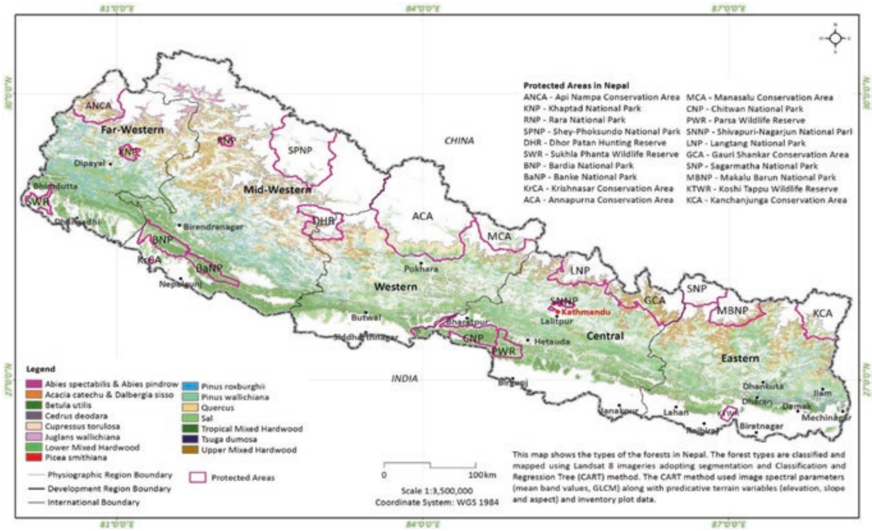

Fig. 11.1 Map of Nepal showing the different types of Forest Found in Nepal. (Source: DFRS 2015)

Nepal has roughly a rectangular geometric outline located between Latitudes 26°22′ 30°27′ and Longitudes between 80° 4′ and 88°12′. The average east-west distance is 885 km and the north-south distance is 166 km. It is divided into three geographical landscapes southwards along the slopes of Himalayas: Mountains, Mid-hill and Terai. The altitudinal range of Nepal falls between 59 and 8848 m and encompasses very diverse bio-climatic conditions. The forests of Nepal have a direct correlation with different sectors such as industries, tourism, watersheds and wildlife conservation.

11.2 Classification of Forest

Forest in Nepal are classified mainly for the purpose of description, administration, management and record. A general framework of classification of forest was provided by Schweinfurtch (1957) in his vegetation map of Himalayas. This was closely followed by Dobremez (1976) through extensive study and field visit. The department of forest (DoF) has also made several bases for the classification of forest in the context of Nepal for their practical management purpose.

Forests in Nepal are majorly classified into:

1. Geographical and Climatic Classification (Ecological Classification)
2. Functional Classification (Productive and Protective)
3. Legal Classification
4. Administrative Classification
5. Silvicultural Classification

11.2.1 Ecological Classification of Forests

The diversity of altitudinal variation allows Nepal to incorporate Palearctic and Indo-Malayan bio-geographical regions and six floristic provinces of Asia creating a rich and unique diversity of life. The topographical and climatic variations of the country make it equally rich in flora and fauna. To maintain the ecological role of forests in the biosphere, forests are classified into different types which eases in their management (Table 11.1).

11.2.2 Classification of Forests for Management (Table 11.2)

11.3 Forest Management in Nepal

Forests play a significant role in nation's development and people's living standard. In the history of the Nepalese forestry sector, different periods have witnessed different practices – some of them converging on central exploitation of resources to

Table 11.1 The forest categories according to HMGN/MFSC (2002) found in Nepal

Forest type	Elevation (m)	Dominant species
Tropical forest	>1000	*Shorea robusta, Michelia Champaca*
Subtropical forest	1000–2200	*Schima wallichii/Castanopsis indica, Alnus nepalensis*
Lower temperate broad-leaved forest	2000–2700 in west and 1700–2400 in east	*Alnus nitida, Castanopsis tribuloides, Castanopsis hystrix, Lithocarpus pachyphylla (bada katus),*
Lower temperate mixed-broad leaved forest	2000–2700 in west and 1700–2200 in east	*Tree species belonging to lauraceae family*
Upper temperate broad leaved forest	2200–3000	*Quercus semecarpifolia*
Upper temperate mixed broad-leaved forest	2700–3100	*Quercus semecarpifolia, acer and juglans spps., Rhododendron*
Temperate coniferous forest	2000–3000	*Pinus wallichiana, Cupressus torulosa Tsuga dumosa, Abies pindrow*
Sub-alpine forest	3000–4100	*Abies spectabilis, Betula utilis, Rhododendron spps.*
Alpine shrub	<4100	*Juniperus spps., Rhododendron spps.*

Table 11.2 Classification of forests for management

Forest category	Management objective	Responsible agencies
Government managed forest	Production of forest products	Government
Leasehold forest	Rehabilitation of forest and production purpose	Leasehold purpose
Religious forest	Protection of religious sites	Religious institution
Protected forest	Protection of wildlife, biodiversity and environment	Government
Community forest	Production, sale and distribution of forest product	User groups
Private forest		

raise revenue, while others are more concerned with protection of resources to supply basic products at the local level. The GoN has developed policies and institutional instruments to materialize the forest management strategies accordingly (Khatri et al. 2015; Bampton et al. 2007).

Objective of Forest Management in the context of Nepal:

- Maintaining and raising the productive capacity of the soil and forest stand with the maximum site potential.
- Promoting the protective effects of forest against any kind of natural calamities like avalanches, erosion etc.
- Execution of various silvicultural operations so as to bring normal state of a forest.
- Maximizing the production so as to provide satisfaction to the stakeholders and raw materials for forest based industries (Fig. 11.2).

11.4 History of Forest Management

The history of Forest management systems in Nepal is categories in five parts, according to the major changes in forest management activities with time.

11.4.1 Before 1926 A.D.

- Very little knowledge among people about forest management.
- Land was given as a reward to the officials as Birta, Guthi etc.

11.4.2 From 1927 to 1960 A.D. (Table 11.3)

11.4.3 From 1961 to 1977 A.D. (Table 11.4)

Fig. 11.2 Forest officials measuring DBH of a Tree. (Source: Authors)

Table 11.3 Forest management in Nepal from 1927 to 1960 A.D.

Time	Major activity	Function
1927 A.D.	Establishment of Kath Mahal	To supply forest products to India
1942 A.D.	Department of Forest with 3 circle and 12 Banjanch	To control and manage forest administration
1947 A.D.	Establishment of Forest Institute under Forest Department	To train the mid-level technicians
1957 A.D.	Nationalization Act	Nationalization of forests
1959 A.D.	Establishment of Ministry of Forest	To carry out forest activities nationwide
1960 A.D.	MoF was abandoned, CCF office was established	To collect revenue for the country

11.4.4 From 1978 to 1990 A.D. (Table 11.5)

11.4.5 From 1991 to Now (Table 11.6)

11.5 Community Forestry

Community forest is defined as a situation, which intimately involves local people in forestry activities (FAO 1978). The control and management of forest resources by the rural people for domestic purposes and as an integral part of their farming systems is community forestry (Gilmour and Fisher 1998). It aims at providing direct benefits to rural people and that "The People" should have a substantial role in decision making. The community forestry program was launched in the late 1970s, when the government of Nepal realized that involvement of local people in forest management was essential for forest conservation and to curb the crisis of

Table 11.4 Forest management in Nepal from 1961 to 1977 A.D.

1961 A.D.	Establishment of Timber Cooperation Nepal	To supply timber, fuelwood from resettlement areas.
1966 A.D.	Establishment of Fuelwood Cooperation	To supply fuelwood to Kathmandu
1967 A.D.	Formulation of Forest Protection Act	To enable protection and conservation of forests.
1970 A.D.	Formulation of Forest Production Rules	To collect and control the revenue.
1973 A.D.	National Park and Wildlife Conservation Act	Seperated National Forests into Protected Areas of Nepal in the name of National Park, Wildlife Reserve Conservation Areas, Hunting Areas etc.
1976 A.D.	Publish of National Forestry Plan (9 circle, 40 division in 75 districts)	To implement forestry activities nationwide

Table 11.5 Forest management in Nepal from 1978–1990 A.D

1978 A.D.	Promulgation of Community Forestry Rules	To involve the local people in the protection of forest.
1982 A.D.	Decentralization Act	To empower local level administration
1983–88 A.D.	Establishment of 5 regional directorates (MFSC) and 75 DFO	To match with decentralization act
1989 A.D.	Master Plan for Forestry Sector was made	To improve the policy of forestry sector

Himalayan forest degradation (Bhattrai 2016). Community forestry is flourishing in Nepal, improving the livelihoods of rural communities and nurturing democracy from bottom level despite a prolonged insurgency and political upheavals (Ojha and Pokharel 2005) (Text Box 11.1, Table 11.7).

Table 11.6 Forest management in Nepal from 1991 to now

1993 A.D.	New Forestry Act	To handover the national forest to the adjoining user groups for accountable management
1993 A.D.	Forestry Act	Categorization of forest into two major class: National forest and private forest.
1995 A.D.	Forest By laws	To launch the Forest Management Acts according to Forest Act.
2000 A.D.	Forest Policy	Initiated Collaborative Forest Management (CFM) in Terai involving all stakeholder including local users, local government i.e. VDC & DDC, NGO's etc
2015 A.D.	Scientific Forest Guideline	

Text Box 11.1: Features of Community Forests (HMGN 1993, 1995)

1. The district forest officers are authorized to hand over national forest to the forest user group (FUG) and provide them with technical support and assistance.
2. The size of the national forest handed over as community forest depends on the FUGs capacity of managing the property. However, the ownership of the forest remains with the state.
3. CFUG boundary can be cross over administrative boundaries such as district boundaries. In that case, FUG can apply to DFO in any district.
4. CFUGs are autonomous and corporate institutions and they follow their operational plan in carrying out management activities.
5. CFUGs can use surplus funds for any community development activity and are not required to share benefit with the government.
6. DFO can take the community forest back from FUGs if they operate against operational plan. However, once the problem is solved, CF can be handed back to the same of different FUG.

Table 11.7 The transition of coverage of community forests

Period	No. of CFUGs	Area of CF (ha)
Before 1997	5355	362,551
1997–2003	13,300	1,100,000
2004–2009	14,431	1,230,000

Source: Kandel and Niraula (2004)

11.6 Collaborative Forest Management

In the hills, community forestry was very efficient in reclaiming degraded forests but the government had been passive to hand over forests to local communities in Terai. Most of the forest patches of Terai were under government management and their existing quality was degrading largely due to conversion of forests for development programs after the malaria eradication (Ojha 1982). To stop the degradation of Terai forests, the government of Nepal introduced a new concept of collaborative forest management (CFM) for the management of block forests in Terai region of Nepal (Bampton et al. 2007). The government tried to implement operational forest management plans in order to manage large blocks of productive national forests, but it could not be implemented due to the lack of acceptance and participation of the local people. The government felt need of policy revision to manage productive block forests of terai, hence the concept of collaborative forest management was introduced which addresses more specific issues of terai such as inclusion of distant users (Ebregt et al. 2007, Text Box 11.2).

Text Box 11.2: Features of Collaborative Forests Management

1. CFM is applied on productive forests of Terai/Inner Terai regions (as per Forest Act 2049, it is applied in “government managed forests”).
2. In CFM implementation, collaboration is made among forest users (close and distant), local and central government.
3. Forest management is based on approved CFM schemes where intensive management is prescribed under the principle of sustainable forest management.
4. Institutional structure of CFM comprises CFM group, committee, sub-committees and implementation units. CFM group is the representatives’ apex body of forest users which is formed from ward representatives (including women, dalit and janajati) selected by ward level forest users who are included in the social unit of CFM; VDC/municipality and DDC representatives, NGOs and line agencies representatives including DFO staffs.
5. Revenue sharing mechanism (as per CFM guideline) is such that 75% of the revenue collected from the sale of forest product goes to central treasury while 25% remains with the CFM group and local government. In addition to forest management, CFM fund can be allocated for various income generating activities for poor, women groups, dalit and janajati.

Source: MSFC (2000) and Paudyal (2007)

11.7 Scientific Approach to Forest Management

The scientific forest management concept was initially focused on 'sustainable timber production and meeting economic objectives'. However, the scope has broadened to include aspects of social, cultural, and environmental values (FAO 2016).

The terms 'scientific forest management' and 'sustainable forest management' have been used and understood interchangeably in the global forestry scenario in recent decades linking management activities to principles of sustainable development and focusing on the balance between three major pillars: ecological, economic and social-cultural. The global understanding on SFM considers that it is a multidimensional concept that integrates a wide array of commercial and non-commercial values, environmental considerations, community needs, even global environmental impact including climate change. In the Nepalese context, SFM is perceived as a potential option for improving depleting forest quality and productivity, and for harnessing the true economic potential of the forest resources (MSFP 2015).

11.8 REDD in Nepal

Reducing Emissions from Deforestation and Forest Degradation (REDD) in developing countries is a mechanism that allows industrialized countries to offset their emissions by purchasing carbon credits from developing countries, which reduce emissions from deforestation and forest degradation by avoiding such activities. REDD has been updated to REDD+ with the inclusion of wider range of forest related activities and recognizes the role of participatory forest management in promoting sustainable forest management which enables communities to access financial mechanisms provided by climate regime – in theory at least (Karky et al. 2011). REDD concept was introduced in Nepal in 2008 and declared as a ministerial priority by the Ministry of Forests and Soil conservation as REDD forestry and Climate Change. The Government of Nepal is committed to REDD through reversing deforestation and forest degradation, conservation of existing forest and enhancing the forest carbon stocks, while addressing livelihoods concerns at the same time (MFSC 2010).

11.8.1 Benefits from REDD

REDD can be a very effective mechanism of payment for ecosystem services with strong potential to reduce deforestation with benefits like (Text Box 11.3):

Text Box 11.3: Benefits of REDD Implementation

Climate benefits: It can strengthen the climate resilience of the ecosystem and adaptation capacity of the communities as the degradation of forests are reduced and the global emissions are significantly absorbed.
Biodiversity benefits: It can prevent the loss of habitat and strengthen biodiversity conservation outcomes.
Social benefits: It can support cultural value and livelihoods of traditional communities which are associated with forests and build capacity for sustainable forest management.
Livelihood benefits: Payment for carbon sequestration and storage can reduce the poverty and promote additional activities like timber harvesting, eco-tourism, NTFP collection.
Other ecosystem services: Soil conservation, Water quality and regulation, Rainfall regulation, maintenance of pollinator populations, Rainfall regulation (Acharya et al. 2009).

Source: Gauli and Upadhyay (2014)

11.9 Fire Management

Forest fires are a major challenge in Nepal, where large patches of forest are lost each year as a result of fire incidents. In recent years, the number of forest fire incidents has risen, further contributing to the destruction and degradation of already stressed forest areas. Past records show that not only have massive forest patches been lost, but army personnel and community members have lost their lives combating forest fires. Different management practices such as fire lines construction, early warning system, controlled burning, training local people on putting out forest fires have been adopted in different places of Nepal. However, ignorance and carelessness of the people while inside the forest has made it difficult to control forest fires effectively (Fig. 11.3).

11.10 Forest Resources for People's Livelihood

Forests are crucial for the goods and services they provide, which people all over the world depend on. Forestry is an integral part of the rural livelihood of Nepal; about 76% of the nation's population is characterized as being forest dependent (Amatya 2013), and 64% of the population is still using fuelwood as the major source of domestic energy (CBS 2014). In addition, non-timber forest products (NTFPs) have become an important alternative source of income for the rural poor especially in the hill and mountain regions. Community forestry program has helped enhance livelihoods of the local communities by fulfilling several basic needs of the users, strengthened natural resource governance, and attempted for equitable sharing of benefits among the rural populations (Gautam 2009). The creation and functioning of the self-governing FUGs at the local level has enhanced social and human capital (Pokhrel et al. 2007) (Fig. 11.4).

Fig. 11.3 Fire fighters putting out wildfire in a forest. (Source: Authors)

Fig. 11.4 Local people collecting fuelwoods from forest. (Source: Authors)

11.11 Conclusion

In Nepal, forests play an important role in the people's livelihood as well as in the economy of the country. The policies made by the government have helped restore and regenerate degraded forests and maintain the balance in the ecosystem and physical cycles. Along with this, the transfer of governance of natural resource from government to people through community forestry has also allowed for the improvement of people's livelihood and well-being. However, as the demand of the people are increasing on a daily basis, management practices need to be more evolved to ensure the sustainability of the forests. Forest fires act majorly in forest degradation, hence fire management practices need to be advanced with the collaboration of government with international agencies with new technologies available today. The people's dependency on fuelwood needs to be shift towards alternative options like bio-gas.

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Part II
Concepts, Cultures, Religions and the Mind

Chapter 12
What It Is Like to Be a Land-Locked Nation: Some Discriminatory Examples and Details from National Watersheds of the Hindu Kush-Himalaya Under the Neoliberal 'Free Market' Participation Paradigm

Falk Huettmann

Born to die, living to win and to be free
Source attributed to Motörhead

12.1 Introduction

The Hindu Kush-Himalaya (HKH) landscape is a globally relevant landscape. It is inherently vast and rugged, featuring remote and isolated valleys, so-called Shangri La's (Hilton 1933; Palin 2004; Baumgartner 2015). However, this results into fragmented and isolated pockets where humans either evolve into, or out of (Karmay and Watt 2007; Baumgartner 2015). Entire cultures, even nations, might just become forgotten for long time and not be apparent in the global community, such as Sikkim, Bhutan, Tibet or Kyrgystan. The high diversity of languages, cultures and customs still remaining in HKH speak to that effect (over 120 languages and many more distinct dialects are known for Nepal alone; Whelpton 2005). Deep religions and spirituality developed and evolved in such isolated pockets (Karmay and Watt 2007). And sometimes other people -marginalized outsiders- take refuge in the pure remoteness of the landscape and its culture (e.g. Baumgartner 2015 for Tibetan-border

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F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department,
University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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regions; Yitzhak 2009 for Uyghurs). For long time many of those places were widely unknown even, 'closed' to the world (Millward 2007; Lama 2012; Whelpton 2005 for overview and examples). As a consequence those groups, cultures and nations found themselves excluded from the wider trade and global community, and could suffer accordingly (again the histories of Tibet or Sikkim and Bhutan make for good examples, e.g. Bhanja 1993). Often this is true to this very day and these places lag behind from the major events of the world still catching up (a typical example for the HKH region is provided in H. Harrer's autobiography from 1952 'Seven Years in Tibet'; see also Hooker 2011). Strange enough, this situation -the so-called untouched environment and culture, and the perceived backwardness -now makes for the fame of the HKH region that people and globalization seek (Lama 2012). In times of globalization, many tourists develop a 'romantic hunger' for seeing such remote, 'primitive', unspoiled places. People actually do seek 'sustainability' and lives free of industrialization! It should be understood here clearly that remote places are not automatically poor, 'bad', un-industrialized, uncivilized or primitive. Instead they can present unique and comparable experiments and role-models while the big world goes '*ga ga*' (Alexander 2013; Cockburn 2013; Harai 2015). Many of those remote areas, specifically Central Asia, have been perceived as cradles of species if not even of humanity (e.g. Elvin 2004). Already the biodiversity of those places is often endemic, natural and less destroyed making it for modern biodiversity and conservation hotspots (see Nyambayar et al. 2011; Amin et al. 2018 for examples). Man-made climate change and its associated globalization have now set their feet and efforts into the destruction of this fabric that otherwise evolved for centuries, if not even millennia (Baumgaertner 2015, Fig. 12.1).

By now, many humans -specifically ones from the industrialized west and urban centers like San Francisco, Paris, London, Frankfurt and Berlin etc. – carry a lot of sympathy with such remote places that are far away from, and not much affected by, an industrial life-style and its western impacts. Islands -and perceived as highly seeked-after wilderness tourist get-away destinations – are typical examples for such desires fueled and created by the modern industrialized world (aka 'the west'). Often those places are seeked out by religious practitioners (and to no surprise, virtually all remote valleys in the HKH region have holy sites and sacred pilgrimage locations for long time; Lama 2012 for an overview for Humla, Nepal and Kailash, Tibet).

But one should also see and understand that such isolated and remote places carry their own dynamics and realities. Often they are actually connected with, or present, a high civilization (see Weatherford 2005 for Mongolia; Chaudhary et al. 2007 for Annapurna, Nepal). It's probably clear that the life-expectancy can be shorter there than in the rest of the (western) world, and that issues like policing, financial wealth, medical coverage, level of 'modern' feminism and technical education are usually somewhat less advanced there too (see Baumgaertner 2015; Harai 2015 for an industrialized perspective).

The international community used to punish, or to cripple, nations by withholding or cutting access to ports and coastlines, e.g. after wars and conflicts as the case with Bolovia in 1879, or Hungary after WW1, Cuba and the ongoing Jemen port embargo. Whereas issues like society, spirituality, harmony and balance with one

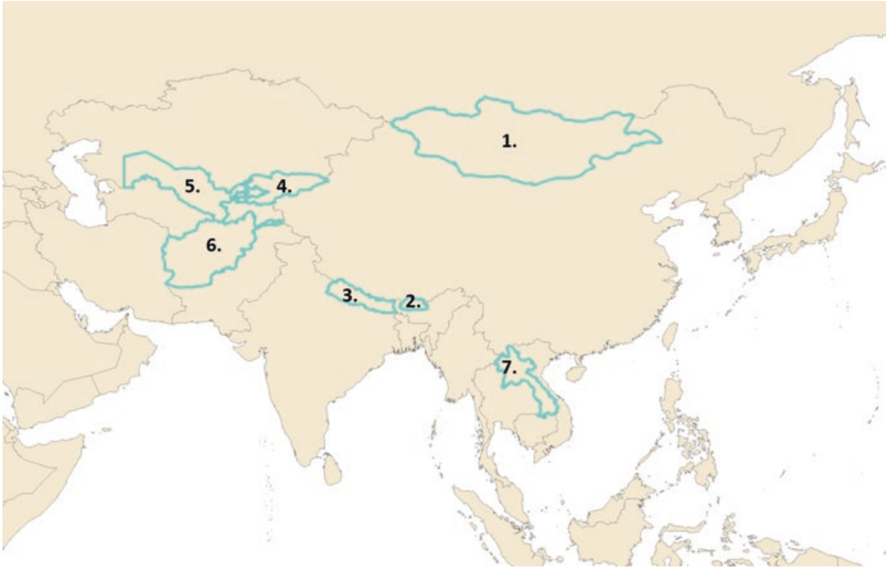

Fig. 12.1 Land-locked nations in the study area (1. Mongolia, 2. Bhutan, 3. Nepal, 4. Kyrgisia, 5. Uzbekistan, 6. Tajikistan, 7. Laos)

own's life might traditionally be more pronounced there in the consequently 'isolated' places (Diamond 1997). Instead, the overly individual lifestyle emphasis of the western society has probably no good place in such remote societies (Palin 2004). In the modern times of the Anthropocene, many remote areas in HKH are now deprived of male labor and subsequent effluence which got drawn into the cities or abroad even (Chaudhary et al. 2007; Hoerman et al. 2010, Fig. 12.2). In the Hindu Kush-Himalaya region this makes for a big scheme where remittance payments make for a high percentage of the GDP (app 30% in Nepal for instance, and now even higher for Kyrgystan; consider the otherwise small national economies of each nations respectively; Table 12.1). In nations that have some natural resources the amount of outside support tends to be smaller though, albeit not zero (see Mongolia, Uzbekistan and Kazakhstan; Table 12.1). The modern form of economy demands international exchanges for the pure sake of liberalism and neoliberalism (Harvey 2006 for textbook definitions). But land-locked nations cannot really participate in such an economy! Their products and themselves, cannot really get to market, but also they cannot compete and sustain market efforts since they lack the expertise and start-up investment, for instance. Lacking access to resources often means lack of access to associated education. It's a major disadvantage.

Despite the various numbers and background metrics (see Tables 12.2 and 12.3), it is clear that all landlocked nations in HKH feature a low GDP and with remittance payments on the increase, even when GDPs of the home countries are growing. This shows that

(a) the national labor market is not strong but habouring a lot of local unemployment,

Fig. 12.2 Devastated rural areas are heavily worked by females and children, in the absence of males who work abroad for better-paying jobs. This leaves the female worker at home with two jobs (family as well field work)

(b) the economy of those nations is widely influenced from the outside (see even the CIA invasion in Humla in Nepal; Lama 2012),
(c) the local environment is just converted for the financial gain of a few (Landes 1999, Daly and Farley 2010), and
(d) citizens are not in charge of their democracy and their nation and own fate even.

A modern nation needs many resources and ones that are based on external input; the national products are actually just half of the story, or even less. In times of globalization the underlying model of a nation now is one of

> *"…having everything, all the time and from all over the world"*. (*sensu* Czech 2002, Alexander 2013)

But in such a world no small and isolated nation can compete with the bigger nations that are better connected and who also have access to the world's oceans and polar regions, resulting from their colonial legacy (Diamond 1997). As shown in Rosales (2008) such a world order runs an inherent discrimination by national area size, geographic location and diversity. The landlocked nations, their democracies and their citizens, have no relevant power in such a global economy (Daly and Farley 2010; for the HKH region see for instance TED talk of Bhutan: https://www.youtube.com/watch?v=7Lc_dlVrg5M). And the watersheds of those nations reflect

Table 12.1 Remittance payments in land-locked countries of the Hindu Kush-Himalaya region

Nation	GDP (US $ MM) nominal	Percent remittance payment of GDP	Remittance trend from 1970	Comment
Nepal	21,14	31.2	Steep increase	Mostly based on Nepali labor from abroad, namely Saudi Arabia, Qatar, Dubai, the U.S. and EU
Kyrgystan	6,55	30.4	Steep Increase	A former soviet nation
Tajikistan	6,52	26.9	Increase	A former soviet nation
Uzbekistan	67,22	3.7	Decline	A former soviet nation
Mongolia	11,16	2.3	Decrease	A nation with a huge GDP growth of over 15%
Afghanistan	19,46	2.2	Fluctuating	A nation in war with many other dynamics (e.g. poppy and ISIS)
Bhutan	2,23	1.5	Steep increase	A formerly closed kingdom with little economic impact and workforce
Laos	15,90	0.7	Fluctuating	One-party Marxist-Lenist Nation
Kazakhstan	133,65	0.2	Stable	A former soviet nation
World	75,543,54	0.7	Increase	Globalization still on the rise, usually based on cheap foreign labor

Data: https://data.worldbank.org

Table 12.2 Nations in HKH that are landlocked and their population and area

Landlocked nation in HKH region	National population (rounded, millions)	Area (rounded km2)	People/area
Bhutan	0.79	0.04	19.75
Nepal	28.00	0.14	200.00
Sikkim[a]	0.61	0.07	8.71
Mongolia	3.20	1.56	2.05
Afghanistan	29.72	0.64	46.43
Tajikistan	8.93	0.14	63.78
Kyrgystan	6.14	0.19	32.31
Kazakhstan	17.80	2.72	6.54
Laos	6.49	0.23	28.21

[a]Sikkim is part of India after its Kingdom was arguably resolved by India

just that: they are overused and pressed hard to make a livelihood in a traditional way while they have to pay modern bills and under a so-called modern economy but which mostly means the carry the 'double whammy'. The pressure to make money from such a landscape is even larger, and invite for hydrodams and similar exploitation of resources. It's failure by design.

Table 12.3 Metrics of wealth of HKH land-locked nations, compared to major nations dominating global trade and HKH

Nation	Landlocked	GDP (in mioUS$; IMF 2018)	GDP per capita (thousand $, rounded)	Economic growth
Bhutan	Yes	2,624	8.70	8
Nepal	Yes	28,813	2.70	0.4
Sikkim[a]	Yes	~1,570	~7.20	<7.1
Mongolia	Yes	12,721	12.60	1.2
Afghanistan	Yes	20,367	1.90	2.4
Tajikistan	Yes	7.350	3.10	6.9
Kyrgystan	Yes	8,013	3.70	3.8
Laos	Yes	18,230	7.40	7.0
India	No	2,689,992	7.20	7.1
China	No	13,457,267	16.60	6.7
S. Korea	No	1,655,608	39.40	2.8
Japan	No	5,070,626	42.70	1.0
USA	No	20,513,00	59.50	1.5
Russia	No	1,576,488	27.90	−0.2
Brazil	No	1,909,386	15.50	−3.6

Source: CIA Factbook, The World Bank
[a]Sikkim is part of India after its Kingdom was resolved by India

Remote and isolated areas have been part of human civilization forever; it provided wealth, freedom and shaped human society to this very day (Chaudhary et al. 2007; Harai 2015 states that it is part of human evolution, disconnected tribes infighting. See Gregson 2002 for an example in the study area). But in the Anthropocene, this concept and such locations decay and disappear now strongly, and it all turns into a single connected group of people. In times of google and the internet, remote sensing, drones and global mobile phone coverage the world evolves, and everything evolves, all happens very fast (see Huettmann 2015a, b for remote field schools and education). In globalization even Shangri La's loose their insulation, and their subsequent appeal. With the internet and subsequent wire transfers, all now get dragged into one huge mass towards a new dynamic and dynamite: "*it's the Anthropocene, man*" (Smith and Zeder 2013).

A key item these days to be included in such a life-style and culture requires 'to be connected', globally. It's a requirement to be part of the modern world and globalization (see for instance in Table 12.1 that the global remittance trend is also on the rise; as is banking, lending and financial exploitation; Rich 2013; Daly and Farley 2010). This requires to have an ocean harbor, a navy, roads and trucks, airlines and a wider infrastructure where exchange of goods and people can occur (Der Spiegel 2018). A nation being landlocked is excluded then and runs into bottlenecks and 'spiral of debt' (Rich 2013, Figs. 12.3, 12.4, 12.5 and 12.6 for examples). Air transport tries to overcome it, but this requires resources to build, it needs an aviation education, approved and certified aviation facilities, including refineries for airline fuel (nations like Nepal and Kyrgystan are widely blacklisted by international air traffic. It's no surprise that the world's most airport is located in Lukla, Nepal;

Fig. 12.3 Friendship bridge between Laos and Thailand: A true bottleneck of friendship, equity and international well-being

https://www.news.com.au/travel/travel-advice/health-safety/inside-the-worlds-most-dangerous-airport/news-story/21519b748e67fe5b14dca1c00d14372c). Air traffic also needs a financing system in place. In the absence of such 'airlink support' the transport of good and bulk then is instead still done through cargo trucks, ships or smaller shuttle services, even on foot (human carriers still play a major role in the HKH region; an employment policy that is seen in the western world as inhumane, if not even barbaric). And last but not least, the navy provides for a world-dominating cargo transport as well as military power and intimidation force: nuclear submarines and aircraft carriers serve that purpose pretty well, but only a few nations really have those navies available to them and the expertise to even get there. The distribution of aircraft carriers in the world shows such power relationship well. Land-locked nations are left behind accordingly and are to be bullied.

Arguably, if one is not globally fluent, or present all the time, being landlocked is a real 'handicap'. Not being present at global events and exchanges can easily mean being at disadvantage. In the light of global wealth, religion and culture, over time not being effluent and 'present' is a main predictor for poverty and backwardness. However, environmentally, the opposite is often the case, defying the Kuznet's curve (see Resendiz and Huettmann 2015). The less modern of a development occurs the more pristine tend the watersheds to remain and being in support of water and industrial provision elsewhere for others, e.g. downriver (Shanghai and the Yellow Sea as the classic example; MacKinnon et al. 2012). Those rich areas can only produce and do well when they get the clean water from remote and 'primitive' uphill headweater regions, but those tend to be landlocked and thus, poor (see for

Fig. 12.4 Yak vs. truck: Such an example shows the reality for many land-locked nations where trucks, airlines and the internet are lacking. (See also in Baumgartner 2015)

instance Lama 2012 for Kailash; details presented in Goel et al. 2018). Wealth is not distributed fairly and equally nor guaranteed to everybody (but as western constitutions state).

Apart of wealth and effluence, what about human happiness? According to the Bhutan government, being landlocked is not a constraint though for being happy (Czech 2002)! But that notion might not be shared by everybody in the western world (Harai 2015) where materialism usually gets equated with personal achievement, satisfaction, and happiness! More and more people see this as a problem though (e.g. Alexander 2013).

When following modern criteria of development, wealth, self-reliance and governance, being land-locked is essentially a disadvantage, and those nations and their cultures '*can not play*'. The advantage of the so-called 'free and open market' and participation for everybody falls easily flat (Rosales 2008). It's a major argument to

Fig. 12.5 Line-up at a Nepali gas station: Reality in Nepal

Fig. 12.6 Friendship bridge between China and Nepal: Another true bottleneck with wider repercussions for India and Nepali people

label a nation as poor, and to make them dependent pumping them up with Development Aid (which tends to come back by perhaps 130% to the donor itself; Erler 2011), and thus, make them dependent on hand-outs. That way takes away their independence and turns the population into cheap labor, and thus, a form of modern slaves. In the HKH nations, this makes for a major pattern in many nations, considering that the major political players and wealthy nations that drive the world are the giants of India, China, the U.S., Russia and others, e.g. Japan, S. Korea, even Taiwan, Singapore, Malaysia, Indonesia or Australia, Qatar, Dubai and Saudi Arabia. All of these nations are global forces when it comes to ports, airlines, trade, internet and coastline access. And in support of such arguments, those all run major airlines. Taken together, this actually is where a lot of their power sits! Add the internet and software, and one is ready to enter the stage of a world power and globalization (Stiglitz 2017) (see Fig. 12.4)!

For a ‘modern type’ nation state to participate in all relevant processes for its citizens it requires much base infrastructure and features (Table 12.4 for an overview). In addition, it requires to be an equal participant in forums and institutions, as well as in the ‘market place’, free and open (Table 12.5).

Next I will list a few case studies of land-locked nations to show some ‘issues’ mentioned above using first-hand experience and the literature:

Case study Nepal: Nepal is a typical land-locked nation and culture. Due to its remoteness and ruggedness, it virtually was deemed as unimportant and ‘not worth’ the effort by British colonialist (Whelpton 2005). So it was somewhat left behind, and a left-alone royal family ruled there for decades, resulting into the current state of Nepal, still supposed to catch up (Whelpton 2005). India’s Prime Minister at the time, Jawaharlal Neru was probably seeing it as an Indian extension and backwater. At some stage, Maoists formed, and they essentially transitioned the nation and culture into a (modern) democracy with all its aspects, as well as associated problems in times of globalization. Arguably, Nepal is poorly managed when judged by the large amount of remittances received due to workers having to go abroad to make a living, any living! But Nepal is now seriously considering to get a navy. This matters though because it allows to obtain/

Table 12.4 A selection of features that are needed for a nation to be ‘modern’ (this view focuses on the wider HKH region, Asia)

Feature	Impact on GDP	Relation with human population size	Relation with environmental destruction
Ports	Large	Highly positive	Very negative
Navy	Big	Positive	Negative
Oil and gas	Large	Positive	Negative
Banking infrastructure	Large	Positive	Negative
A globally trading stock market exchange	Large	Positive	Negative
Book keeping standard	Somewhat	No direct	Not well studied, but somewhat required
Army	Large	Positive	Negative
Military budget	Large	Positive	Negative
UN representation	Somewhat	No direct	Slight negative (UN promotes industrialization)
Leading school and university systems	Big	No direct	Not well agreed on (can be pretty negative for impacts)
Health care	Large	Positive	Positive but poorly exposed thus far

Table 12.5 Indirect features and metrics related to maintaining the current world power structure across nations

Feature	Landlocked nations of HKH involved	Landlocked nations of HKH affected	Closely affiliated nations for the feature mentioned
Security Council access/ membership	No	Highly	India, China, U.S., Russia
Influence with OPEC	No	Highly	Saudi Arabia, Russia, U.S.
Airline industry participation	No	Highly	India, China, Japan, Korea, Malaysia
Influence and participation with The World Bank	Little	Highly	India, China, Japan, U.S.
Independent power supply	Little	Highly	India, China, Russia
Large set up of embassies around the world	Incomplete	Highly	India, China
A strong and modern airline fleet	No	Highly	India, China
Strong army	Little	Highly	India, China, U.S., Russia
Aircraft carriers and submarines	No	Yes	U.S., China, Russia, UK, France
Involvement in IPCC	Little	Highly	India, China, U.S.
Representation in FAO	Little	Highly	India, China, U.S., Russia, EU
High degree in industrialization	Little	Highly	India, China, U.S., Japan, Korea, E.U.
High degree of roads and car industries	Little	Highly	China, India, EU
A high degree of secularism	Partly	Highly	China, U.S.
Sophisticated tax system	Yes	Highly	
Tourism for ‘primitive’ places and nations	Yes	Highly	U.S., India, Japan, Korea, E.U.
Olympic gold medals	Not really	Somewhat	U.S., Russia, China, EU nations

trade fish from the ocean (an otherwise huge food subsidy that marine nations have easily available). Even marine claims like for Antarctica and the Arctic can be made, and it provides additional resources, employment and thus income, too. In addition, trade goods can be shipped to Nepal. With a navy, Nepal would become a more serious actor on the global playing field.[1] However, Nepal lacks a major airline (tourist and cargo) and it still suffers from a transportation bottle-

[1] It’s noteworthy here that Nepal is world-renowned for its Ghurka soldiers. Those people are now seeked after as security forces and they can even be found as ‘bouncers’ or on cruise ships of the world. It’s part of a vast labor force ‘at sea’, often from nations that have no real maritime history or legacy.

neck that is making them widely depending on the surrounding nations (India and China; see Figs. 12.5 and 12.6) to receive those goods: oil, gas and goods like computers, cars etc. When land-locked, one gets easily abused and marginalized in a so-called open and free market. Nepal experienced that first hand, again, when the earth quake hit in 2015. The ‘friendship’ bridge from China was destroyed and kept closed for long time. All awhile fuel was not able to be shipped from the Indian refineries. While Nepal blamed India to block ‘fuel transports’, India in return blamed Nepali extremists to close down such transports at the border region. China simply stayed outside of the conflict but, kept its bridge to Nepal closed longer too, and the international community did hardly notice nor act. What that does to fuel prizes, and to associated industries does not need to be mentioned much. A landlocked nation – Nepal – became a playing ball played with by coastal nations (China and India) who played out their monopoly. In the case of the 2015 earth quake and the fuel blockage, it also affected how Nepal designed and wrote its new constitution (done in favor of India). Arguably, live-quality is affected.

Case study Bhutan: Bhutan was a locked up nation for long time, widely forgotten by the international community and thus, not much directly affected by modern industrialization (Fig. 12.6). It’s still run by a royal family, not really a democracy and it can be found in a state of transition. So far, there has been not much (war) conflict, other than unresolved refugee problems with Nepal and the Indian dominance. Although not so well known, Bhutan is arguably widely dominated by India, as can be seen in several examples of its recent history and culture. While Bhutan maintains a great reputation for most of its splendor, e.g. nature and the largest buddha statue in the world, it features many other topics that carry problems and that are not well known, for instance its great discrepancy between the rural poor and the more wealthy and ‘free’ urbanites. Health care is another one of those. Much of the public image is dominated by the government, and schooling is far from perfect; drug consumption and associated decay can be seen in public urban spaces too. Due to shortages of goods and products, Bhutan ranks low in such metrics, and the population of Bhutan is widely excluded to join the ‘free and open market’. Thou looks the Happy Nation in real life (Fig. 12.7).

Case study Mongolia: Mongolia is another typical example of a land-locked nation in the wider HKH region. Once its empire broke down after Genghis Khan it had Islamic ties and essentially was under Chinese influence til the 1920s, then got briefly swamped by the Russian White Guard, just to turn into a communistic nation for many decades, and then, eventually opening up in the 1990s for the ‘western system’ of democracy and its capitalism and neoliberalism, all but just ‘to be used’ by international mining corporations for their claims and resource extraction. This resulted into extensive ‘boom and bust’ cycles typical for poor capitalist management, leaving the environment and its people widely exposed to the will of outside power dynamics (see Fig. 12.8 for a landscape example). Mongolia is sandwiched-in between the great powers of China and Russia, but being further exploited by mining and industrialized nations of Australia, Canada,

Fig. 12.7 Keeping Bhutan in a 'simple' state helps tourism: The landscape remains widely 'pure' due to the lack of an industrial footprint there

Fig. 12.8 The Oyu Tolgoi Mine (mainly owned by Rio Tinto) in Mongolia: Devastating landscape reality of coal mines also resulting into overgrazed landscapes due to unconstrained economical growth for the world export market

the US, Russia, China and the EU (namely Germany, France). In the process of transition, it literally went from a medieval state though communism, socialism and shot-gun capitalism, now globalization. Millions of people left their lives in that process, others were dragged with it. Whereas historically Mongolia is placed centrally in Asia and benefitted greatly from such a position from which it was able to expand its influence all over the (old) world in the eleventh century onwards. Some of this linkage and mindset still exists and are used now in other forums and globally. For instance, Mongolia is located on the Silk Road and gets access to traded coastal wealth that way. Nowadays, the camel tracks are replaced by planes and railroads, but new road systems are to be built, e.g. the Belt by China (https://asia.nikkei.com/Spotlight/The-Future-of-Asia-2018/Belt-and-Road-provides-landlocked-Mongolia-with-chance-to-grow).

Case study Tibet: While the story of Tibet is already widely told elsewhere (Harrer 1952; Lama 1990; see Buckley 2014 for its watersheds), here just to report that the Tibet Autonomous Region (TAR; see Buckley 2014 for the region not being autonomous), as a national culture or Chinese province, is also land-locked. Many aspects of its history have been made famous though the experience by H. Harrer's 'Seven years in Tibet', by the story of the Dalai Lama and his escape and subsequent conflict including acclaimed genocides (see for instance molestations of monks; Lama 1990). One might easily argue, on the one hand, that the different perceptions around Tibet, its claims, ownerships and the alleged genocide, is due to this region and culture being land-locked, in-accessible and thus not well resolved and protected by the wider international community and the associated value system, e.g. universal human rights. Rosales (2008) shows us some of such conclusions. However, on the other hand, Tibet always was a hub between nations with great international connections, even linked with sea ports, and it might be the reason why it's 'isolated fate' eventually became so famous internationally.

Case study Laos: Laos is another landlocked country. It is located in southeast Asia and it is affected by the Hindu Kush-Himalaya region, e.g. water source, weather, culturally, religion and topography. Formerly, it was the great kingdom of Lan Xang Hom Khao (also referred to as the Kingdom of a Million Elephants Under the White Parasol). For app. four centuries it existed as one of the largest kingdoms in Southeast Asia! After colonial power and being invaded and dominated by France and Japan, it went through internal struggle and became communistic eventually. Without coastal access but to remain viable, Laos embraced a development path to sell hydrodam electricity to other nations. The infamous Xayaburi Dam on the Mekong River was build without getting formal approval or valid environmental impact study creating an international outcry! Arguably, this leaves a large footprint and is due to the fact of being landlocked without much access to natural resources, namely coastal and marine ones. When poverty rules, so does its ideologies. Laos is now trying to develop itself very quickly for the western mindset, e.g. mining, forestry and railroads, and thus features an economic growth of app. 7%. An expanding road system is to cater those developments (Fig. 12.3) Tourism is growing (Awarded in 2013 for "World's Best Tourist Designation"). Human right violations and accusations of genocide, e.g. the Hmong, remain a major problem in Laos. Arguably, having a direct coastline access for this country would have had another outcome for this now land-locked nation, its people and watersheds.

Case study Kyrgystan: Kyrgystan is a land-locked country in Central Asia and it featured for several centuries a vast kingdom (Turkic and Mongols). Kyrgystan is located on the Silk Road, and was recently awarded a major road construction grant by the Asian Development Bank (https://www.adb.org/documents/kyrgyz-republic-carec-transport-corridor-1-bishkek-torugart-road-project). Gold makes up a large section of exports and hydrodam electricity for export is part of major development projects. Kyrgystan was widely dominated by the Soviet Union. Uprisings and ethnic clashes followed. Although now independent, it still keeps strong ties with Russia. Remittances make up for 40% (!) of the national GDP. Kyrgystan lacks an internationally accepted airline. Being located in dry mountains (deserts) it features subsistence farming based on goats and cattle; the Fergana Valley remains the agriculture hotspot of the nation. Human right violations are known.

12.2 Conclusion and Outlook for Land-Locked Nations in the HKH Region

So what should land-locked nations do? They have clear profiles (Table 12.6, Figs. 12.1, 12.2, 12.8 and 12.9), they have problems with the modern world and how business is run, and are widely on the poorer side of the global community; their options are few. The concept of global nation states – the free world – locked them in, and they cannot get out on their own. Boundaries are set. Keep in mind, most land-locked nations were not only proud kingdoms for centuries (e.g Nepal) but they also were dominating even entire continents, e.g. Mongolia! Nowadays, they cannot compete with the ruling mega nations, hardly with industrialization or super-urban centers. In the western world, the assumptions are to be citizen-based (democratic voting), run social concepts and well-being, with a form of regulated and secular government. But how good and efficient -how modern – is such a governance, really (Alexander 2013)? And why and how to implement it, and by whom (Daly and Farley 2010)? Arguably, modern nations and their governance feature neoliberal concepts and thus, marginalize the environment, certainly watersheds (Czech 2002, 2008).

From a justice perspective, clearly, wealth in this world is not distributed equally, and likely it will not happen any time soon (Rosales 2008). While global human rights exist, they are hardly enforced nor even realistically to be achieved for every citizen in every nation, certainly not for land-locked nations. Not all actors in the world are equal partners or actors, the so-called ‘open and free market’ does not exist (Landes 1999; Daly and Farley 2010) and certainly is not fair or moral.[2] This

[2] A common argument one hears in the western world is ‘I worked for it, and thus, I earned it and I am entitled to it’. Well, most poor people (~<4$ a day) work more than 40 h a week, without healthcare and got virtually nothing from their labor life-long; thus is slavery.

Table 12.6 Shared realities of landlocked countries

Commonalities	Landlocked nations	Comment
Mining	Tibet, Laos, Nepal, Mongolia, Kyrgystan	Probably the major growth industry
Hydrodam investment and eletric energy export	Tibet, Laos, Nepal, Mongolia, Bhutan	Also a major development scheme primarily for export
Transportation hub	Tibet, Laos, Nepal, Mongolia, Kyrgystan	An ancient scheme
Human rights violations	Tibet, Laos, Nepal, Mongolia, Bhutan	Virtually unresolved in most of those nations
Strong reliance of subsistence farming	Tibet, Laos, Nepal, Mongolia, Bhutan, Kyrgystan	A source of income while other employment and resources are lacking
Multiethnicity	Tibet, Laos, Nepal, Mongolia, Bhutan, Kyrgystan	Tens, if not hundreds, of different tribes
Occurrence of uprisings and civil war	Tibet, Laos, Nepal, Mongolia, Kygystan	While common in most nations's history here it is still lingering and often active
Neoliberal as well as communist ideologies	Tibet, Laos, Nepal, Mongolia, Kyrgystan	Nepal and Laos remain Marxist-Lenist
Exclusion from Antarctic Treaty	Tibet, Laos, Nepal, Mongolia, Bhutan, Kyrgystan	A major power tool to participate in globalization
Rural poverty	Tibet, Laos, Nepal, Mongolia, Bhutan, Kyrgystan	Not well addressed by the current globalization
Imports of refined oil and gas	Tibet, Laos, Nepal, Mongolia, Bhutan. Kyrgystan	Lacking those resources results into vast dependences
Tourism	Tibet, Laos, Nepal, Mongolia, Bhutan	Usually ecotourism
Remittance payments and outside labor	Nepal, Kyrgystan, Mongolia, Tibet	A major problem for various aspects, e.g. social, ethical, and democracy

can easily be seen for the less privileged in society, which in HKH are usually the females, the children, the lower casts and the poor overall; the majority of people. With climate change on the rise, none of those are to get better any time soon. Having an equal and fair access to marine resources and the required infrastructure could be a way to achieve a better life for the land-locked nations and their people, and also reduce conflicts overall, globally. So why not working on that, and using public money and tax-funded work towards it?

Environmentally, the case is pretty clear for such nations and their cultures: All land-locked nations of the HKH region are pretty low in consumption, low in GPD, have not much modern industry to show and carry a rather low carbon footprint. They are environmentally benign, and when compared to the big leading polluters of industrial nations. By coincidence, most land-locked countries happen to be pretty peaceful, too; their military budgets are small despite having a history of

Fig. 12.9 Hydrodams in landlocked nations: Planned and built by foreign expertise and primarily used for exporting energy abroad leaving devastated watersheds behind. Who wins?

providing great soldiers, e.g. world-renowned Gurkas from Nepal that serve in armies worldwide (Great Britain, India, U.S.), or the world-famous armies of Mongolian and Laos kingdomes. Some of the land-locked nations in HKH even claim to be a global leader in happiness. While some internal conflict exist, arguably, those ones rank little to what other nations went through in the last 150 years, e.g. the American Civil War and indigenous genocides, or the wars and purges in Russia, China, Korea and Japan, where easily 100 million people got killed in that process, leading to the 'modern' world as we know it. Was that worth it?

Issues to resolve are many. Some remain about a combination of economic, social and environmental values, and all are to be done for global sustainability. So far, many land-locked nations still run management and governmental schemes from 40 years ago or older, and nobody really wants those nations really to be world-dominant anyways. Just think of a Mongolia again that dominated for centuries much of the continent (including China and reaching to Japan and the EU), or Laos (bombed into heavy destruction due to its assumed role in the Vietnam war) or even the Dalai Lama (exiled; Lama 1990)! The low position of land-locked nations in the global 'pecking order' and GDP ranking works well in favor of the powers in charge and for their cultures and subsequent business and wealth. But like most other nations, these land-locked nations are now transitioning aggressively into the new millennia, also trying to claim their place in the world of globalization. Arguably, the people, the economy and the environment – the watersheds- already pay the prize. Modernity is not kind to the environment (Alexander 2013; see Czech 2008 for an inherent conflict). Unless the trends of globalization are changing, HKH, with an environment and status as we know it, will soon be another sad story of the past, sacrificed by drivers in the west and a not-so-well-understood form of Americanization (Czech 2002; Alexander 2013; Cockburn 2013) and the wish to be 'modern' and well connected. Greed tends to drive it. So far, being locked away might have been pretty beneficial for wilderness areas and the watersheds overall. It boosts Ecotourism (which is then part of the western industrial life-sphere by its employees seeking unspoiled 'primitive' places far away from the workplace). But in times of global change – which does not really consider any borders – even that concept is not dealt with well. The future will be a true Anthropocene – inherently neoliberal and thus abusive and unsatisfactory at its core – and while the verdict is still out how the mélange will look like for the next 100 years, with the water crisis looming further, no good outlook can be expected for the watersheds and for what relies on it in such a world order and its culture.

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Chapter 13
Ethnobiology and Indigenous Regimes in the Conservation of Species, Watersheds, and Landscapes: Experiences and Evidences from the Hindu Kush-Himalayan Nations for a Global Application

Tirth Raj Ghimire, Pitamber Pant, Ganga Ram Regmi, and Falk Huettmann

13.1 Introduction

The Merriam Webster Dictionary defines 'ethnic' as relating to large groups of people classed according to common racial, national, tribal, religious, linguistic, or cultural origin or background (Merriam-Webster 2004). Ethnicity is about institutions, learned behavior, and customs (Upadhyay 2013). The word 'Indigenous' means 'son of the land' which is actually hold by the ancestors for future generations. Indigenous people have actually no real history of migration from other places and are the vulnerable tribes who only have a limited ability to participate in the ongoing development process (Upadhyay 2013). Although it is not easy to differentiate between the definitions of ethnicity and indigenous, these terms are used in many texts synonymously.

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T. R. Ghimire (✉)
Animal Research Laboratory, Faculty of Science, Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur, Nepal
e-mail: tirth.ghimire@nast.gov.np

P. Pant
Tri-Chandra Multiple Campus, Tribhuvan University, Kathmandu, Nepal

G. R. Regmi
Third Pole Conservancy, Kathmandu, Nepal

F. Huettmann
-EWHALE Lab- Institute of Arctic Biology, Biology and Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA

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Western scientists state that ethnobiology is a science of biological knowledge of a particular ethnic group about the cultural and religious use of plants and animals for their welfare, especially for the veterinary and human health. Although biology seems to be principal, the study of an integrated approach of various branches like anthropology, cognitive psychology, geography, environmental studies, and indigenous studies is critical to understand ethnobiology. Thus, ethnobiology is a multidisciplinary approach of traditional or local understandings of the many relationships among plants, environments, and invertebrate and vertebrate animals including humans for the aim to treat and prevent the diseases, to enhance the longevity, and the physiological, physical, and psychological well-being. Ethnobiology can be further easily rebranched into ethnobotany, ethnozoology, ethnomedicine, and ethnogenomics. The term ethnozoology is defined by Jose Geraldo W. Marques, for instance, as the transdisciplinary study of the thoughts and perceptions (knowledge and beliefs), sentiments (affective representations), and behaviors (attitudes) that intermediate the relationships between human populations and the species of animals in the surrounding ecosystems (Alves and Souto 2015). It has been further subdivided into ethnoentomology, ethnoichthyology, ethnoornithology, ethnomastozoology, ethnoprimatology, and ethnoherpetology depending on the human interactions with the respective aspects of insects, fish, birds, mammals, primates, and amphibians and reptiles (Alves and Souto 2015). In comparison to ethnozoology, ethnobotany usually deals with plants and their relations with humans and animals. The term ethnomedicine is actually an inherently multi-disciplinary approach that accompanies with a set of empirical indigenous practices of use of plants and/or animals, spirituality with or without *mantra*, and the natural environment for the healing process in animals or human. Another important modern term called ethnogenomics, previously ethnogenetics or ethnic genetics, is defined as dealing of genetic structure of human population living in different geographies and time. Interestingly, to deal with this sub-branch, the critical analyst such as a geneticist, mathematical modeler, and programmer is required.

Thus, it should be noted that an ethnobiologist records myths, religious practices, spiritual beliefs, economic activities, kinship associations, and other knowledge of plants and animals that can be found in landscapes (Anderson et al. 2011). While often ignored in some circles, the recorded ethnobiologic information has actually received critical attention in resource management because it has been suggested to lead new paths in scientific research by enhancing the understanding of ecologic processes and conservation monitoring (Berkes et al. 2000; Huntington 2000; Olsson and Folke 2001). It matters in real life (see Fig. 13.1 for urban Kathmandu). This can be illustrated by providing an example of The Earth Summit (TES) articles {Articles 8(j) & 10 (c)} in Rio de Janeiro in 1992, through the Convention of Biodiversity (CBD) that highly recognized the essential role of indigenous knowledge in understanding the role of customary livelihoods within sustainable development and the links among environmental management, science, and well-being (IASG 2014). Since then, academies, conservationists, and authorities have prioritized the value of local knowledge in informing the design of people-centered resource management approaches on a landscape-scale (Cunningham

Fig. 13.1 Animal parts and other products from nature sold in modern Kathmandu, Nepal. A typical example for modern Hindu Kush-Himalaya. (Photo by Pitamber Pant)

2001). In 2009, the Government of Nepal (GoN) already started a landscape management program in Nepal, part of the **transboundary Kailash Sacred Landscape** that extends across parts of Nepal, China, and India (MoFSC 2014a). The International Centre for Integrated Mountain Development (ICIMOD), in collaboration with various agencies and communities in eastern Nepal, Sikkim, and Darjeeling of India, western Bhutan, and China, has also implemented the transboundary Kanchenjunga Landscape Project (KLP) (Sharma 2008). Other landscape programs like the **Tarai Arc Landscape (TAL), Kailash Sacred Landscape Conservation and Development Initiative (KLCDI), Sacred Himalayan Landscape (SHL), and Chitwan Annapurna Landscape Programs (CHAL)** are also crucial in promoting sustainable livelihoods and conserving biodiversity (MoFSC 2014a, b).

The use of local knowledge is applicable for the people working on academics and research institutes in the Hindu Kush-Himalayan countries like Nepal. There are large heaps of knowledge on ethnobiology, but its association with conservation science has not been fully detailed yet and awaits wider study, recognition, and implementation. Thus, the aim of this chapter is to review the available data collected on ethnobiologic studies, political history and development, ethnic groups, their ethnic knowledge and practices, and roles in conservation. Finally, we list a few recommendations for the concerned authorities and the Government of Nepal (GoN) to advocate the utilization of ethnic knowledge in conservation of flora and fauna.

13.2 Ethnobiology in Nepal

While it is believed that the study of a western-style ethnnobiology started in the European regions in the late nineteenth century (Sobral and Albuquerque 2016), several religious books indicate that practice of this subject had actually been made since the beginning of human civilization. Many gods, goddesses, and sages (Sanskrit: *rishis*) came to Nepal, meditated, spent very simple lifestyle, survived by consuming cow's milk and plants, and taught the pupil about these practices. Thus, the actual history of ethnobiology in the eastern civilization – including the civilization of Nepal – really dates back to the origin of human race that principally depended on a close association with food, shelter, medicine, clothing, and other necessary materials. These associations have been well-documented in the *Vedas, Puranas, Upanishadas*, *Samhitas, Mahabharata, Ramayana* and other several literatures that were written many years ago (Flood 1996; Knott 2016). Although most literatures and original texts have been lost in the course of Indian history, the currently available ones written in Sanskrit are the remaining rhythms of Hinduism. Notably, ethnobiology is the basis of Ayurvedas in which it is studied from the medical point of view and for the Sanskrit University where it is studied from the traditional and philosophic approaches in Nepal. Since few years, the course has actually been included in undergraduate and graduate levels of few universities in which its main aim is to enhance the knowledge regarding conservation biology. Conservation action is facing critical problems particularly because of the lack of meaningful participation, for example, the ongoing equivalent participation problem of local communities in the management of natural resources (MoFSC 2014a). Equivalent participation might be difficult probably due to the presence of multi-religious, multi-ethnic, multi-racial, multi-lingual, and multicultural people within this small country. To solve this issue, the concept of the equivalent participation among the ethnic and local people has been decided by establishing the Community Forestry Program (CFP). CFP itself is a participatory approach which has already gained worldwide popularity and one of the successful participatory approaches in the sector of conservation. CFP has been prioritized to enhance the conservation of wildlife and to spread the forest areas by the Nepal Biodiversity Strategy and Action Plan 2014–2020 (MoFSC 2014b). That is why consideration of ethnobiology in the conservation of species seems to be essential and wise.

13.3 A Short Hindu Kush-Himalayan (HKH) Political History, Its Ethnic Groups, and Related Conservation Output on a Landscape Scale

Several religious articles state that since the start of life – since deep time – the Himalayan region has been one of the crucial parts for the gods, goddesses, intellectuals, meditators, emperors, and sages. That region had been the last target of their life to achieve wisdom, peace, and the way to heaven. During those periods, all the people including rulers and common men would follow the ethnic knowledge and practices to treat and prevent the diseases.

Interestingly, already the name Nepal itself has been suggested to be derived from various words related to ethnic knowledge. For example, *nepalaya* (*Sanskrit*) meaning at the foot of the mountains; niyampal (*Tibetan*) meaning holy land; ne (*Tibetan*) meaning wool and pal (*Tibetan*) meaning house; nepa (*Newari*) meaning country of the middle zone; ne (*Lepcha*) meaning holy and pal (*Lepcha*) meaning cave (Bhattarai 2009). It is widely believed that a Buddhist deity named 'Manjusri' drained the water from snake pond (Sanskrit: *Nagadaha*) within the valley and made inhabitable. Then, saint Ne, one of the great writers and teachers, selected a pious cowherd, Bhuktaman, to be the first king of the *Gopalvamsi* or the Cowherd Dynasty (Shaha 1992; Bhattarai 2009). That dynasty followed the spiritual life including meditation and cattle rearing and ruled this Himalayan country over 500 years. Subsequently, the country was ruled by *Mahispaalvamsa* (Buffalo-herder Dynasty) who would rear buffaloes during their period. When the king Mahispaalvamsa was defeated by Yalambar in the final phase of Dwaparyuga or at the beginning period of Kaliyuga or around the sixth century BC, the Kirati Dynasty came into existence and ruled the Kathmandu valley for more than 1200 years. The valley had been flourished socially, economically, and religiously during that dynasty (Bista and Singh 1972; Shrestha and Singh 1972). Indian, Tibetan, and Chinese traders used to visit Nepal for commercial purposes, especially for the wool (Shrestha and Singh 1972). The dynasty was followed by the Soma Dynasty, the Rajputs, when Nimistakar Barma defeated Gasti, the last Kirati King. Bhaskar Varma, the rich and open-hearted last king of the Soma Dynasty, adopted Bhoomi Varma, a Lichchhavi Kshetri of the Solar Dynasty who started the Lichchhavi Dynasty. Lichchhavi Dynasty became one of the golden ages in the history of the country and was comparable to the Elizabethan period in English history (Bista and Singh 1972; Shrestha and Singh 1972). It mainly focused on the use of ethnic and religious knowledge, with the flourishing arts, sculpture, architecture, and languages like Sanskrit, Newari, and others. Further, literature, astrology, medical sciences, religious scriptures including the tantric Buddhism, as well as the trades and commerce with India, Tibet, and China grew with the concept of Nepal being the central link between India and China and for the generic good growth of agricultural products like rice, but giving equal values to all religious and ethnic people like Kirantis, Abhir, Karnatak, and Mallas (Shrestha and Singh 1972).

During the Lichchhavi dynasty, the Thakuri clan also practiced parallel government. Consequently, the Thakuri Dynasty, the Malla Dynasty, and the Shah Dynasty all came into existence and the practice of ethnic knowledge in medicine – widely shared – became an important topic to the general people although it was without any (western-style) scientific basis. From 1320 AD, the Malla Dynasty – led by Arideba Malla – started ruling the country. In the mean time, the Karnatak Dynasty fled from Delhi and ruled a few years in the country. The Malla Dynasty is blamed for the differentiation of people into different caste, sub-caste, dresses, their duties, and social customs. Increased trade with the neighboring regions, and an increased art, culture, and literature, also practicing of Tantrism were found predominantly in that era (Bista and Singh 1972). During the era, there had been the establishment of Yasho Brahma Shah, the Rajputs of Mewar of India, located in the hilly areas of the country. One of his successors, Prithvi Narayan Shah and his successors, defeated the smaller states and kingdoms ruled by the Malla Dynasty and by various ethnic and indigenous groups like 22 kingdoms in Gandaki region, 24 kingdoms in Karnali region, 3 kingdoms in the Kathmandu valley, Kiranti states in the eastern region, and other several states (Baral 1964; Whelpton 2005). This resulted into the geographic unification of the country and the values of the Shah Dynasty came into being (Baral 1964). From 1814 to 1816, Nepal or the Gurkha had to face a war with the British East India Company probably due to the consequences of disputes for border or some believes that the Company was searching a trade route to Tibet from India via Nepal (Marshall 2005). A treaty called 'The Treaty of Sugauli' was finally signed in 21st December, 1923 and was the first formal proof by the British that Nepal as an independent nation that had rights to formulate the foreign policy independently. However, following the Treaty, several touristic regions and low, and high lands with many ethnic people of the country like Kumaon and Garhwal were ceded to the British (Marshall 2005).

All these changes occurred during the Shah Dynasty in which there was a huge political instability within the Kingdom. It resulted into the emergence of the Rana tyranny in 1846 ruling until 1951. The Rana Dynasty followed the policy of friendship and cooperation with the British Raj in India, even in the context of handing access to the people in the form of Gurkhas or armies to Britain and natural resources (Marshall 2005). It should be noted that both Rana and Shah Rulers have been blamed for the loss of flora and fauna and indigenous skills and knowledge and the prejudice to indigenous people. Before the end of the Shah Dynasty in 2008, the King Birendra had contributed much in the conservation of the biodiversity by establishing national parks, conservation areas, CFP, and various research centers including Nepal Academy of Science and Technology (NAST), one of our author's current affiliations.

Although the constitution of the country before 1990s advocated the equality for all ethnic groups, in practice, there had been somewhat discriminatory system of caste/ethnicity in many areas and fields including the head of politics. The entrenched system of caste hierarchy and its practice was the underlying cause of leaving behind many ethnic groups except the few of them in mainstream politics or decision- making bodies. As a result, the majority of the ethnic groups, especially in the rural areas, had been suffering from prejudice and partiality in the context of opportunities of education, social status, and employment, and use of local natural resources (Bennett et al. 2008). With the formulation and foundation of the Constitution of Nepal-2015, many leaders, including women from various ethnic groups have been selected and now established in the central and local politics and in many fields of development and system due to the principle of proportional equality. It resulted into a better concept of local empowerment with a mean-to-be more fair participation.

13.4 Associated Religions and Practices of Ethnobiology by the HKH People

It has been reported that there are 125 different ethnic groups including top 25 major ones like Chhetri, Brahamana (hilly), Magar, Tharu, Tamang, Newar, Kami, Muslim, Yadav, Rai, Gurung, Damai/Dhobi, Thakuri, Limbu, Sarki, Teli, Chamar/Harijan/Ram, Koiri, Musahar, Kurmi, Sanyasi, Dhanuk, Dusadh/Paswaan/Paasi, and Mallah indicating the crucial significance in diversification of ethnic knowledge all over this Hindu Kush-Himalayan country (MoPE 2017). This results into large cultural complexities (Figs. 13.2 and 13.3). The major Nepalese religions include Hinduism, Buddhism, Islam, Kirat, Christianity, Prakriti, Bon, Jainism, Bahai, and Sikhism (MoPE 2017). The caste/ethnic groups have been classified into various divisions depending on their habitat by altitudinal landscapes, for example, mountains, hills, and terai (low land) (Bennett et al. 2008; Table 13.1).

While two or more of the above ethnic and religious groups may have shared ethnobiologic knowledge, they are mostly unique, inherited, and locally vital. They still regard sacred forests and sacred mountains, and also practice social and cultural activities that contribute to the protection of geology, geography, and natural environment, including flora and fauna. While herbal medicines actually provide the health needs of about 80% population of the world (WHO 2001), still 87% of the people living in rural area of Nepal directly or indirectly depend on the formal and informal system of traditional medicine for healthcare (Bhattarai 1992). In this context, it has been reported that although the percentage of plants used as ethnomedicine increases along an increasing altitude, there is no significant trend in increased usage of plants for ethnobotany (Kunwar and Bussmann 2008).

Fig. 13.2 A house of a Musahar. (Photo by Tirth Raj Ghimire)

Fig. 13.3 A Musahar making a fishing net. (Photo by Tirth Raj Ghimire)

Table 13.1 Nepalese caste and ethnic groups and their further divisions and social groups

Main caste/ Ethnic groups	Regional divisions	Divisions of caste/ethnic groups
Brahaman/ Chhetri	Hill Brahman	Hill Brahman
	Hill Chhetri	Chhetri, Thakuri, Sanyasi
	Terai/Madhesi Brahaman/ Chhetri	Madhesi Brahman, Nurang, Rajput, Kayastha
Terai/ Madhesi other castes	Terai/Madhesi other castes	Kewat, Mallah, Lohar, Nuniya, Kahar, Lodha, Rajbhar, Bing, Mali Kamar, Dhuniya, Yadav, Teli, Koiri, Kurmi, Sonar, Baniya, Kalwar, Thakur/Hazam, Kanu, Sudhi, Kumhar, Haluwai, Badhai, Barai, Bhediyar/ Gaderi
Dalits	Hill Dalit	Kami, Damai/Dholi, Sarki, Badi, Gaine, Unidentified Dalits
	Tarai/Madhesi Dalit	Chamar/Harijan, Musahar, Dushad/Paswan, Tatma, Khatwe, Dhobi, Baantar, Chidimar, Dom, Halkhor
Newar	Newar	Newar
Janajati	Hill/Mountain Janajati	Tamang, Kumal, Sunuwar, Majhi, Danuwar, Thami/Thangmi, Darai, Bhote, Baramu/Bramhu, Pahari, Kusunda, Raji, Raute, Chepang/Praja, Hayu, Magar, Chyantal, Rai, Sherpa, Bhujel/ Gharti, Yakha, Thakali, Limbu, Lepcha, Bhote, Byansi, Jirel, Hyalmo, Walung, Gurung, Dura
	Terai Janajati	Tharu, Jhangad, Dhanuk, Rajbanshi, Gangai, Santhal/Satar, Dhimal, Tajpuriya, Meche, Koche, Kisan, Munda, Kusbadiya/ Patharkata, Unidentified Adibasi/Janajati
Muslim	Muslim	Madhesi Muslim, Churoute (Hill Muslim)
Others	Others	Marwari, Bangali, Jain, Punjabi/Sikh, Unidentified Others

Adapted from Bennett et al. (2008)

The Kirati people including Limbu, Sunuwar, Rai, and Yakkha are regarded as the indigenous groups in the Himalayas that extend from eastern Nepal to India, Bangladesh, Burma, and beyond. The Kirat priests never use medicine for the treatment of sick people unless they are directed by the Good-spirit God in their dreams for its use (Cemjoṅga 2003). They practice Sakela/Sakewa in which they worship using plants like *Bauhinia variegata, Nephrolepsis cordifolia,* and others. The Kirati are famous for the beautiful stone masonry of their farm terraces. They also build *chautara*, stone resting platform topped by large, shady *Ficus religiosa* tree, on the trail outside villages as memorials to the dead (Burbank 2002).

The Limbu people normally reside near jungles and streams in the eastern hill regions due to their dependency upon natural resources. In these parts, they have been reported to use the roots and barks of 225 species of plants for medicinal purposes like rabies, snake bite, diarrhea, cut, constipation, sprain, sinusitis, piles, tonsillitis, jaundice, burns, scabies, toothache, fracture, epistaxis, and others (Limbu and Rai 2013). The agrarian law of Limbu suggests that one day should be observed without working in the fields if a domestic animal bears a calf or pig (Cemjoṅga 2003). Similarly, a holiday should be taken after clearing the forest indicating their close-association with pregnant animals and nature overall (Cemjoṅga 2003). The eastern part is also inhabited by the Rai community which has been shown to use 87 plant species and 27 animal species to treat illnesses including gastrointestinal (GI), cardiac, psychologic, respiratory, skeletal, parasitic, gynecologic, hormonal, hematologic, vector-borne, and nervous diseases (Rai and Singh 2015; Table 13.2). Their indigenous traditional knowledge (ITK) has given ideas to cure vaccine-preventable diseases like cholera, pneumonia, measles, rabies, mumps, whooping cough, leprosy, chicken pox, tuberculosis (TB), Herpes Zoster, and tetanus suggesting a further possibility of causal pharmacologic mechanism. These are great achievements for mankind, and they wait to be applied correctly virtually anywhere in the world!

The Tangbetons is an ethnic group found originally in the Mustang district, western Nepal. But by now, they have migrated to Jomsom, Pokhara, and Kathmandu. A study on the migratory Tangbetons of the Pokhara valley found that they used 17 species of animals and 60 species of plants to treat one or more of gynecologic, cardiac, hematologic, urinary, ophthalmic, hormonal, skeletal, immune, and psychologic disorders (Paudyal and Singh 2014; Table 13.2).

Lapcha, an ethnic group found in close association with forest or forest patches, are mostly found in eastern Nepal. They were described to use 19 animal species and 61 plant species for scabies, jaundice, snake bite, insect bite, dog bite, intestinal worms, measles, typhoid, dysentery, nose bleeding, and cut and burnt wound (Tamang and Singh 2014) (Table 13.2). They are skilled at preparing dyes, preparing bamboo materials for houses, bridges, handicrafts, bows, arrows, furniture, baskets, fences, firewood, and flutes, preparing and using biopesticides from *Bhumea lacera* and *Nicotiana tobaca*, and preserving the biodiversity of medicinal plants, wild edible food, and animals (Tamang and Singh 2014).

The Raute, a wandering group, live in the forest or on riverbank and are also called as 'Kings of the forest'. They possess a unique tradition of hunting few species of monkeys like *Macaca mulatta, M. sylvanus, and Semnopithecus schistaceus*

Table 13.2 A selection of ethnic groups, their knowledge of using plants and animals against illness in the Hindu Kush-Himalaya region

Caste/ ethnic groups	Geographic locations	Ethnic knowledge for using		Used against	Citation
		Animals	Plants		
Limbu	Limbuwan area (Eastern Nepal)		225 species of plants	Rabies, snake bite, diarrhea, cut, constipation, sprain, sinusitis, piles, tonsillitis, jaundice, burns, scabies, toothache, fracture, epistaxis, and others.	Limbu and Rai (2013)
Rai	Bhojpur (Eastern Nepal)	27 animal species like *Ichhneumonid, Lophura leucomelanos, Cosmopolites sordidus, Panthera tigris,* and *Paa liebigii*	87 plant species *Schima wallichi, Daphny papyraceae, Centella asiatica, Urtica dioica, Viscum album, Vitis capreolata, Curcuma longa,* and others.	GI, cardiac, psychologic, respiratory, skeletal, parasitic, gynecologic, hormonal, hematologic, vector-borne, and nervous diseases.	Rai and Singh (2015)
Tangbetons	Pokhara (Western Nepal)	17 species of animals like *Bos grunniens, Capra hircus, Panthera tigris, Canis aureus, Moschus chrisogaster, Bos indicus, Gyps himalayaensis, Apis cerana, Periplaneta americana, Equus hemoionus kiang, Equus kiang,* and *Apodemus gurkha.*	60 species of plants like *Justicia adhatoda, Ephedra gerardiana, Rhododendron arboretum, Emblica officinalis, Swertia chirayita, Hordeum vulgare, Solanum surattense* and others.	Gynecologic, cardiac, hematologic, urinary, ophthalmic, hormonal, skeletal, immune, and psychologic disorders.	Paudyal and Singh (2014)

(continued)

Table 13.2 (continued)

Caste/ ethnic groups	Geographic locations	Ethnic knowledge for using		Used against	Citation
		Animals	Plants		
Lapcha	Ilam (Eastern Nepal)	19 animal species like *Anadenus, Apis dorsata, Equus coballus, Panthera tigris, Elephas maximum, Hystrix brachyuran, Palaemon malcolmsoni,* and 61 plant species like *Ageratum conyzoides, Heracleum nepalense, Tagetes erecta, Cucumis stivus, Mentha aquatic, Rosa brunonii, Nephrolepis auriculata,*and *Dryopteris filixmas*.		Scabies, jaundice, snake bite, insect bite, dog bite, intestinal worms, measles, typhoid, dysentery, nose bleeding, and cut and burnt wound.	Tamang and Singh (2014)
Raji	Surkhet (Mid-western Nepal)	36 animal species like *Rana tigrina, Melurus ursinus ursinus, Columba livia, Tor tor, Varanus* spp., and *Cosmopolites sordidus*.	91 plant species like *Justica adhatoda, Achyranthes bidentia, Drymeria diandra,* and *Utrica dioca.*	Asthma, cold, fever, hemorrhoids, pneumonia, rheumatism, mastitis in livestock, diphtheria, conjunctivitis, cardiac and psychologic disorder, and snake bite, gynaecologic and GI problems.	Poudel and Singh (2016)
Tharu	Chitwan (Central Nepal)		71 species of plants	GI, cardiac, respiratory tract, genitor-urinary, parasitic, and dermatologic infections.	Dangol and Gurung (1991)

(continued)

Table 13.2 (continued)

Caste/ ethnic groups	Geographic locations	Ethnic knowledge for using		Used against	Citation
		Animals	Plants		
Tamang	Sindhupalchok (Central Mountain of Nepal)	41 genera like *Apis* spp., *Schizothorax* spp., *Paa* spp., snakes, *Gallus* spp., *Lepus* spp., *Ovis* spp., *Hystrix* spp., slugs, *Pheretima* spp., *Sturnus* spp., *Myophonus* spp., *Spilornis* spp.		Asthma, burns, cuts, fever, gastritis, and typhoid; the fat of these species are to treat arthritis, burns, cracked skin and rheumatisms.	Lohani (2010)
Tamang	Makwanpur		161 species of plants	Foot-and-mouth disease, diarrhea, eye problems, as well as tapeworm, lice, and tick infestation, dyspepsia, neck wounds, and to enhance sexual stimulation as well as milk production.	Luitel et al. (2014)
Tharu and Magar	Rupandehi (Western Terai of Nepal)		74 plant species	Tumors, anemia, piles, and toothache.	Singh et al. (2011)
Magar	Gulmi (Hilly region) of Nepal		161 plant species	GI, dermatologic, ophthalmic, respiratory infections and snake bite.	Acharya (2012)

(continued)

Table 13.2 (continued)

Caste/ ethnic groups	Geographic locations	Ethnic knowledge for using		Used against	Citation
		Animals	Plants		
Magar	Kavre (Central hilly region of Nepal)	39 species of animals like *Manis pentadacyla, Panthera tigris tigris, Melurus spp., Myotis spp., Sus scrofa, Vanellus indicus, Ketupa spp., Muntiacus muntajac, Cervus unicolor, Hystrix indica, Tor tor, Schizothorax spp., Varanus bengalensis,* and *V. flavescens.*		Aphrodisiacal as well as esthetic values	Lohani (2011a)
Balami	Nuwakot (Central Hilly region of Nepal)	65 species like *Pila, Helix, Araneae, Plytis stigma*, Termite, *Vespa*, *Canis aureus, Felis chaus, Selenarctos thibetanus, Hystrix brachyuran, Bubo bubo, Hemidactylus flaviviridis,* and *Bufo*.	185 plant species like *Allium hypositum*, *Acoras calamus, Berberis asiatica, Terminalia chebula.*	Headache, arthritis, asthma, dysentery, infertility, cough, paralysis, typhoid, allergy, cut, wound, cough, jaundice, anemia, asthma, rheumatism, diarrhea, mumps, fracture, urinary disorder, taeniasis, and scabies.	Timilsina and Singh (2014)

(continued)

Table 13.2 (continued)

Caste/ethnic groups	Geographic locations	Ethnic knowledge for using Animals	Plants	Used against	Citation
Jirel	Dolakha (Mid-mountain region of Nepal)	49 faunal species like honeybee, earthworm, slug, snail, spider, crab, *Hoplobatrachus tigerinus*, *Paa polunini*, python, sparrow, starling, *Lophura leucomelanes*, *Lophophorus impejanus*, *Ithaginis cruentus*, *Python molurus bivittatus, Hystrix indica*, *Panthera pardus, Melurus ursinus, Selenarctos thibetanus, Panthera pardus, Canis lupus pallipes, Moschus chrysogaster, Muntiacus muntjac, Sus scrofa, Macaca assamensis, Macaca mulatta, Myotis, Canis alpines, Canis lupus pallipes,* and *Martes flavigula.*		Diarrhea, dysentery, cold, cough, and others.	Lohani (2011b)

and the collection of forest vegetables resulting in the declining of these flora and fauna (CV 2011; Chan 2016). This group barters with the local communities so that it exchanges wooden products like bowls, boxes, beds, and other utensils with the quantity of grains that the same product can contain (CV 2011). Although this may indicate that their livelihood ultimately depends on deforestation, they cut down only a certain common species of trees rather than *Shorea robusta, Acacia catechue,* and *Dalbergia sisoo*. Also, they continue moving from one forest to another to reduce deforestation and allow for sufficient re-growth (CV 2011). Modernization including the increased use of cheap plastic goods have replaced the public use of wooden products affecting their livelihood (Chan 2016).

The Raji community actually originated at Surkhet and later migrated towards Dang, Bardia, Kailali, and Kanchanpur districts of Mid-Western and Far-Western regions of the country. Although initially they were nomadic, they settled in their own permanent community indicating they are closest to nature after nomadic Rautes (Poudel and Singh 2016). They have been reported to use 36 animal species to treat 30 different ailments like asthma, cold, fever, hemorrhoids, pneumonia, rheumatism, mastitis in livestock, diphtheria, conjunctivitis, cardiac and psychologic disorder, and snake bite as well as 91 plant species to treat 60 different ailments like gynecologic and gastro-intestinal (GI) problems (Poudel and Singh 2016; Table 13.2). However, they practice sustainable forms of wildlife hunting and trapping, and they actually cultivate wild medicinal plant species in their gardens also practicing mechanical and biologic control, for example, handpicking and spraying cow's urine, local beer (*Jaand*), tobacco and *Azadirachta indica* leaf juice to control insects promoting their involvement in conservation and in safe insect pest management (Poudel and Singh 2016).

Most of the Nepalese tribes depend on wildlife for their food products. It has been shown that the Chepang community has been using 17 forest species for their food requirements (Lamichhane 2017). They hunt many bats especially for their family or for business purposes at the hotels in the highways (Acharya 2015). Local people and tourists highly demand the meat of wild species because they believe they are delicious as well as have pharmacologic properties. Besides, hunting these species is a recreational activity without any taxes or cost, thus, leading even income generation. In addition to Chepang, other tribes like Raji, Bankariya, and Raute principally depend on wild foods including fiddlehead ferns, *Dioscorea deltoidea, Dioscorea alata, Asparagus racemosus,* and *Urtica dioica* (Acharya et al. 2017).

It is believed that the word Tharu represents 'man of the forest', probably because of the forest life for hundreds of years maintaining inherent and strong economic, spiritual, and cultural links to forests (Muller-Boker 1991). They are fully dependent on the forest for vegetables, fruits, and medicines and *Imperata cyli1indrica* for covering the roof of the house and *Saccharam* for house walls (McLean 1999). Interestingly, the Tharu communities, living in the tropical region of the southern foothills and inner Terai of the country, have subsequently a very rich and diverse food culture that may vary according to geography. In a study, they have been reported to use 101 species of non-timber forest products (Lamichhane 2017). They traditionally conserve, grow, and consume various local varieties rice including *Anadi*, a type of sticky rice used to prepare a traditional dish called *chichor*. Their food habits include consumption of wild mushrooms, yam, sesame seeds, legumes, and wild vegetables including fiddlehead ferns. They collect and eat invertebrates like mussels, shrimps, crabs, and snails and vertebrates like mice of paddy fields, chicken, ducks, pigeon, pigs, wild boars, and fish. It is interesting to note that these groups in the Far-Western region of Nepal extract bark of trees accompanied with phloem tissues of endangered species called *Shorea robusta* to prepare local alcohol that may by now result in the species being overused, and having a threatened conservation status (Pitamber Pant pers. comm.). A study in Chitwan, the central part of Nepal, shows -not really surprisingly – that the Guruwas of the Tharu community has a wealth of ITK. For example, they use one or more of the 71 species for the treatment of GI, as well as cardiac, respiratory tract, genitor-urinary, parasitic, and dermatologic infections (Dangol and Gurung 1991). Both ethnobiologists as well as ethnogenecists are curious to know the physiology and genomics of Tharus because of the presence of genes for thalassemia, resistivity to *Plasmodium* infection, and the resulting reduced incidence of malaria in these ethnic communities (Terrenato et al. 1988; Modiano et al. 1991).

Majhi is another ethnic group that lives cooperative. They are distributed along the inner terai, plain terai, and mountain areas especially near the river shore. Because of their close relationship with water and water sources, people usually think that they are the sons of river. They traditionally work as a swimmer, boat builder, river transportation service provider, fishing net-builder, and fish-catcher. They sell *Marcha*, an ayurvedic raw material to prepare wine. For a cash-based livelihood involving food and money, they solely depend on fish and aquatic products. It makes for a unique perspective to consider in the puzzle of sustainable lifestyles in Nepal. However, with the increasing water pollution and development projects along riversides may pose the risks of increase the adverse effects on their livelihood, and an entire culture gets lost.

The Dom people of the terai area fulfill their needs from the jungle by using their own tiny gardens. They plant *Mangifera indica, Dalbergia sisoo, Melia azedarach,* and *Eukalyptus camaldulansis*, for human consumption. As found elsewhere, they use mostly dry animal dung for cooking as fuel (Shah 2007). Their occupation includes bamboo works, mat-weaving, basketry, drum beating, scavenging, pig-, hen-, goat-, and duck-taming, and general agricultural works (Shah 2007). In eastern Nepal, they use dried flesh and bones of snakes for medicinal properties (Shrestha 2001).

Sauka or Bhote, residing in mountains of western Nepal, and subsequently toward the Kumaun Himalaya in India, follow a semi-nomadic lifestyle and they rely on natural resources (Joshi and Pande 1997). They practice the collection and marketing of medicinal plants, animals, and their products which suggest their main role in conservation for such resources, too.

In the mountains, the Sherpa communities have also many sacred forest areas, the temple and monastery forests, the sacred mountains, the lama's forests, and the nawa system involving the management of community forests, wildlife, and rangelands (Stevens 2008). These features are commonly found throughout the Hindu Kush-Himalaya region in which lama and monastery guide for the conservation of these species because they believe that conservation is their ancestor's duties (Stevens 2008; Verschuuren et al. 2010).

The Thakali people of Mustang – including its Upper region, the Myagdi, Baglung, Parbat, and Kaski districts – celebrate a cultural festival in which they pierce yak's neck to collect fresh blood and drink it. They do it particularly for the reason in that they traditionally believe that the yak feeds on herbs like *Ophiocordyceps sinensis, Nardostachys jatamansi*, and *Dactylorhiza hatagirea* and thus yak products cure gastritis, jaundice, muscle sprain, and body swelling (Bhattarai 2015). This leads not only to the appreciation of yaks but also of their habitats, and consequently results in their protection. It essentially goes back to the ancient concept of 'use or loose it' when supported by a wider good cultural framework allowing for sustainability for centuries, if not millennia even.

Another ethnic group, the Gurung, live in the hills around Pokhara and east toward Gorkha (Burbank 2002). In a large study involving Gurung, Shahi, Sherpa, Rokaya, Thakuri, Kshetri, Brahamin, and Dalit, they were reported to use 107, 59, 44, and 166 species of ethnomedicinal important plants from Dolpa, Humla, Jumla, and Mustang districts respectively (Kunwar et al. 2006). These ethnic groups were found to prepare many traditional drugs by various methods such as juice, paste, extract, decoction, powder, oil, and smoking of the root, rhizome, tuber, leaf, flower, fruit, seed, shoot, bark, wood, resin, and whole parts of 84 species of plants to treat diseases like GI illnesses, skin diseases, cuts and wounds, and febrile illness all indicating a wide application of ITK on ethnomedicine (Kunwar et al. 2006).

The Tamang are the largest of the mountain-living groups and the most independent one having retained their own language and peculiar Buddhist religion. They live in the high hills to the north, east, and west of Kathmandu, however, they are also found in the terai region. It has been shown that the Tamang have a traditional knowledge of using wild and domestic animals like *Apis* spp., *Schizothorax* spp., *Paa* spp., snakes, *Gallus* spp., *Lepus* spp., *Ovis* spp., *Hystrix* spp., slugs, *Pheretima* spp., *Sturnus* spp., *Myophonus* spp., *Spilornis* spp. that possess great food and or medicinal values. In these contexts, *Schizothorax* spp., and *Hystrix* spp. are killed to extract the ingested fresh algal and plant materials that are believed to have medicinal values (Lohani 2010). These ethnic groups believe that the bile of domestic cow, buffalo, sloth bear, and *Hystrix* spp. can treat asthma, burns, cuts, fever, gastritis, and typhoid; the fat of these species are to treat arthritis, burns, cracked skin and rheumatisms indicating the existence of ethnomedical practices and their values (Lohani 2010). A study in the Makwanpur area shows that they use whole plants or their roots, rhizomes, bulbs, tubers, young shoots, stems, bark, wood, leaves petioles, flowers, fruits, seeds, and resins of a total of 161 species to cure 89 types of human illnesses (Table 13.2). These plants are used in various ways for construction, and people use them to make wooden tools like plough, and to worship gods (Luitel et al. 2014). They also practice the delivery of drugs prepared from plants either through oral or topical methods to treat, for instance, foot-and-mouth disease, diarrhea, eye problems, as well as tapeworm, lice, and tick infestation, dyspepsia, neck wounds, and to enhance sexual stimulation as well as milk production (Luitel et al. 2014).

The ethnic group of the Magar also lives in the central and western parts of Nepal. The Magar have had the longest contact with caste Hindus from India (Burbank 2002). In a study conducted in the terai region of Western Nepal, the Tharu and Magar communities were listed to use 74 plant species to cure various types of diseases like tumors, anemia, piles, and toothache (Singh et al. 2011). In another study conducted in the hilly region of the Western Nepal, the Magar community was found to use 161 plant species to treat GI, dermatologic, ophthalmic, respiratory infections, and snake bite (Acharya 2012). In the central region of Nepal, they have been found to use 39 species of animals including *Manis pentadacyla, Panthera tigris tigris, Muntiacus muntajac, Cervus unicolor, Hystrix indica, Tor tor, Schizothorax* spp., *Varanus bengalensis,* and *V. flavescens* for food, medicine, ethnomusicology, religious, and magicoreligious values, aphrodisiacal, as well as esthetic values indicating Magar people's wide relations with above-mentioned endangered and threatened faunal species (Lohani 2011a; Table 13.2).

The Newar are actually the indigenous inhabitants of the Kathmandu Valley, where they have been living for the past 1500 years (Burbank 2002). It is accepted that they are the oldest and so-called most developed and civilized groups in the region. Newars have a heterogeneous, urban, and highly stratified society that has developed for at least two and a half millennia in the Kathmandu Valley. The ITK for medical practices by the Newars are many and they vary within their subcastes, subgroups, and genders in several areas (Tuladhar-Douglas 2008). There is a report of catching, killing, drying, rolling, and heating a 'house bat' of the Hipposideridae and Rhinolophidae family in mustard oil to prepare bat oil medicine by the Newars in the Kathmandu valley (Tuladhar-Douglas 2008). The oil is used to remove ear bugs, and also as a cure for baldness, and as an antiparalytic liquid (Tuladhar-Douglas 2008). Culturally, the Newars practice a ritual called *Bel Bibaha* (Nepali; *Bel*: *Aegle marmelos* and *Bibaha*: marriage), which means the first marriage of a lady with the fruit of *Bel* suggesting a huge respect and relation with plants (Verschuuren et al. 2010). Balami is a subcaste of the Newar that were once traditionally farmers, porters, woodcutters, and firewood sellers living near forested areas all around the ridge encircling the Kathmandu valley (Timilsina and Singh 2014). However, most of them have left these jobs by now and they are good field workers and buffalo traders. A study in the Nuwakot area shows that although they occupy a comparatively small geographic area, they have been reported to use 65 faunal species and 185 plant species (Timilsina and Singh 2014) (Table 13.2). They practice the use of eggs and whole body of animals, fats, stings, blood, web of birds, meat, bile juice, the head and skull, but also the mud where the animals live to treat various diseases like headache, arthritis, asthma, dysentery, infertility, cough, paralysis, and typhoid and leaf, stem, rhizome, fruit, bark, seed, shoot, tubers, or whole plant and its extracts to cure allergy, cut, wound, cough, jaundice, anemia, asthma, rheumatism, diarrhea, mumps, fracture, urinary disorder, taeniasis, and scabies (Timilsina and Singh 2014).

In a study of the Jirel group in the hilly areas, it has been reported that they use one or more parts of 49 faunal species including their flesh, viscera, bones, GI tract, skin, claws, whiskers, fur, spines, and products like musk, milk, semen, fecal matter, and urine suggesting a huge link of the faunal diversity in Jirel's livelihood and their medical health (Lohani 2011b; Table 13.2).

It has been reported that people in the Kailash Sacred Landscape were using the fruit, leaves, stems/shoots, bark, buds, bulbs, flowers, tubers, corms, roots, and seeds from a total of 99 species of wild and non-cultivated edible plants for the purposes of food, medicine, spice, and others (Aryal et al. 2018). Interestingly, people's attitude toward using these plants in treating stomach disorder, colds, and cough, wounds and cut, skin diseases, fever/headache, nausea and vomiting, worms in the stomach and snake, as well as scorpion bites suggest that the landscape is highly important in the indigenous knowledge as well for its application in public health (Aryal et al. 2018).

13.5 Ethnobiology, Traditional Healers, and the Conservation of Resources, Landscapes, and Watersheds

The history of relation of traditional healers with ethnobiology is very deep and long. It makes for a crucial and essential link all over the Hindu Kush-Himalayan region including Nepal. Although acupressure, acupuncture, aromatherapy, ayurvedic medicine, balneotherapy, biofeedback, chiropractic, homeopathy, naturopathy, reflexology, and reiki are emerging subjects, the actual practice of Ayurveda (*Vaidya*) and folklore systems like shamanism (by *Jhakris* in Nepali) and tantra (by *Jharfuk* in Nepali) is predominant all over Nepal. Amchi – the traditional healer and a perhaps now called village-doctor – is another practice of a traditional healing system of the Tibetan region that has now been gaining significance in the wider HKH regions of Nepal like Mustang, Dolpa, Humla, Mugu, Gorkha, and Rasuwa for instance (Pandey 2006). Amchis have multiple skills of diagnosis and treatment and have a well-founded ITK, thus, they are actually responsible for the conservation of high altitudinal medicinal plants.

The exact methodology is somehow different among shamanists because these magico-religious healers use parts or all of invertebrates and vertebrates in addition to medicinal plants and herbs. They exercise and perform to remove evil spirits from the patient's body. They wear animal part/s, exercise and play with or without traditional music. In some cases, they may ask the patient's relatives to sacrifice domestic or wild animals in order to please gods and subsequently remove the spirits from the patient's body. Interestingly, in the Far - Western Region Hills, it can be observed that they demand the sacrifice of *Gallus varius* and *Lophura leucomelanos* (Pitamber Pant personal observation). The situation is further somewhat problematic by the fact that the shemanists use bones and claws of *Hemidactylus* spp. and *Spilornis cheela*, bones, claws and whiskers of tiger *Panthera tigris tigris*, musk of *Moschus chrysogaster*, the tail of *Bos grunniens mutus*, or horns of *Cervus unicolor* to remove the spirits, and milk of *Panthera tigris tigris* might be used to prevent the spread of fire in the village (Lohani 2010). Limbu healers (*Phedangma*), who are ethnomedicine practitioners, also recite some magical words called "mantra" during the treatment. It is considered that the use of the mantra increases the healing power of the herbal medicine resulting into more effective treatment (Limbu and Rai 2013). Notably, all the healers prepare drugs from raw herbs through personal experience and ancestral prescription (Aryal et al. 2018). They collect those plants from wild landscapes, watersheds, and ancient groves which are essential for healing. These drugs are actually thought to be effective, inexpensive, and beneficial and have a lower side effect compared to allopathic drugs although they need further proofs (Aryal et al. 2018).

Arguably, the healers have a high level of strong faith on ethnomedicine. They also have a high level of concern on the harvest location and the timing of the medicinal plants. For example, by studying the effects of traditional harvesting patterns by local healers or by commercial collectors on the population ecology of two highly threatened Himalayan medicinal plants, *Nardostachys grandiflora* and *Neopicrorhiza scrophulariiflora*, in Shey-Phoksundo National Park and in its buffer zone in the northwestern part, it has been concluded that ethnoecological knowledge, plant life forms, and growth patterns are essential to consider for the actual management of Himalayan medicinal herbs (Ghimire et al. 2005).

While the above traditional healers play a critical role in the management of public and veterinary health all over the country, they normally do not transfer their knowledge to other people creating a gap in the ITK transfer in the traditional healing system. They are not much concerned in listing and preserving the plants and animals with ethnomedicinal principle. In addition, young generations think that either ethnobiology is not a trustworthy science to treat diseases or it is not easy to earn money through the application of this subject, thus, creating the risk of disappearance of this subject altogether in the near future.

13.6 Ethnobiology, Musical, Esthetic and Recreational Tools, and Conservation of Landscapes

Ethnic people in Nepal are highly skilled at making musical tools especially from the skin of various animals that is concerned with the conservation of many species. For example, the skin and stretched leather of *Muntiacus muntjac* and *Varanus flavescens* is used to prepare different musical instruments (Lohani 2010; Tamang and Singh 2014). Tamang keep *Cervus unicolor* as a decoration purpose in the house (Lohani 2010). Hunting of vertebrates for recreations and alcohol preparation, for example, from the jackal's flesh is common in many ethnic groups (Lohani 2010; Tamang and Singh 2014). These examples indicate that overuse of faunal species for esthetic, musical, and recreational tools may lead to an endangerment process.

13.7 Ethnic Knowledge: At Least Two Sides of a Coin in Conservation

Since time immemorial, deep time, ITK has been an inseparable theoretical and practical experience of ethnic and indigenous people living in the HKH nations like Nepal. This greatly differs from industrial societies, their landscapes, watersheds, people and societies. The knowledge has been classified as individual, distributed, and communal (Maden et al. 2008). Among them, individual knowledge is strictly confidential and even is not shared among family members that may otherwise lead to the risk of wide and generational disappearance after the person dies. This is true in the case of many ethnic groups like the Gurus of Tharu (called Guruwas) who do not want to share their ITK because they think that the ethnomedicine fails to treat the disease if they share the idea with other people (Tirth Ghimire personal observation). The same concept applies to many Ayurveda practitioners who keep their materials and methodology even away from their own children. However, few groups may share it with the next generation or with community members so that anyone can practice the ITK whenever necessary.

While ethnic knowledge is both – somewhat open as well as secret – it also has both cons and pros for the conservation management of the species. In many cases, it increases the negative impact on conservation because the practice of ethnic knowledge is actually one of the underlying causes of endangerment of many species of flora and fauna. Some of the plants and animals are regarded as a symbol of evil or are believed to have magical powers leading either to success or failure in their lives, and thus, people harm those species. In the western world, many examples can be found, for instance, the European-centric perspective to rid predators, wolfs, raptors or even snakes and spiders. The disappearance of the Yew (*Taxus bacata)* followed a similar motivation as it might kill horses when eaten. In Nepal, several examples are found, for instance, *Artocarpus heterophyllus* as a symbol of awfulness, *Canis lupus* as a sign of evil, whereas the bone of *Panthera pardus* as a symbol of protector from evil, and *Panthera tigris tigris* as a symbol of bravery, and the tail hair of *Elephas maximum* as a sign of beauty and attraction. The horn of *Rhinoceros unicornis* is believed to be the symbol of protector from evil power, skin is to be sacred for using in annual rituals (*Shradda* Nepali) for a dead person, and it is believed to have unlimited medicinal values including aphrodisiac effects. Similarly, sights of flying *Gyps fulvus* near the house, unusual sounds of *Bubo bubo*, the laughing sound of *Ketupa* spp., and howling of *Vulpes vulpes* are thought to predict bad news for the living people (Lohani 2010). Believing such myths may lead to the mass collection or wholesale destruction of the fauna by the local people. It has been frequently shown that ethnic people residing nearby forest areas are reported to involve in poaching for recreation, money, and accessible employment leading negative impacts on wildlife (Dangol 2015). Taboos, and their establishment and decay play a big role in this discussion. Just consider a holy cow vs a cash cow (Fig. 13.4). This general principle also applies to *Ophiocordyceps sinensis*, the Himalayan Viagra, that is also gaining significance in the national and international markets. And thus, people have actively collected it *en mass* for its legal or illegal trade. It appears like a new culture stimulated by Asian rise of markets and global governance of *laissez faire* and in the absence of proper law, rules and regulations, this mushroom becomes a widespread means of corruption, crimes, and war among politicians and government officials leading a problem of overharvesting and hindrance in sustainable development of the local people (Harvey 2014; Schaedla 2016).

Such types of commercial overharvest have also been reported to lead to the endangered status process of *Valeriana jatamansi*, *Rauvolfia serpentina*, *Trillium govanianum*, *Nardostachys jatamansi, Dactylorhiza hatagirea, Trillidium govanianum, Frittillarai cirrhosa,* and many species of orchids throughout the country and the wider Hindu Kush-Himalaya region (Raut and Khanal 2011; Byers et al. 2016; Acharya et al. 2017; Acharya 2017). The situation is also challenging due to the lack of ITK and taboos for such newly-formed cultures often triggered by outside

Fig. 13.4 Holy Cow vs Cash Cow: Cattle Worshipping during Dipwali festival of Hindu as a sign of animal respect. Those concepts have by now been pushed out in the western scheme of things. (Photo by Tirth Raj Ghimire)

demands not attached to the local resource. Globalization and with a neoliberal capitalism promotes such destructions, now almost globally and certainly in the HKH region. Often, nations like China, Korea, Singapore, Taiwan, and India are big drivers on those issues, backed up by development banks from elsewhere. The lack of ITK has one important example with *Pterocarpus marsupium:* It's a critically endangered plant and its population in natural stands is limited in the western parts like Kanchanpur and Kailali districts (Bhatt 2007). The tree has a peculiar medicinal properties as its wood is considered astringent, antioxidant, anthelmintic, and anti-inflammatory (Barstow 2017) although it is targeted by the local people and is cut down for the sole use of firewood because of the modern lack and decay of ITK (Bhatt 2007). Thus, while the endangered status and trend is caused by the medicinal, economic, and daily purposes, or spiritual issues, the haphazard research mechanisms also critically play role in this process. For example, many research scholars and scientists make a field visit and intentionally and unintentionally collect many ethnically important flora and fauna without following relevant rules and regulations. This also applies to media and TV companies and all their contactors. It has been usually reported that many type specimen from this Himalayan country have been exported even without informing the GoN that has unable to identify, address, and solve this issue (Chaudhary 2015). The HKH region has many issues of specimen repatriation to deal with and to resolve still.

But the positive aspect of ethnobiologic knowledge is that people themselves become aware of conservation if they are guided by two approaches or factors:

- Firstly, if they are controlled by religious and traditional ideologies of protection and conservation, it creates the plus point. For example, it is believed that killing animals without proper justification will result in the punishment by the god in his/her life or in rebirth. The killer of bird, *Hirundo rustica* is believed to suffer from leprosy, the snake- and bird-killer is to suffer from lifelong sin. A cat-killer will suffer from hand paralysis, a dove-killer from the tragedy in his/her family, and a pigeon-killer will suffer from war. Many strict Hindu fellows and scholars prohibit killing of all animals including a single insect because they think that if a person kills an animal in his/her life, he or she will be killed by the animal after his/her rebirth (BDS 2015). Hindus worship, care, love, and conserve few sacred species like *Ficus religiosa*, *F. benghalensis*, *F. benjamina*, *F. racemosa*, *Ocimum sanctum*, *Aegle marmelos*, and *Desmostachya bipinnata* indicating their religious activities in the conservation management because their destruction is a kind of taboo. These religious groups worship cattle, ox, dog, crow, and snake as symbol of gods and goddess which directly helps in the conservation of these species. However, during certain occasions, in order to appease and gratify their gods, they sacrifice male goats, chicken, ducks, buffaloes, and others presenting a controlled utilization of species.
- Secondly, if people are properly guided and are offered alternate opportunities for economic development, they become fervent towards conservation. This is because of the principle of sustainable natural resource management practice in which permission is to be granted to the local people with their participation in their management (Yonzon and Hunter 1991). The population in rural areas and around protected areas often consists of distinct ethnic groups with specific socio-cultural practices and ITK. ITK is a pillar of the environment management strategy in Nepal, and it has been adopted into policies that attempt to ensure that indigenous communities live in and benefit from 'nature' in a sustainable manner (O'Neill and Rana 2016). Other practices like agroforestry and sustainable harvesting practices of medicinal and useful plant species may further provide economic incentives necessary to ensure the effective conservation of wild species (GoN 2015). In this context, CFP is handing the duties of sustainable resource management and conservation to the native communities who have traditionally and ethnically used forest and its products for many years (O'Neill and Rana 2016).

Interestingly, the appointment of Rautes as Forest Security Guards by the District Forest Office (DFO) of Surkhet in 2014 for 5 years term for controlling wildfires and deforestation is based on this approach (CV 2011; Poudel 2014). This CFP is one of the best and successful participatory conservation programs in the country (Beltran 2000). The Annapurna Conservation Area Project (ACAP) is an example of the most successful conservation program that employs the partnership approach based on traditional life and subsistence systems. In order to replicate the success gained from ACAP, GoN has designated Kanchanjungha, Manaslu, Krishnasar, Gaurishanker, and Api Nampa Conservation areas. These areas target communities to be the main actors and beneficiaries and they promote integrated conservation and development.

The integrated and participatory approach has given people a greater appreciation of conservation and a feel of ownership and subsequent engagement towards the protected areas (Khatri 2010). It has been shown that the communities, local level authorities, and civil society organizations have now been directly involved to support the national park and the protective area management and associated livelihood programs indicating public enthusiasm toward conservation (DNPWC 2017a, b). The most recent Acts – the Local Government Operation Act 2074 BS, and the National Natural Resources and Fiscal Commission Act 2074 passed by the GoN – are essential to participate, empower, and utilize ITK for the conservation. These Acts have handed many powers and responsibilities over to the local authorities in order to formulate, amend, and apply the necessary rules and regulations. Thus, the GoN has been on the right track of principle that ethnobiology can help to establish and improve the two important links; firstly, the ITK and its uses on biodiversity, and secondly, the understanding and maintenance of culture (Bobo et al. 2015).

13.8 Conclusions and Recommendations

In older times, there was lack of the advanced tools and techniques we now consider as 'essential', 'standard' or 'modern. And thus, ITK had had a great impact on humans who used to spend life also maintaining a good harmony and relation with nature and natural resources. That was usually done through entrenched policies and following taboos linked with a sustainable approach. Leisure and happiness were valued (Fig. 13.5 for musical instrument). While the topic remains debated by some scholars, the traditional methods were ecofriendly, sustainable, and long-lasting and did not cause global devastation, world wars, and climate change. At least, it was more benign for thousands of years than what has happened just the last 40 years during unconstrained globalization affecting the entire universe. For example, cooking was made in a soil stove (Fig. 13.6), digging of land was done by wood plough, husking and grinding through a water flour mill (*Ghatta* Nepali; Fig. 13.7) based on the community or with locally made husking equipment (*Dhiki* Nepali) in individual houses (Fig. 13.8) or with locally made bamboo basket to collect garbage (Fig. 13.9). Water is the fuel and consequently why disturbing or not protecting it, or the landscape and watershed when entire religions and good lifestyles can be run with it (Fig. 13.10 for a praying mill fueled by a mountain stream).

A sustainable harvesting of wild species was commonly done, traditional healing systems exist being holistic and connected with 'Mother Earth', and the system of worshipping to the nature, and natural resources are among the prime concerns of indigenous people. It allowed for a relatively low, somewhat sustainable human impact, if at all. Thus, although ITK is a critical part of biodiversity conservation, now with the rapid human population explosion, increased globalization, and with the advent of modern tools and techniques, e.g. mobile phone and internet, it starts to have been lost and by now sometimes even threatening the conservation of flora and fauna. Traditional approaches to new problems are still used and new and

Fig. 13.5 A musical instrument with its outer one-side skin made up of skin of animals. (Photo by Pitamber Pant)

Fig. 13.6 Cooking in a locally made soil stove by an ethnic lady. (Photo by Tirth Raj Ghimire)

blended ones are used and forming (Figs. 13.8 and 13.10 as an example). ITK remains an invaluable basis though for developing cost-effective, participatory, and sustainable adaptation and natural resource management strategies in response to environmental and other forms of change (IAC 2010).

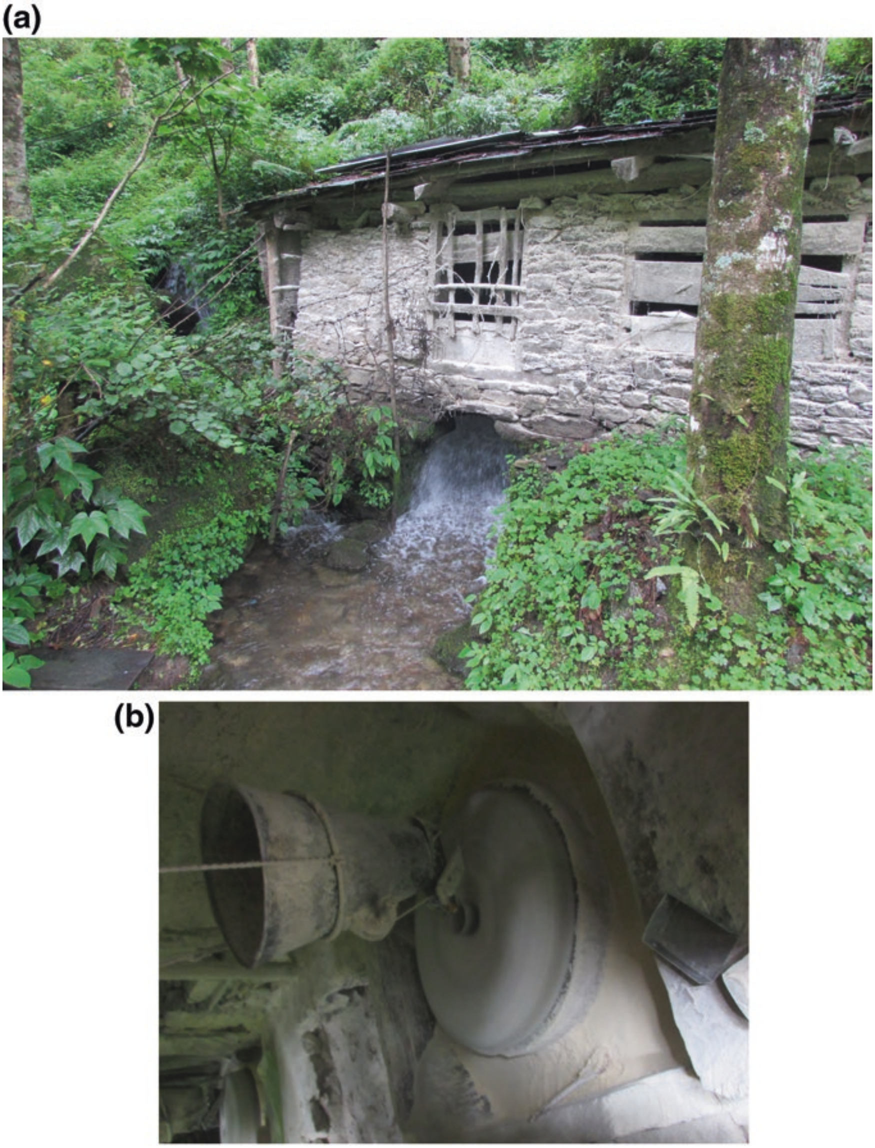

Fig. 13.7 A community water mill for flour 'fueled' naturally by water. (**a**) building, (**b**) the actual mill; Photo by Falk Huettmann)

In conclusion, experiences and evidences of ethnobiologic practices from this HKH nation suggest that conservation strategies developed by 'first' and so-called developed countries cannot and must not be imposed rigidly onto so-called developing countries like Nepal. Needless to say that those 'modern' and highly technical policies even fail in the western nations themselves and thus are no so

Fig. 13.8 Dhiki and Doko (bamboo carrier) from the hilly region of Nepal. (Photo by Tirth Raj Ghimire)

Fig. 13.9 Bamboo basket used for collecting garbage at hilly areas of Nepal. (Photo by Tirth Raj Ghimire)

Fig. 13.10 A praying mill, fueled by a mountain stream. (Photo by Falk Huettmann)

good (global) rules to go by really. This issue is essential to acknowledge when we review the failure of the protection of ITK and diversity of Tharu groups, for instance, who were protectors of the forests and had a wealth of ITK, however, they were forcefully relocated from the current geography of the Chitwan National Park through a 'modern' mindset. These groups were then not allowed to grazing or any collecting of wild fruits, vegetables, medicinal plants, and materials for making houses and household items. It is a typical example where an entire culture was put to extinction; some might call it a certain form of genocide. In turn; even the increased conflict with the natural' wildlife led to a loss of their harvest and livestock. For example, their 80% cattle decreased without any compensation from the authorities (Muller-Boker 1991). This particular issue suggests that the permission to use natural resource sustainably by the local people and within traditional concepts should probably be reviewed and then provided for their effective management (Yonzon and Hunter 1991). It is a well-known scheme to follow for an alternative of the western concept. It is here where nations like Nepal and the HKH can contribute towards a better global conservation scheme, rather than *vice versa* and just top-down.

Thus, in summary, the following recommendations can be made:

- A good global framework is to be found that actually has a valid track record of sustainability.
- Identification and documentation of knowledge related to use of various plants and animals should be conducted.
- Morphologic, molecular, and genetic characterization of the local flora and fauna should be made.
- Biochemical, pharmacologic, and immunogenic properties of plants and animals with ethnozoolgic, ethnobotanic, ethnomedicinal, and ethnoveterinary significance should be analyzed, characterized, and documented in the research laboratories.
- Further scientific proofs of efficacy, specificity, and susceptibility of the products obtained from flora and fauna in the treatment of vaccine preventable diseases, snake and dog bite effects, and vector-borne diseases should be looked for.
- Research in the history, sociology, distribution, biology, and ethnogenomics including resistance to various diseases of ethnic or indigenous groups should be conducted.
- Awareness and training programs related to the proper and modern-time management of the biodiversity, sustainable harvesting of natural resources, modern tools and techniques in agriculture, safe disposal of landfill site, and reduction of pollution should be conducted by and for the local people.
- Trainings related to identification and harvesting of flora and fauna to local people by involving special focus groups such as researchers, woodcutters, cattle herders, and healers should be organized and conducted.
- Ethnobiolgists should be properly trained with updated and proper ethical guidelines that are necessary before discussion with focus groups and collection, identification, and documentation of specimen used by the local people.

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Chapter 14
Spirituality Beats It All: A Quick Conservation Overview, Self-Organization and the Great Value of (Indigenous) Religions for Hindu Kush-Himalaya Landscapes, Its Geo-Parks, Species, Ecological Processes and Watersheds

Falk Huettmann

Life is an endless struggle full of frustrations and challenges, but eventually you find a hairstylist that understands you.
Commercial District, Downtown New York

Dukha: The concept in Buddhism of life-long suffering, pain, unsatifsactoriness or stress.
Keown (2009)

Think like a mountain.
Aldo Leopold (2012)

Whoever has witnessed the vast number of pigeons near Asian shrines, temples and monasteries knows that those are not in natural abundance there: religion is at play here boosting their populations in those landscapes, as it can easily found all over Asia and in its religious landscapes (Shiu and Stokes 2008; Fig. 14.1). Similar can be found with released gold fishes in holy sites and lakes, such as Mai Pokhari, Nepal, now also a RAMSAR site. Such an activity is called 'Mercy Release' (https://conbio.org/images/content_groups/Religion/Policy_Brief_for_Prayer_Animal_Release__RCRC__FINAL_SCB_Letterhead.pdf). Areas that have pray animal

F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department,
University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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Fig. 14.1 Pigeons in Durban Square, Kathmandu, Nepal; a religious (mercy) release and feeding site. (Photo credit: Author)

release are all brimming with spirituality, perhaps like no other places I ever saw before. Those sacred sites (often referred to as 'power places', e.g. Dowman and Buriski 1995 for ancient Kathmandu valley, Nepal) exist as many small locations in the landscape as well as large ones – such as Lhasa or Kathmandu – and they can be found all over the Asian landscapes and watersheds. The Himalaya region, including Tibet and Mongolia are core examples for that. And many of those sites go back to deep time, are 'pure' and were worshipped since human memory (Fig. 14.2). Other sites are less spectacular perhaps but link with religions and spirituality worldwide (see Matthiessen 1992 and Khaleafa 2019 for U.S. and Canada for instance).

Apart from few exceptions, the modern western world is not much familiar with such concepts and how spirituality drives a society, its landscapes and conservation of natural resources. Because Jesus obviously never set foot to the EU, U.S. nor Canada, the western world overall – certainly its North America powerhouse – is virtually free of authentic Christian deeply sacred sites (and it speaks to the argument made in this chapter that most Europeans and North Americans do not really worship sacred sites of their respective local indigenous people; see also Catlin and Matthiessen 2004). And Rome -an initial capitol of a brutal heathen empire that actually killed Jesus Christ in Jerusalem – cannot convince us much on that matter: Rome is primarily just a man-made global religio-political power-base, at best. Despite other statements made by the pope (e.g. On Care for Our Common Home[1]) just looking at the world, it's hard to believe that there are not just double-standards at

[1] See the world famous statement, the Encyclical Letter Laudatio Si′ of the Holy Father Francis On Care For Our Common Home. http://w2.vatican.va/content/francesco/en/encyclicals/documents/papa-francesco_20150524_enciclica-laudato-si.html (accessed 1st July 2019).

Fig. 14.2 Protected sites in Asia are commonly seen in the landscape: A shaman holy site in Mongolia. (Photo credit: Author)

play (Diamond 1997). Other sacred sites in the Old World are often linked with initial ancient pagan traditions from deeper times, e.g. Stonehenge (e.g. Davies 2011) or Santiago de Campostela (now a world heritage site celebrated by Christianity: https://whc.unesco.org/en/list/347). And the African nation of Ethopia worshipped its mountain forest churches already for centuries. In terms of 'power sites', the HKH region remains a hot spot in that regard! But arguably, many other deeply sacred sites exist outside of central Asia, North America and the EU, reaching from Papua New Guinea over Australia and Africa to Latin America and to many oceanic islands (e.g. Eastern Islands or Wakiki Beach of Hawaii; see Hayashi 2002 for Japan).

Worshipping landscapes and its features actually is a global scheme that humans celebrated almost everywhere! It's currently just ignored in the western world governance (Davies 2011). Since the time of 'enlightenment' the west just pushed aside those approaches to life and its underlying concepts (Diamond 1997). Landscapes in the new and modern world are usually not protected for their religious meanings, certainly not for spiritual ones. Money and economic growth matter instead (Czech 2002; The Guardian 2017b), the endless use and development of landscapes and their resources rule and that leaves devastation behind (e.g. when ignoring Planetary Boundaries; Steffen et al. 2015). The long-term modifications of the initial Endangered Species Act (ESA), the reforms of the farming bills in the U.S., the U.S. Forest Act, the content of the RAMSAR site legislation, the Convention of Migratory Species (CMS), or the EU Habitat Protective show it clearly what the dominating land culture and ethics there really consists of and what it is to cater: western money and economic growth for just a few. The world's GDP rose to c. 75 trillionUS $ by now; a world record in human history and the universe for that matter (Rich 2013)! But clearly, it is just an administrative-cultural construct and fabrication. The ‘modern’ western world is not much more beyond that, kept running by a collective belief with a vast colleteral on the rise. It ignores that money, and wealth, cannot be de-coupled from wilderness and health, leaving an ecological footprint behind (Daly and Farley 2010)! In the regard of that gigantic techno -GDP, how mundane looks the Buddhist economy (Schumacher 1966) or the policy of ‘honor trees’, tree ordinations and where Holy Community Forests are looked after by Cambodian Monks to effectively reduce poaching and maintain forests of this world? It’s next to impossible to bring that back to forestry universities as a main scheme.

Clearly, the recent western world policy is not even in good agreement with Aldo Leopold’s view of the world (Leopold 2012) where ‘coins’ are now in the sole driver seat of decision making. The importance and relevance of spirituality -harmony with the creation and of one-self (e.g. Hayashi 2002; Lama 2009, 2012) – got widely ignored when it comes to the modern conservation of nature, of watersheds, of atmosphere, the earth and the associated sustainable administration, teaching, profession and culture. Carrying capacity – the limits if finite resources and earth – was pushed aside and even modern forms of ecology cannot change the ongoing drama and crisis (Næss 1989; Huettmann 2011) But even in the western world exceptions exist, for instance Byers (2017) reports in detail for the British climber Charles Evans – Deputy Manager of the 1953 British Everest expedition – respecting the sacred mountain peak of Kajenjunga in India and not climbing it. Same was done by Reinhold Messner when offered to climb Mount Kailash, a holy peak (Lama 2012). And in Japan, Mountain Fuji was climbed only once in 600 DC by a monk and not after by anybody for long time, as far as it is known. So some mountain respect can easily be done, and why not?

Instead, ‘the west’ constructed an economy and a science with underlying (christian) ethics as the driver to ignore wider spirituality but which actually has religious-like characters by itself (e.g. Iannaccone 1995; Altvater 2008; Loewy 2009; see Salsburg 1985; Guthery 2008; Ziliak and McCloskey 2009 and Greenland 2012 for statistics and science analysis as its driver and all used like religious rituals by its high priests). However, it should be stated that the ‘modern’ concept of geo-parks (http://www.unesco.org/new/en/natural-sciences/environment/earth-sciences/unesco-global-geoparks/) might come close to a more holistic landscape protection in modern times. In that context it is noteworthy that specifically China – a nation that is officially atheist – promotes those (somewhat spiritual) concepts of geo-parks strongly, with the EU running out of space to achieve and the UN lagging behind with UNEP still promoting unlimited economic growth on a finite landmass. Whereas North America just having declared many of its national parks around concepts of remote ‘rock and ice’ and in areas with relatively little biodiversity (Dietz and Czech 2005), e.g. Yellowstone, Alaska (where most of the U.S. protected area is located but without a proper protection) or in the Canadian high arctic! It is noteworthy here that North America actually has a deep culture with many power places and holy sites within the deep time indigenous community (e.g. Matthiessen 1992; Bringhurst 2011).

We know that humans have affected landscapes – we actually live in the Anthropocene – and consequently humans influenced wildlife since deep time and now overrule most ecological processes. Landscape modifications are well documented and known (e.g. bird ovens, caribou drives, fire, fish migration barricades).

The shape of the modern landscape and habitat is made-up due to people, their values and beliefs, e.g. urban areas and for instance the Empire State Building and large monuments (see the following reference for India striving to outcompete with Hindu buildings larger than the Statue of Liberty: https://www.theguardian.com/world/2018/sep/14/india-to-break-record-for-worlds-largest-statue-twice).

Associated man-made extinctions have been debated for long time and those details are well reported (e.g. Diamond 1997; Araujo et al. 2017). But as can be seen in North America's Clovis sites (c. 13,000 years old or older; Kelly 2003), in North Brazil likely for over 40,000 years (Guidon et al. 2002 see rockart etc. there), in Papua New Guinea for even 40,000 years (Groube et al. 1986), and Australia for over 60,000 years (Diamond 1997) people and civilizations are still alive and ready to live another 70,000 years or more… But this can only be successful for all of us when we find a good steady state, balance and harmony with the resources we have available on earth (Daly and Farley 2010). Global sustainability is the one and only aim to survive long-term. Efforts and resources should be placed there, and sprirtuality geared towards Mother Earth can help us to get there globally; it's already 'here' and has been with us for millennia.

When seen from that angle, the mentioned artificial animal concentrations like pigeons released and nurtured around holy sites are easily misunderstood (Gutierrez and Buchy 2011), often used by atheists to point out rational flaws in spiritual cultures and people, whereas humans are not always rational and cannot live without wider believes. Instead they might be meant to serve and to celebrate 'life' and to teach respect of 'the being' itself, globally. And Mercy Release really achieves just that (needless to say that the concept of reincarnation – the consistency of live, 'the being' – supports those thoughts even further and makes it really worthwhile in that respect. When thought-through, reincarnation is also a smart concept to maintain live and pick a leader, for human governance and for sustainability; Xiaoming 2004, BBC 2015).

Beside the catch-and-release of pigeons, those details of spirituality and resulting actions are found all over Asia and in a rather high concentration! In the Tibetan region for instance individual fish gets released (which then are easy prey for river otters for instance)! And if these animals – fish, pigeons etc. – serve one purely ecological purpose, then it's to maintain a predator food chain, which eventually supports the maintenance of ecological processes and ecosystems. Peregrine falcon populations will fare well in such cities with Buddhist animal release! And along the same lines, vultures are also found in many Asian cities. These birds there are usually left untouched or even fed through 'vulture cafeterias' – due to spiritual reasons. That has been the notion for centuries. And if they are now affected by one thing, then it is man-made contamination and commercial western urban processes and lifestyles, e.g. cause by the pharmaceutical industry (see 90% population crashes of vultures in Asia due to pharmaceuticals; Green et al. 2006).

But beyond western reasoning, the concept of mystery, of respect and of awe about nature -harmony with nature – and fearing unknown things in the wild and in remote regions are far from new; this has been with mankind since millennia (Diamond 1997; e.g. Xiaoming 2004; Karmay and Watt 2007; Lama 2012; Baumgartner 2015 for Nepal). In the mountain watersheds of HKH the yeti is the classic example for it (Messner 2000), and Poyang Lake, China, is said to have freshwater dolphins making ships disappear (Bajii: it is worshipped as a goddess of protection by local fishermen and boatmen in that part of China). As a matter of fact an endless array of those ghosts, bad and powerful spirits can be found in the HKH region! It's a big driver for people, society, cultures and subsequently watersheds! Such type of 'scary' ghosts can actually keep the real bad and evil powers away so that things remain safe. It's a commonly found concept in the HKH region (e.g. Lama 2012 for 'good sorcery' in Nepal; Figs. 14.3, 14.4 and 14.5)! And in case the ghosts get annoyed, they can revenge! Such cases got described by Byers (2017) when westerners worked on glaciers and climbed in high altitudes of Kumbu, Everest region.

Whereas the overwhelming globalization movement – the western world push overall- in it's institutionalized form is widely secularized by now and mostly just pursuing materialism and monetary wealth for its own sake (Marx 2010; just see what Google or Microspft promotes). A superficial life easily takes over, all based on food and games. Commercialized football, sports, the Olympics and their organizations are to rule, while actually big corporations benefit coincidentally the most from that hype! The discipline of 'Marketing' is creating this hype as part of their paradigm; it tries to do so on a global level (Kerin and Hartley 2014) and achieves it (see Apple products, FACEBOOK or TWITTER). It becomes a self-fulfilling

Fig. 14.3 Powerful spirits can help to protect against evil. (Photo credit: Author)

Fig. 14.4 A river dragon in China. (Photo credit: Author)

Fig. 14.5 The daily feeding of food and milk to the Ganesha. (Photo credit: WWW)

prophecy, the huge sums spent on soccer world championship, NBA or NFL Finals advertising spots cannot show it more clearer! In such schemes, now rolled out globally, religion and deep spirituality with one-self and with nature play less of a role and it is widely discriminated against, one way or another. There stands deep reflection and a humble worldview -all embedded in the natural resource and its limits – versus the endless hype created by the TV, the www and urbanized Anthropocene. And all is reachable by car and air planes. Not surprisingly then, the decline of the Christian church attendance throughout the western world speaks for itself (increases have been observed in atheist China though; see The Guardian 2017a for Nepal). Worldwide trends towards 'reading less' and promotion of individualism (see for instance bowlingalone.com) come with the same western worldview: promote individual freedom and 'careerism' on the cost of others, avoid to reflect on yourself, on your balance and how you affect landscapes and watersheds! But surprisingly, in the western world spirituality is still in demand and seeked after; often this comes in different forms than religion as such (Altvater 2008). Many indicators show that, such as the rise of certain video games, gothic cult rock, monster movies, obsessive shopping or even a rise of pilgrimages like Santiago de Campostella or a dreamed memberships with ISIS by westerners and to actually confront and fight the western world itself on spiritual grounds![2]

In contrast, in the HKH region it is easy to find that people pray five times a day, at little temples 'around the corner' in the suburb, or at central sacred places and in vast landscapes and mountain passes (Xiaoming 2004; Fig. 14.5). Milk and food is given daily to the ganesha and deities. People live in those religious stories (Textbox 14.1). And one of the biggest pastime events during the year are festivals (see in Chaudhary et al. 2008 for Manang) and those are alive and popular with events even growing or becoming revived and re-designed!

Throughout the history of humankind the worshipping of nature, including rivers and the sun, is found to be wide-spread all over cultures, across continents and the world. In such schemes the sun appears as the over-allmighty to humans – a scheme that is found in many religions and civilizations (very common among the Egyptians as well as Mayans). And why not? Is god not pure energy? Humans know that energy is 'entropy' and here is what unites science and religion and conservation (Georgescu-Roegen 1971; Lama 2005; Carlson 2012). God can be seen then in many features, including in the sun, the weather, rain, wind, temperature and water, even in the sciences. And there are many river gods and they are the ones who give life (see Textbox 14.1).

[2] It should be stated though that the Western world has (much) spirituality also; somewhat mislabeled and hidden such as in 'Dr Faust' by J.W. Goethe (who did science as well as ghost story poetry as a German classic), R. Schuman (who did a piano piece on Walpurgis Night and forest ghosts there), or endless monster stories and zombies in Hollywood movies. Those things are all over the place if looked right. Just have a look at the Black Madonna in Spain, gargoyls at traditional Christian churches (, e.g. Notredame; Paris), or with H. Bosch's paintings of hell. The famous '*Phantom of the Opera*' musical run for years in cities like London, New York or Hamburg shows us no other.

Textbox 14.1: The Hindu River (Indu, Ganges)

The Ganges is a major river in the Hindu Kush-Himalaya, it feeds over 1 billion people. But it is also perceived as a wild goddess and central to the Hindu universe and religion. This river and its seven major tributaries are divine and pure; they are a lifeline for India and Bangladesh. Taking a bath in the Ganges purifies and brings one closer to heaven! As per Hinduism and its ancient believes, this river starts in the universe and comes down to earth. Initially it did so in full power, but that way it can destroy the earth. And thus Lord Shiva put Ganges in his matted hair and opened just one of his hair locks and so it now comes out in a more controlled manner…

This short simplified version of a rather complex worldview and religious belief shows the complexity and the holistic view commonly found in Asia. Rivers, and its water, is to be treasured as it bears life and wealth, always has been and always will!

Fig. 14.6 Religious caves for praying and eremite monks on the Qinghai-Tibetan Plateau, China. (Photo credit: Author)

Holy landscapes can be vast, with rivers within and fed by glaciers in the mountains. Mountains are the gods! The HKH region has many examples (Fig. 14.2, 14.6). For instance Kakku – a unique temple complex of more than 2,000 stupas at Inle Lake in Myanmar (Fig. 14.7). It's on app. 4,000 m elevation, directly linked with HKH and with its weather: the monsoon which gets its water from the ocean! Thus all is truly connected! Beyond pilgrimage, it has now developed into a major tourist place as well (http://inlelaketourism.com/kakku-pagodas.asp) as the global citizen is eager for a spiritual base in their lives.

Fig. 14.7 (**a**) A high concentration of temples and monastries in Myanmar. (**b**) A high pass temple (Credit: WWW and T. Ghale)

Still, 'the west' hardly sees, and certainly does not accept yet, that landscapes- and the earth – are part of the religion, of humans as spiritual beings, and as a wider spirituality. There is virtually no political party in the western world that has those concepts in its portfolio. Modern science just tends to be very parsimonious and reductionist (Burnham and Anderson 2002), it's biased in its methods and subsequent outcome (Arnold 2010), a non-reflective template (Guthery 2008) and misses seeing reality (Breiman 2001), spirituality and the wider picture. It does not ask for changes and of the 'business as usual'. That is certainly true for the HKH region, and the wider polar ecology it relates to (for 3 poles see Huettmann 2012; Carlson 2012). Spirituality is not part of the world-dominating western science concept and its governance at all (Zar 2010); for Asia see for instance in Prins and Namgali (2017). As can easily be seen, the 'common law' -the very constitution and legal system – of the western world widely ignores such a link (Marsden 2017). Talking to any lawyer, attorney or court judge – and most politicians in charge -will show us nothing but that. You will find yourself to be laughed at when speaking in such circles about 'harmony with nature' or a more holistic perspectives and universal spirituality (compare that with Lama 2012; Duraiappah et al. 2012; or Trinley Dorje 2018 for instance). That's one of our tragedies in global governance.

Instead, reality about mountains, spirituality – the gods- and humans show us it's clearly all linked (Næss 1989) and such linkages are easily found worldwide in the religions too (Lama 2009, 2012): Mohammed secluded himself in a mountain cave (named Hira) for several nights of prayer; Jesus is famous for praying from a mountain (see Luke in the Bible etc), and the mountain-landscape and watershed of Kailash is part of a pilgrimage in Hinduism and in Buddhism alike (http://www.icimod.org/?q=9456). The caves in mountains are used for purification (Lama 2012; Fig. 14.5). Buddhism itself dispersed and spread over the mountain landscapes and its passed over the regions several times (for phases and roads of Buddhist diffusions see Xiaoming 2004; Chopel 2014) and those landscapes are used for pilgrimage and purity etc. (Lama 2012). From the HKH region it reached along the silk road into Afghanistan and beyond. Many shaman sites in Mongolia are found on a mountain (Fig. 14.2). And many archeological findings in the mountains of HKH also speak to those details, e.g. Ladakh (Vernier and Bruneau 2017). Figure 14.7 shows temples and monastries devoted to mountains and their gods! Same can be found with many lakes in such landscapes, for instance the infamous lake in Kailash (Lama 2012) and Lake Baikal in Russia associated with Mongolia (for Olchon island in Baikal see: https://www.welt.de/reise/Fern/article181363580/Sibirien-Drei-Tage-auf-der-Insel-und-die-Schmerzen-waren-weg.html).

Many eremite monks and shamans carry out pilgrimages across landscapes for their own cleansing and enlightment into remote mountain areas to obtain wisdom and purity (e.g. Lama 2012; Chopel 2014), as can be seen in the many caves in the Kailash area (Lama 2012), Madan valley of Annapurna, Nepal or in (Duhuang https://en.wikipedia.org/wiki/Mogao_Caves) along the silk road (which links directly with the HKH region; Lama 2012). In the HKH region the mountains, their clean air and water, are all one! While the western world still does not really approach things from that angle (see with ICIMOD.org for examples), it can be seen there though indirectly in many studies and textbooks, such as Næss (1989) or

Miller and Spoolman (2011); see also Huettmann (2012) for the tropics. One should take good note that Oxford, Cambridge, Harvard, MIT, CERN and such so-called leading and elite research institutions with gigantic science budgets do eventually search for a holy grail in the universe, of sorts (they just are biased and do not allow spirituality to enter the scene, agenda and question). It's there though where it actually all combines into one, as stated by Carlson (2012); see also Lama (2005, 2012). A good example is found at Duke University and its spirituality and health center https://spiritualityandhealth.duke.edu/).

Pilgrimages are an inherent part of the HKH culture and the entire family life is planned around it. Nowadays those trips can be done as tourist packages even, e.g. Svambunath in Kathmandu, Lasah or Kailash. Much of the tourism in the HKH region is now locally from Asia! Such a holy trip does not only affect the society and its history and actions, but also, entire landscapes and their resources, as well as how they are valued and how they look like! The HKH landscape is a spiritual landscape, after all. It acts on a global level! The Kathmandu and Lasah areas have their many World Heritage Sites for a good reason. Another great example to be looked at in closer detail is Kailash: It sits on top of a major river watershed as a headwater source of four major Asian rivers (Sutlej, Karnali, Brahmaputra and Indus). It is holy to Buddhists as well as Hindus, Jainism, Bon and Shamans (Lama 2012) encompassing a high mountain top and tourist trails (ICIMOD 2018a, b, c). Associated to Kailash is Lake Manasarova (the 'Supreme Holy Lake'), which is an inherent part of the purification process (Lama 2012). All of these functions and features of the landscape require it to be clean and free of pollution. Proper sanitation and clean surroundings are also essential for promoting tourism that provides local livelihood co-benefits. Arguably building a train with a road around those areas (as currently done by Chinese investors) misses the entire concept and just spoils it (http://www.icimod.org/?q=25659). It spoils an entire global belief-system.

When religions are just seen as a set of rules, as a structure to life, then it raises the question which of these rule sets are the better ones to go by, for whom,[3] and how does its society and associated landscape look like? Associated with the ruling god(s), these rules create a culture how humans life and how they relate with the earth and how they treat 'Mother Earth' and its deities. It's a form of governance!

Central to that discussion is the concept of 'sin'. Here this matters for the discussion of an environmental wrongdoing, or poor conservation management (Table 14.1). Areas are to be protected for infinity, and with the reason to keep them for future generations. Thus destroying those areas clearly is a sin. But not so in the western world, or among atheism. Instead, virtually one is awarded for not protecting it (Czech 2002), e.g. through a culture of use and associated subsidies (coined by some as perverse subsidies Myers 1998; Daly and Farley 2010), all even encouraged by the wider governance and institutions (ministries). Instead of sin one may also refer here to taboos: the taboo of greed and of taking beyond what is needed

[3] This question raises the GAIA theory (Lovelock 2016) because it could well be that the wider society is to survive while an individual member, or location, is not.

Table 14.1 A selection of traditionally perceived environmental sins and their global context and practices

Perceived Sin	Religion	Consequence	Comment
Killing of animals and plants	Buddhism, Hinduism	'Holy cows', sacred elephants and vultures/birds, and animal sanatorias and hospices	A classic example of spiritual and religious impact
Killing of freshwater fish	Bon, Shamanism	Lack of a freshwater fishery and such food items	Until recently lake biodiversity of the HKH region has been widely untouched since deep-time
Drilling of tunnels	Bon, Shamanism	Mountains remain intact	Such actions stand in strong conflict and require major compensations, I ever possible. It creates a major rift between developers, government and local people
Drill for oil and gas	Bon, Shamanism	Little oil and gas exploration in the HKH region	This has many implications for sub-surface rights. It also includes drilling for water
Extract natural resources in excess	Bon, Shamanism, Buddhism, Hinduism, Daoism	Mining, forestry	Arguably, a major topic in the HKH region, namely Tibetan plateau
Waste natural resources, unnecessary excess and geed	Bon, Shamanism, Buddhism, Hinduism, Daosim	This includes herds of sheep, goats and yaks that are too large, beyond carrying capacity	This stands in conflict with capitalistic values and concepts, e.g. unlimited economic growth or freedom
Pollute natural resources	Bon, Shamanism, Buddhism, Hinduism, Daoism	Water pollution	This is mostly expressed as the 'beauty' of nature, less the topic of microplastics, pesticides or the promotion of organic products. Climate change is not really addressed directly.
Destroy harmony with earth	Bon, Shamanism Buddhism, Hinduism, Daoism	Affects a holistic perspective and thus most aspects of life and on earth	A major worldview reaching into life and earth, and the universe and cosmology.
Ignore mother earth's needs	Bon, Shamanism, Buddhism, Hinduism	Another holistic view, e.g. applied in anticipation of human actions	A sustainability concept
Destroying the creation	Bon, Shamanism, Buddhism, Hinduism, Daoism	Includes the destruction of any life	A major scheme in the life and teachings of Buddha

(continued)

Table 14.1 (continued)

Perceived Sin	Religion	Consequence	Comment
Modifying the creation ('The ancient way')	Bon, Shamanism, Buddhism, Hinduism, Daoism	A rule of sustainability	A major rule and policy, resistance to bad change
Creating long-term harm to natural resources	Buddhism, Hinduism	Sustainability concept to life	A sustainability concept

(Lama 2005, 2012 for an example)! Taboos can set the limits not to overstep carrying capacities, in any shape and form.

Outside of the western world the concept of sin is widely steered through taboos. Taboos can have many shapes and forms, many are convoluted but tend to include peer-pressure and ethics. Those taboos are not all known or described even. They carry their own evolution and dynamics and might be in conflict with the western world. But taboos exist, and they can be bigger drivers in society (Lama 2012 for an example). Taboos, and associated folk rules and policies, even local non-spiritual ones, do have massive impacts on landscape conservation and shape (see for instance Bocharnikov and Huettmann 2019 for Russian wilderness conservation as a major percentage of the world's boreal forest and global wilderness). In the HKH region, the notion of witches are among those agents, or even spirits and kumaris (a practice still shared and celebrated between Hindu and Buddhism, for instance). In shamanism, many more of those concepts can be found but not all are even known and described yet (see Bon for somewhat blended concepts; Karmay and Watt 2007)! It's the shamans that stand between the humans and the gods, and they are the messengers and can effectively steer human action accordingly (Lama 2012)!

Such type of taboos are obviously linked with, and embedded in, spirituality, and which tend to be connected with the environment and its forces. The essential part here is that taboos, or rules, any religious or other rules (law or habits) can provide a good and sustainable structure to human life, as well how to operate the environment and landscapes (Baumgartner 2015; Byers 2017 for an example). It is here where 'culture' comes to play. Some features or their landscapes, entertain cultures that allow for self-organization, even in the largest break-down of governance: society still operatesa and moves forward (Lama 2012; Baumgartner 2015 for a civil-war example in Nepal. Aldo Leopold also emphasized in his writings the self-organization of land and resources, and land as an organism; Meine 2013). That way, the break-down of, or the change in, governance, does not automatically mean an end of life or society. Most Asian nations have experienced that, e.g. Nepal during the Mao'ist insurgency, Tibet during its various governance struggles, China and Korea during Japanese invasions, Bhutan in times of transition towards democracy, and so on. Many examples can be provided (see for Burma during English invasion and killing of religious/scared elephants to shock the local culture into obedience; Myint-U 2007). It's the deep culture, usually widely entrenched in a belief-system and spirituality, that keeps people and the nation going there, as a functioning society. In that regard, the self-organization of Asia, and specifically of the HKH region is stunning to experience; it's a major engine to keep mankind and civilization (!) flowering no matter what. With that, top-down approaches of governance can only reach that far (Marsden 2017), whereas, bottom-up approaches, a self-organizational power that keeps structure going, is the real engine and hard to break (arguably, industrialization and capitalism tries to achieve that, but can only go that far)! That spirituality is driven and inspired by nature itself!

This matters for conservation because many of the those protected site concepts in the western world and elsewhere now go back to national parks as the only valid model, e.g. Yellowstone, and those are promoted and approved by very religious people in North America, e.g. Jon Muir (trained in Scotland by priest parents) and Teddy Roosevelt (a republican with strong religious values). The Yellowstone example is a classic and peculiar example in that it's an aesthetic site and which actually was celebrated for long time by indigenous people before. This is a common feature found in many other national parks also. Noteworthy here is to say that the national parks, as a concept, are not the only way to achieve protection. Russia used a very different concept to protect nature for instance based on zapovedniks etc. (Shtilmark 2003; see Bocharnikov and Huettmann 2019 for effective alternatives), and another more complex system is used in China (Li et al. 2016; see Elvin 2006 and Harris 2008 for performance). And many more, localized, concepts of landscape protection are found throughout the world and they contribute to conservation in big terms; that is certainly true for the HKH region and its natural wonders.

An additionally relevant feature to know is that another argument for the creation of national parks came from the need to protect resources from 'commercial harvest (=a relentless economic growth scheme favored and still dominated and pushed by the western world; Czech 2002). It's a well-recognized issue in the U.S. and its conservation policies, e.g. in the establishment of the Migratory Bird Act (Taber and Payne 2003). The inherent contradiction between nature and a taboo-less killing spree for financial gain was already well-known 150 years ago based on devastating evidence, e.g. U.S. market hunting, commerical whaling by Europeans and the U.S. Seen from that angle, the failure of the Christian church on that matter must be seen as tragic (Marx 2010 for humanity): they just widely promoted to rule and to manage the world (Czech 2002; Marx 2010). It was only a few marginalized splitter groups in the catholic church that pointed out this problem, e.g. Quakers (Chornok and Guindon 2008 for a Costa Rica example) and Liberation Theology (Marx 2010). The arbitrariness, and its inherent contradictions, in the current western model, in globalization actually, was already well outlined by M. Mead (Howard 1984) as well as by Altvater (2008 for economic contradictions) and it got described economically and widely heralded by the late Nobelprize winner E. Ostrom (Ostrom's law; Ostrom and Hess 2007). The logic conclusion is to link it all back up into one, into a more integrated and holistic concept as a much better model of management. However, we are currently far away from such awareness and push (Belgrano and Fowler 2011).

In Asia, and specifically in the HKH region, at least six main spiritual groups can be described: Shamanism, Hinduism, Buddhism, Islam and other religions and view points such as Christianity as well as atheism. Other blends also exist such as Bon (standing between Shamanism and Buddhism; Karmay and Watt 2007) and Jain'ism (Lama 2012). But not enough, these main groups also have an endless array of sects and literally thousands of gods, and even more deities and spirits (see Xiaoming 2004 for Tibetan Buddhism). Many of those details are hardly written down even (Chopel 2014)! Asia is spiritual, and it ranks at the opposite spectrum of the secular western concept and its understanding and management of natural resources!

And then there even is another rather relevant religion and concept in eastern HKH, which is Dao'ism (Tao; e.g. Miller 2003; Silvers 2005; Robinet and Brooks 1997 for overview). It's found primarily in China but easily reaches into the HKH region, its mountains and watersheds. Historically, Dao'ism was even a state religion in the seventeenth century and assigned by emperors. It's wide-spread and persistent. It promotes to be in harmony with the 'Tao' (the source, pattern and substance of everything that exists). It has its roots in cosmology and naturalism, namely in the school of Yingyang starting many centuries ago. Female shamans also play a large role in Dao'ism and sacred mountains are worshipped. This religion affected other religions like Zen for instance, and it has modern applications (e.g. the virtue of small 'Te', see Hoff 1983, 1993 for Piglet and Pooh). As taken from Lowe (2003), some of its principles center on notions like society is to be seen as multi-level self-organizing "living" systems (a crucial topic we will come back to later); aesthetics are favored over absolute or scientific "truth"; dialectical acceptance of simultaneous multiple realities; and, to consider multivalent, non-linear holistic acceptance of contradiction and paradox. When those concepts get applied to landscapes and societies, globally, we would clearly live in a different world! And like found with Shamanism, Bon, Buddhism or Hinduism, it's needless to say that modern ecology is not that far from those wisdoms, see for instance (Næss 1989), Czech (2002) or Miller and Spoolman (2011) but compare with realities in the Ecological Societies, e.g. America, Australia, Switzerland, UK or Germany.

Virtually all landscape resources are affected by spirituality -often channeled into, and expressed as – those religions. From a natural resource perspective that concept certainly applies to the rivers, forests, the earth and the air, including human actors. That exactly is Mother Earth at its heart, a concept that was widely ignored in the Paris etc Agreements on climate change (one scheme to be applied there was to keep oil resources in the ground). Certainly the IPCC (https://www.ipcc.ch/) is far from it in its models, now in its seventh generation but the effect of the sun ('solar effects'), deep oceans, clouds or the wider universe synergies and telecoupling spill-offs are still vastly excluded[4]! Also 'modern' wildlife management stays far away from it (Dodds 2001; Silvy 2012). Whereas, the Mother Earth concept is widely entrenched all over the world. River burials, or sky burials – as done by the Zoonostrians (Zarathustrians) in the HKH region- speak clearly to that argument.

[4] The concept of oceans as climate predictors got repeatedly ignored by IPCC and just enters in recent models. Oceans cover app. 70% of the world. Most of the world's freshwater is fixed in glaciers, snow and ice. That's why the HKH region is part of the 3 polar system (Huettmann 2012) and our focus here.

Table 14.2 A short selection of pilgrimage sites in the HKH region; many of them are 'power places'

Pilgrimage site	Location	Religion	Comment
Kailash	Tibet, India, Nepal	Buddhism, Hindu, Shamanism etc	Sources of holy river
Durbar Square	Kathmandu, Nepal	Buddhism and Hindu	World Heritage Site
Pasupatinath	Kathmandu, Nepal	Hindu	World Heritage Site
Swoyambhu	Kathmandu, Nepal	Buddhism	World Heritage Site
Muktinath	Annapurna, Nepal	Buddhism and Hindu	Annapurna circuit
Buddha's Birthlace	Lumbini, Nepal	Buddhism	A central place in buddhism, India claims a second birthplace; World Heritage Site (See Adesh and Amita 2017 for associated sarus cranes)
Tienshan temple	China	Dao'ism	
Lake Manasarovar	Tibet (China)	Buddhism, Hindu, Shamanism etc	Purification
Caves of Dunhuang ('Caves of Thousand Buddhas')	China	Buddhism	Silk Road; many more exist
Mount Wudang	China	Dao'ism	One of several mountains worshipped
Vaisno Devi temple	India	Hindu	Hundreds of temple sites exist all over the HKH region
Burkhan Kaldun	Mongolia	Generic, Shamanism	A vast list of holy mountains exist and are outlined by the UN (https://whc.unesco.org/en/tentativelists/6068/)
Lake Baikal	Russia	Shamanism	Olchon Island

Other aspects are found in the sheer huge number of pilgrimages and associated governance (see in Lama 2005 or documents in ICIMOD.org), as well as in day-to-day actions of people in the HKH region (Tables 14.1 and 14.2).

Clearly, spirituality remains officially disputed by the powerful 'west' and its institutions – at least widely marginalized, as being 'not serious' and irrelevant, or even it is seen as a hinderance. This is specifically obvious in 'modern' conservation journals, e.g. Conservation Biology, Biological Conservation and their professional societies and NGOs. And thus, in the (so highly ranked) western science education system spirituality is widely absent (see conservation management textbooks taught as the global standard, e.g. Dodds 2001; Silvy 2012). The Society of Conservation Biology – a self-declared global leader in conservation (https://conbio.org/)- features now some aspects of religion in its events. However, it still stays entirely in the mainstream, mainly science-based atheism and some Christianity, with the Dalai

Lama just given a celebrity interview/token status! Shamanism is still absent. When it comes to real-world spirituality, virtually all of this western approach is incomplete at best, naïve and widely biased; often those actors are incompetent and untrained on the issue, scared to take it on and lack fluency. The power of spirituality, and how we relate to the world, can correct that current world-view better, but it just remains widely unused.

To many people and institutions, spirituality still represents a 'scare' that can stop the entire industrial machinery and its mindset; and perhaps rightly so. Thus, it is to be avoided in full in our western governance. Instead, and for a global guidance, the HKH region can provide many examples where spirituality shows good and additional progress in conservation, social structure as well as in environmental protection and sustainability. Athreya et al. (2018) present documentary evidence of the worship of 'Waghoba' – the big cat deity – resulting into good tolerance to the large cats in many traditional communities even today. Authors further state that the study highlights the need for interdisciplinary research in conservation for better understanding of human wildlife interactions beyond that of "conflict". The protection of snow leopards around monastries show already its positive impacts (Li et al. 2014), and so do the many sacred sites for plants and groves (Chaudhry and Murtem 2015). And even from an atheist point of view, China's geoparks show some good leadership on the notion of respecting nature and landscapes and progress towards conservation, as a global role model! Already many people flock to those priority areas, and that speaks to itself. So why not unleashing it more than for conservation and good guidance (Chapin et al. 2011)?

In central Europe, and in most of the western science and conservation model, the sacred sites and such groves were either abandoned or widely marginalized. The notion of science plays a big role instead, which is in those questions just secular, limited and biased, usually envoking odd hypothesis and many meaningless p-values (Gigerenzer 2004). Instead, the aim is to set aside landscapes and seascapes on the large scale- including the atmosphere- and it does not really matter how that is achieved (assuming it is done peaceful and in a fair and professional way). Reaching global sustainability is a somewhat declared national and also a worldwide goal! It would be foolish to allow relevant areas to be 'developed' and destroyed just because they are not 'sacred', 'holy' or not really relevant otherwise for the western mindset that tends to ignore aesthetics; just think here of Yellowstone (a beautiful and sacred site since deep time), Antarctica (as per Antarctic Treaty System ATS), or the landscapes around Stonehenge, Serengeti or Everest (the latter two are now part of a major road and train development plan, e.g. Fyumagwa et al. 2013; https://www.theguardian.com/world/2015/apr/09/china-may-build-rail-tunnel-under-mount-everest-state-media-reports). In Africa, Latin America, in indigenous North America (Catlin and Matthiessen 2004) and certainly in Asia, specifically in India, Nepal, Mongolia and Myanmar, many groves have been left untouched for millennia because they are said to host ghosts and spirits; it's common knowledge (see here for India for instance https://en.wikipedia.org/wiki/Sacred_groves_of_India). A switch of the local belief system, usually achieved by mining or neocolonialism and a so-called sustainable development and its PR, result into a complete breakdown of a life-support system that stands in good harmony with nature now abandoned for the profit of few people, usually abroad (e.g. Diamond 1997, see Mack 2014 and Henton and Flower 2007 for Papua New Guinea).

The western mind – trained by, and packed with the reductionist narrow monotheistic worldview (e.g. Burnham and Anderson 2002)- clearly cannot fully grasp the width, depth and complexity of such an approach to life. The western world is now widely urbanized and lacks a good relationship with Mother Earth. It has virtually no tools that allow that any other (e.g. Zar 2010; Burnham and Anderson 2002; but see Ohse et al. 2009; Regmi et al. 2018). Already the legal system as it is applied to the world and to parts of HKH makes that clear (an anglophone set of rules and mindset can never give full justice to HKH or Mother Earth as a concept, certainly not to any ecosystem as we know it. At best, Ecology tries to catch up with the complexity of the 'real' life, e.g. Næss (1989); see Silvy (2012) for narrow and segmentorial views, and see Rosales (2008) and Marx (2010) for real-world problems affecting wealth and its distribution affecting poverty impacts on conservation and governance. The western environmental, social and economic crisis cannot show it more clearer than that (Alexander 2013; Cockburn 2013). The western world is usually hierarchical, obedient, linear, is to be political correct, carries demagogical aspects and just knows one super god, one solution and one guidance to a problem, while in earnest the money market rules it all (Czech 2002; Marx 2010; Altvater 2008). By now, this means speed-trading and the use of toxic bonds at the few stock markets (namely New York, London, Frankfurt, Hong Kong and Tokyo). In such culture, landscapes and society, and the atmosphere, look accordingly. They get marginalized by design.

Who would challenge the paradigms of the west? Well, spirituality does and can fully outmaneuver it. In HKH, this paradigm gets pushed a little further though, here some details and aspects:

What is really the meaning of a name for things? A name is just a short-term label, at best. With millions of 'things' and people, names carry less value, and with re-incarnation, names actually come and go.

And how many genders are there? Most people will say two: male and female; but instead science has moved on already decades ago (e.g. Fausto-Sterling 1993).

Time can bend! Time is location-dependent and affected by gravity. This is well proven by A. Einstein and widely accepted now, but most western people still cannot really understand, apply or support these concepts.

Health consists not only of a singular physical aspect. While most people will understand this concept in their life, it is difficult to grasp, and to apply it. Pharmaceutical and hospital companies- selling pills and treatments with governmental help- try to avoid this subject in their portfolios or argue against it via media outlets etc.

Numbers do not describe life and situations in full and can mislead reality. This fact of life is another difficult concept for most people and governments to understand, specifically, the education and banking systems have a difficult time to move forward with it.

Life is bigger than what meets the eye. While this easy understandable by just looking at the wave lengths and the set up of the eye (receptors), it's widely not acted on. Humans and governments only act, defend and justify their own facts then.

Harmony with life matters. This is a core scheme in many Asian policies but hardly implemented in the western world at all, yet, e.g. business and foreign policies.

Perspectives from the universe, and unknown powers/forces do exist and matter. While most people will agree with it over their life-time, it's difficult for most western people and governments to adopt such positions

Several truths can exist and can move and get adjusted. This is a central dispute about values, beliefs and facts, e.g. when it comes to the western world, lifestyle, law and science. However, already in the narratives about history many different versions can often be found, certainly when it comes to 're-telling the truth' (the bible, koran and lives of Jesus or Mohammed as classic examples) or interpreting so-called facts and scientific evidence. Typical examples are found in the history of plate tectonics or in quantum physics (e.g. light as either particles or as rays).

Life creation, and life after death are not really understood at all. These are also concepts that are heavily disputed in the western world. However, no evidence exist for what created earth, life, or what happens after detah.

And there then comes the crux: Can spirituality beat the facts and policies of the west, globalization; or can they at least be equal or co-exist? Yes, it can and it actually does it all the time already. The HKH region shows it for many years! However, one-sided globalization still comes as an endless push. It certainly destroys wilderness and the atmosphere, besides other things. So far, just a peculiar, one-sided blend was found between the western world and spirituality that supports nature and Mother Earth. It's a somewhat artificial and arbitrary blend that mixes computer programming and online media with the gods (as seen in Bangalore, India) or cars and their protective spirits (Fig. 14.8). The ghost is in the machine, but it clearly is not really sustainable yet and thus those ghosts can be expected to be rather angry!

Landscapes are said to have a spirit. So when '*the ghost sits in the machine*', it might well be also located in the society then, as well as in the institution and its governance. And those ones are changing too. That's what culture stands for and what it does: constant change, self-adjustment, mitigation and re-arrangement. It's clearly a pattern of self-organization. For an example, see the cargo cult in Papua New Guinea (Diamond 1997), or how globalization changed Madang (Chaudhary et al. 2008), Khumbu (Byers 2017), Everest peak (Kodas 2009; Baumgartner 2015) and a vast range of national governances related to it.

The western mono-theism breaks down quickly in Asia where each family can have their own set of gods, uniquely served by them. Create your own good, as your family needs. That way, easily millions of gods exist (Davies 2011; Keown 2009; Knott 2016). Asia has those ones all over.

But such a religion has many more messages than just to deal with many gods and to serve them. Buddhism for instance is very clear on the hardships in life; the

Fig. 14.8 Protective spirits on a fuel truck. The oil refinery world mixes with an ancient system. (Photo credit: Author)

concept of Dhuka (Keown 2009) expressed it clearly! Life 'is' endless suffering. But compare that with the western world and its progress and endless joy, instant satisfaction and fun, the limit there is the sky. Not so in HKH though: the mountain peak is the limit and one does not go there! Being humble, grateful for the small pleasures in life are concepts that are widely gone in the western world. Such concepts, and the pursuit of unlimited growth, are in clear contrast to what Asia and the HKH region – limited by mountains and earth itself – has to offer. Landscapes and watersheds then look accordingly! Across the Asian religions, concepts of the Ying and Yang (e.g. Miller 2003) are frequently encountered still.

Perhaps human societies are a super organism after all, just as described in Taoism or even GAIA (Lovelock 2016)? Perhaps it self-organizes, and based on the surrounding context and tools provided? Those questions are not well addressed in the western world yet, but might well be at play here. Once more, those topics like self-organization are cutting-edge science in the western world, e.g. entropy (Georgescu-Roegen 1971), chaos theory or butterfly theory (Lovelock 2016). Whoever has witnessed how the masses of the people in the HKH region, e.g. Bangladesh, India or China, organize themselves in what the west would call 'chaos' will understand what is at works here. Is there structure in chaos, where did it come from (https://www.npr.org/sections/13.7/2013/03/26/175352714/the-origin-of-the-universe-from-nothing-everything), and how to achieve it (Fig. 14.9)?

Such concepts are not new though, among Buddhists, Daoists and in Hinduism, let's say. Those religions are clear on the topic of harmony with nature and the super natural in human beings, and in natural life. They have been described for long time, by many regimes, and are part of a mystic that surrounds HKH and beyond. And it's easily found in virtually any indigenous culture known (Diamond 1997). For

Fig. 14.9 Castles in Bhutan: Century-long protection against chaos like invaders from the outside to promote new and other religions and beliefs. Most of those castles organize themselves around waterways. (Photo credit: Author)

instance, Shamanism and Buddhism already offer us some insights into metaphysics, and also apply them to human health and for a balanced living! These are concepts that the western world and its medicine is still unskilled in and trying to catch up with but what is known by humankind in HKH for millennia. The Dalali Lama has stated those things frequently (Lama 2005, 2009), and similar hints are found in writings about Asia for long time (e.g. Chopel 2014 for ancient Buddhist texts), including Marco Polo (Marco Polo and Latham 1958). There is now western science, economy and medicine using those concepts to widen their 'portfolio' but they still struggle with it, e.g. when it comes to health payments for that issue and to push it into the wider western mindset, economy (Schumacher 1966) and law as a foundation. Still, there is a connection between health and the mind, diseases and sychology, well-being and harmonious living; a well-balanced work-live.

Spirituality is found throughout all aspects of the Asian society, certainly in the HKH region. This includes public decision-making and deciders up to the highest level (Xiaoming 2004; Lama 2005, 2009).

The western world is somewhat biased in recent times by believing that religion, buddhism and hinduism would be free of politics (Xiaoming 2004 and Lama 2012 for some details). Buddhists and hindus would likely point out here first that they are not one 'religion' in the Christian sense (Keown 2009, Knott 2016). But instead they are rather a group of many believes, as well as a lifestyle. And then, there is really no tax system linked to those, nor a real single leader; many gurus and lamas exist. Asian religions (which differ from the western world) make for a complex topic when it comes to questions of a state religion (most EU nations pursue state religions; Germany with taxes). Probably HKH is more pristine and clean in that regard, but the history of the Nepal court (driven by Hindus, Gregson 2002), and certainly Tibet's development over the last 400 years (driven by Buddhists; Xiaoming 2004; Lama 2005; Karmay and Watt 2007) shows a clear connection between the noble courts and the role of politics and religion, usually done to impact people and their behaviors and eventually payments to the leaders. Entire wars are fought about it, and the existence and imprisonment of the Panchen Lama and exiled Dalai Lama (who never set foot on Nepal) tell their stories accordingly (Xiaoming 2004; Lama 2009). This usually plays out in a farming society, with peasants, knights and nobles and many minorities. The recent discussion around a fair and considerate constitution for all minorities in Nepal speaks to that effect (Whelpton 2005); see also the civil warfare in Khumbu (Byers 2017) and in Dolpa and Humla (Lama 2012).

There are already deep treatises on spirituality (e.g. Karmay and Watt 2007 for Bon; Davies 2011 on shamans and paganism introductions), it makes for classic works of Asian scholastic works which are impossible to catch up on here. One focus should be mentioned here though for sure: Protection of landscapes and species and subsequent watersheds, and our relationship with the earth (Trinley Dorje 2018).

Spirituality matters for species and landscape conservation (see Adesh and Amita 2017 for Sarus cranes), and Li et al. (2014) remains a classic world-celebrity example finding that snow leopards are more protected near monasteries. In Tibet, fresh water fish species are usually not eaten due to spiritual believes (Buckley 2014); the net result is that a) fish species remained in a widely untouched status (abundance and diversity) til recently, and b) water resources are respected. Impacts of such believes are far-reaching, and obviously stand in direct conflict with globalization or atheist views like Chinese and communist mindsets (Marxist, Leninist. Note that Lenin was a hunter himself and valued nature). More of such studies can probably be made, and it shows that spirituality can provide additional, cost-free services for conservation and protection, as shown in the example of the Kailash landscape (Lama 2012). This is not a new concept though for several reasons: Most of the classic national parks are located in areas that were worshipped by indigenous people for centuries, such as Yellowstone (U.S.) or Banff (Canada), Kailash (China) or Everest (Nepal and China). Most animals and landscapes have received respect by humans, and thus, carry a certain sacred label either way, regardless whether in, or outside of a protected area. The notion of '*holy and scared groves*' are well-known and practiced by people and much research exist to show the benefits. Considering the link between the noble class and religion, most hunting reserves were closed, taboo, for the public (Taber and Payne 2003). Often a stigma was created by the rulers -sent by god- that it would be 'a sin' to enter. While this might be debatable or not, the effect is that the landscape remained untouched, or used less. Thus, it received a certain protection status (Note that the label 'national park' does not mean it is virgin or untouched, that's just a widely believed myth and misunderstanding; see Gailus 2010 for Canada, Elvin 2006; Harris 2008 and Buckley

Table 14.3 Examples of spirituality features adding to the protection and conservation of nature benefitting watersheds

Topic	Benefit	Location	Comment
Kitakyushu city[a]	Less climate change, globally	Japan	Asian Center for a Low-Carbon Society
Inle lake	Respect lake resources	Myanmar	See text for details
Satoyama-Satoumi Ecosystems[b]	Respect landscape and its ecological services	Japan	See text for details
Crocodiles[c]	Supports water resource	Bukina Faso, Africa	A unique approach where local villagers accept crocodiles and share resources with them
Grizzly bears	Supports coastal river ecosystem	McNeil River, Alaska	Another unique approach where a predator is treated with respect and allowing for a unique approach dealing with predators
Blacknecked Crane	Spiritual and ecosystems overall	Monastry at Qinghai Lake, China	Cranes play a big role in Asia and are widely valued for protection
Large cat god[d]	Large cats and their ecosystems	Western India	An inherent part of Hinduism

[a]https://www.japanfs.org/en/news/archives/news_id035880.html
[b]Duraiappah et al. (2012)
[c]China Daily (2018)
[d]Athreya et al. (2018)

2014 for China, and 'paper parks, for generic problems with National Parks, certainly in the HKH region) (Table 14.3)!

There are many other aspects of spirituality, and one angle that remains equally fascinating for the western world is the notion of Mother Earth's warning and its revenge upon bad treatment. Considering a massive onslaught on the HKH landscape and the earth and atmosphere, with roads, tunnels and railways, and the destruction of the atmosphere and weather patterns, why would the gods not revenge mankind for its loss of taboos and destruction of the earth? Mother Earth is a living universe and it breathes, acts and re-acts. Mother Earth organizes itself (Fig. 14.10).

Arguably, this is not really a call to action towards going back to the creation, jumping back into indigenous history, trying to turn the global society native or to consult shamans.[5] Every landscape and culture differs, and life is forward-looking for the new generation. The next 40 years matter indeed for us, likely for the world and universe! But one should indeed consider what can be learned from cultural approaches, from Mother Earth, how to use them for better conservation and why they work well with a global buy-in. Being holistic and all- inclusive in

[5] Nancy Reagan, the wife of the former U.S. president Ronald Reagan, was known to consult frequently with astronomers. And the chairman of the U.S. Federal Reserve, Alan Greenspan, followed the 'cult' by Ayn Rand called Objectivism and arguably he used it for his decision-making.

Fig. 14.10 A recent earth quake in Nepal: The gods must be angry. (Photo credit: Author)

decision-making, and having respect of nature remaining humble and in awe is not a bad concept and has worked for millennia (Bandura 2007). We need a sustainable relationship with nature, and the earth! As earthlings, Mother Earth must be on the major agenda for us. We have all the tools needed to get us there, so why not making good use of them for a global governance and sustainability culture?

How many soldiers does the church have? (Quote attributed to J. Stalin).

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Chapter 15
Settling the Terror of Your Mind with the Deities: About Fear, Anxiety, Inherent Chaos and Self-Doubt in Hind Kush-Himalaya Expeditions and Associated Research

Falk Huettmann

They tried to burry me but I turned out to be a seed
Source unknown

The Hindu Kush-Himalaya (HKH) area is not your average holiday location; it still lacks the big commercial tourist buses and hotel franchises as well as pretty ocean party beaches with high waves for surfing. But it still can feature mass tourism, as well as some 'dudes', mostly from abroad; many of them are naïve in the sense that they do not really know, prepare for, or truly can handle and grasp the deep culture and spiritual connection of the region with 'Mother Earth' (see for instance Chopel 2014; Karmay and Watt 2007; Knott 2016). That's because the real issues in HKH are not even the very high and overwhelming mountains – arguably the roof of the world – surrounded by a vast foreland, hinterland and breathtaking water systems of relevance to global mankind (walking and operating in such a landscape remains to be a gratifying experience; Ohmori 1994; Bonington 2016). Instead it is the associated embedded and complex human culture that it creates and attracted over the years, and which is so 'foreign' to us westerners; we are always in a learning situation there (Herzog 1997; Messner 1998; Bonington 2016). HKH has over 150 languages and dialects spoken in its landscapes and remote valleys (Whelpton 2005). Many distinct religions are found there (Lama 2012). Outsiders, like westerners, are

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F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department,
University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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somewhat tolerated there, dealt with and treated like certain ‘deities’ (a certain type of outsider god) that are better left untouched but treated with respect. And thus the locals remain indifferent to them; this makes for a peculiar and convenient blend of uttermost ignorance and helpfulness. Nowadays this is spiced up with flavors of globalization (see Baumgartner 2015 for international mountaineering tourism start-up companies). However, the outsiders are not really part of the intimate fabric and deep culture of the wider mountain landscape and its native inhabitants. It’s unlikely that without guidance and pointers outsiders will fully see and understand the depth of the local fabric (e.g. Lama 2012) (Fig. 15.1).

But simply compare that respectful -spiritually-driven – attitude to foreigners (Knott 2016) with your average western urbanized Anthropocene and how foreigners and refugees are treated there: From the narrow perspective of our industrialized world we can only look with big awe at HKH and its people, cultures and resulting landscapes. In my view, and due to the strong spiritual base, the HKH region carries a certain superiority on how to handle ‘foreigners’; something is to be learned from HKH for the world and how to treat each other (Lama 2005). And thus, here I will elaborate on it further because of the own work experience we have from there, and because those deities of ‘Mother Earth’ can be peculiar to deal with but they matter for a project success and for harmony. Without them, science and projects overthere cannot really work out, hardly be successful. Everybody who seriously worked in the HKH region can speak to those details, e.g. Herzog (1997), Messner (1998), Bonington (2016) and Knott (2016) (Fig. 15.2).

As a usual ‘western’ person initially one hardly tends to recognize those details, beyond the many smiling faces, the Namaste’s, the monastries and the busy life in the travel hubs of HKH. But one clearly is an outsider, and one is watched there; it’s hard to break in.

Fig. 15.1 The Hind Kush-Himalayas are shaped by Mother Earth since deep time

Fig. 15.2 Buddha was already there (a holy site for praying on the road between Tibet and Nepal). This road is located along a valley and which likely was used in the several processes of diffusion of Buddhism across the Himalayas

Interactions, the environment, context, and certainly the (perceived) ghosts, play a role in the Hindu Kush-Himalayas and what people do, and how (Baumgartner 2015 for a detailed description). One finds it in all corners of HKH in high density. Spirituality matters (Fig. 15.3).

The western world is by now widely secular and capitalized plagued with wholesale problems (Alexander 2013; Cockburn 2013; Vanaik 2018 for India; see also http://bowlingalone.com/). It presumes to be fully science-based with an objective perspective and superior foundations (Lama 2005). Likely such a perspective is not so fluent with the spiritual world and its relevance that is found in the HKH region, e.g. Lama (2012) and Knott (2016) nor does it even mater much there (Lama 2009) (Fig. 15.4).

A simple perspective, as taken from your average tourist book, might state that Hinduism is found more in the low lands, Buddhism in the higher regions, that blended forms exist (e.g. Kumaris; Whelpton 2005), and that Tibet runs a certain blend of ancient religions like Shamanism merged with Buddhism (Bon; see Karmay and Watt 2007; Xiaoming 2004), now overruled by an atheist regime driven by German/Russian ideologists that never even lived in Asia. However, never having set foot on Nepal the Dalai Lama plays a strong role there while being based in exile in Dharamshala, India (Lama 2005). He also provides a lot of influence via its followers in the western world, namely U.S. (San Francisco), France and Germany,

Fig. 15.3 Spirituality is found and expressed everywhere… (**a**) on a door handle, (**b**) at a wall painting, (**c**) and at a tractor with the eyes of Buddha

just to name a few of the major donors for the region. A few pockets of Christianity exist too but this is not a dominant religion in HKH usually. Whereas, the Islam is more prominent in western HKH, in some urban centers and in the southern and Lumbini area of Nepal, for instance. In HKH, monotheism just plays a smaller role, instead there are easily over 1000 gods and deities in HKH to be found (Lama 2012; Knott 2016). This presents a strong deviation from the western world-view and is often difficult to explain and to relate to.

Fig. 15.4 Spirituality is practiced anywhere: A worship at a sacred grove site near the Indian border

It is this spirituality, all these pursued and perceived ghosts and deities that are worshiped, that are to deal with daily when visiting or working in HKH. The 'gods can easily be angry' and you better tame their fears, and the people that serve those. It's context and perception that matters. People who have been in the HKH area and its landscapes and watersheds for a longer time might come to a good peace with this complexity that we are not really used to in the 'western world' (we might be used though to the 'ghost in the machine'). But it can easily play with your mind, and it is to be reckoned with (Fig. 15.5).

Need some examples? The occurrence of 'The Yeti', a human superbeing of sorts living in the high mountains of HKH, has been described by many people for millennia (Messner 1998; Baumgarnter 2015), certainly in HKH (the western world is quite obsessed with such things, see for instance Bigfoot and Sasquatch sightings in North America as presented in Google Earth upon such a query!). Documentations are found in the historic writings throughout. Entire expeditions and studies were devoted to this topic, e.g. R. Messner (1998) as well as the infamous Russian Pamir expedition with the St. Petersburg University funded by American and UK donors. Believe it or not, but the yeti did play a big role for local people (Baumgartner 2015). To me, the bigger role of those things sit in sacred sites, and when linked with shamanism or monasteries, for instance. Scared sites are not to be touched and thus result into a virtual protection that is not achievable any other: it's a taboo! A great example on a landscape scale is presented for snow leopards having a good status around monasteries (Li et al. 2014), equal good things or more can be said for sacred forests and water ways. Another good example are the sacred groves found all over the HKH landscape (e.g. Bhagwat and Rutte 2006; Lama 2012; Saikia 2006) (Fig. 15.6).

Fig. 15.5 Spirituality can take many shapes and forms (An animal sacrifice practiced by Hindus near the Jiri area, Nepal)

Fig. 15.6 Does the yeti perhaps live there?

Those spiritual considerations and details have a rather high influence on the behavior, politics and day-to-day life of the local population in the HKH region. Many holidays are set up to worship the gods and deities. But also, when working there it affects the infrastructure and what one can do, and how, and what not. Such belief systems set us the limits, too. A typical example can be provided when asking for research permits to handle plants or 'animals' in the HKH region (those animals tend to be sacred and thus must not be touched, removed or stressed. Studies using specimen, or DNA or diseases done by the western world will have to consider this. Compare that to our western mandatory Institutional Animal Care and Use Committee (IACUC https://www.aalas.org/iacuc) rules claiming to achieve the same or often assumed to be superior even) but then doing almost nothing (bred lab mice, insects, plankton etc are widely excluded btw) but just cater to the industrial model and its finances.

In HKH instead, and like most sherpas and staff expeditions do, many mountaineers for instance check and connect first with the surroundings, and with the environment, and with their inner feelings and being – with Mother Earth (Messner 1998, 1999; Bonington 2016). It's a requirement for them, part of their ritual even, before they start and give their lives into the hands of an environment, deities and gods they cannot fully control (just think of avalanches or blizzards; Baumgartner 2015 for incidents). For those who work in nature, and who do that a lot, they all know: being well-connected with yourself and with what is out there and around you makes for a key element of the experience, and of the success too (although success is quite a relative term when working in such settings, and in HKH). People who carry out big, complex and ambitious expeditions, often involving 100s of people from HKH and from all over the world have their own stories to share when working in HKH, with its locals, landscapes and features. The deities are watching, and acting, the bad and the good ones, and many others too. Success is when you come home safely and in a balanced way with yourself and your personal environment! The rest is in other hands (Fig. 15.7).

In my own work, I have seen and experienced many of such things many times too, virtually all the times. I observed them and was wondering and puzzled each time. Whatever the deities do, or not, and what your stand is on those things, any work and preparation in HKH seems to be affected by it, either way. I would argue that dealing with those 'deities', settling with them and with yourself is a way to be successful in HKH and to reach goals and agreements there, and in life. Returning from HKH with a 'mission completed' means an inner wider quest and deeper mission was achieved and settled; a wider harmony reached, and a higher level of wisdom traveled to. It can serve the wider public good and one is blessed. Now, how spiritual is that?

It is nothing unusual to be excited about any great and exciting fieldwork and for expeditions. Anxiety is part of the game. The amount of angst can well be overwhelming for people though. It's a certain terror that builds in the head, stomach and body prior to departure and before the start of an expedition. This can manifest itself in many ways, from body pain to sleepless nights, angst, tension and injuries (lost wallets, car crashes, infections or even just torn lignaments are good examples). It's the skill of the expedition leader and member to handle it. It makes for explorations and science to be successful! But this topic – where the 'roof of the world' and its people and deities might mess with your head when walking across the cultures – can be substantial. Reinhold Messner speaks a lot about those 'borderline experiences' and to be in those marginal zones (e.g. Messner and Huetlin 2014) so do

Fig. 15.7 An ancient gumba (**a**) and a new monastery (**b**). Spiritual values survive over time

others (e.g. Bonington 2016; Dyhrenfurth 2018). Leaving one culture and emerging into another is a big deal. It's all where spirituality, science, people and performance meet: another front line of human wisdom (Lama 2005; Carlson 2012).

15.1 Mind Games

Below I show next some examples from our own work and how such field work can be affected by outside forces, outside of everybody's control. Here a short list from memory how such things look like in reality:

Trip 1 Time crunch by hours: One of my first trips into the HKH region was based on a professional science data meeting for 3 days in Kathmandu. It was meant to be a quick in-and-out session due to other ongoing projects and time commitments back home. I was fully sandwiched-in between projects, before and after, while other commitments back home were requiring full attention in the middle. It turned into a 3 days non-stop work session, essentially with a 24 h work effort to prepare sessions and to interact back home in the other time zone, doing it all the time. While I was in a big, very impressive and magnificent hotel (a place where all beginners to Nepal are put…) the 'power load share' in KTM proved interesting' and challenging' (a 'power load share' refers to 4 h electricity shifts, rotating on and off, provided by suburb, due to lack of a consistent power supply for all of the city). Inconsistent power plug compatibilities added even more to the story, and the biggest factor added the major stomach issues I observed (but which I mostly was able to stay clear from; I found stomach upsets to be a very frequent problem in the HKH region adding further to the complexity). Bigger issues came also through the airline travel in assigned traveler lounges at major hubs and during connecting flights though the many other nations when the wifi hubs and power cables are 'off' (the usual experience). Overall, it really was a large ordeal, but it worked out more or less fine eventually. The head was spinning though.

Trip 2 Pressure builds due to the complexity of the region: The second trip to HKH was relatively easy, so I thought, because first I spent time in one big Asian country, then went on to Nepal for a session, and left again. Anyways, it was clear that logistics, money transfer and visas are to be reckoned with. It was a real shock when it actually came to it, but it got resolved somehow. By now, it dawned on me what is to come when working in HKH.

Trip 3 No pick up and no set up: On my third trip to HKH – this time for a longer stay – I had to prepare many financial and organizational aspects first. This took app. 6 months ahead of the trip; so your mind is occupied with the trip for long time. Anyways, upon arrival, I saw no pick up that was arranged with the agency I was to stay with 'professionally'. 'No big deal', one may think. But with all my stuff and preps I was suddenly all on my own, surrounded by the usual air port mob ("Mista, wanna taxi, friendship price with discount"). It worked out fine

Fig. 15.8 In the midst of an expedition, how field-work-based science in the Hindu Kush-Himalaya region can look like

eventually but mostly just because I know 'the system' by now. It was a lot of work and mind power, again (Fig. 15.8).

Trip 4 Yukon river, San Diego and cancer scare: This time, the HKH travel things got more serious, with having to make many decisions and overcoming problems for a team a year ahead of the trip. As part of the arrangement leaving office, the Nepal field work then actually started with a field trip to the Yukon river, Alaska. Then came an overnight flight next day for a software conference in San Diego, U.S. There I was told that my co-traveler felt having lumps under the skin. The on-the-road diagnosis was 'suspicion of cancer'. While fully on transit already, a quick google check showed us no suitable clinic in Kathmandu (cancer treatments in Nepal are suggested in New Delhi or elsewhere, ideally in the western world). So what to do now, a few hours before another departure? Finally, an attempt was made to wait it out, while in the plane and at airport hubs, and see then how things develop (they developed fine, btw).

Trip 5 Riots and strike: Tickets bought, all prepared for over 5 months, checking email one more time before departure, and my international co-worker writes me: "*Please do not come, riots and strikes all over the nation. IT'S NOT SAFE now*". Being last minute before departure, I checked online reports, embassy advisories (which are always more conservative than realistic for their own liability reasons. One may often just ignore them, unless one can read between the lines) and they said the same what my co-worker urged me to do. But no deaths or problems reported yet. What to do, and once I arrive there in 2 days? I decided to take the plane ticket I had booked, and then boarded and sat in a plane with very few passengers (Great for sleeping in the plane, but no sleep to catch due to the uncertainty how it will look on the ground). With a scare one looks down when the plane flies over Nepal and Kathmandu for landing…Well, upon arrival the ground was beyond perfect. Little car traffic in the city for a change, everybody nice and friendly, trip worked out great. I could not detect relevant problems, apart from the fact that a Supreme Court Judge was killed a day before my arrival. But I just did not notice, and I was able to move ahead fine.

Trip 6 Knee ligament torn up, great hiking trip. Next trip, right after a long long winter in Alaska (HKH mountain work is ideal in spring, thus, everybody comes there then), my knee started to hurt c. 4 weeks before the trip; a strained ligament. I did not have knee pains for years; why now? Panic built up because this HKH trip involved a new exploration and survey of a remote mountain area in 4000–5000 m; all to be climbed. The winter was long and I still skied, with pain. But what would the long hikes bring in May? Anyways, once on the ground in Nepal, it went all 'smooth sailing' (the only complaint came from my co-workers that I was too fast and that I snored very loud at night!). They had thought they better book a VIP hiking session for their surveys (whereas I was prepared for tougher efforts than that and got a little unsatisfied with such type of expedictions…).

Trip 7 Earth quakes, scares, death, victims and life experiences: As done before, the expedition was prepared for over 6 months, and all was set up; perfectly this time round. Well, until the first wave of earthquakes hit a month before departure. While a tragedy, I tried to ignore it. No change of plans. Over the last 3 weeks before start co-workers dropped out like flies (arguments like '*my mother back home got sick*'). Then the second tragedy came for Nepal: another earthquake just hit a week before my arrival. Well, how serious is that, really? I was even asked to brief a rescue mission from the U.S. going over there before me. But I decided no change of my plans. While all worked out, very well eventually, I saw tragedy first hand, and I learned a lot from it (Some of the team I briefed just before departure in U.S. were later killed in an earthquake helicopter rescue mission in the remote mountains of Nepal). I stayed, foolishly, in a large hotel in Kathmandu 4th floor, which was shaking over night…but all went well eventually. The gods were with me, again.

Trip 8 Cancelled Flight connection prior to departure: This one, after years of experience, was probably one of the worst experiences: Due to other projects and field work linked up, I bought four separate tickets to get to HKH. It was cheaper and more safe on delays, so I thought. By now I had learned not to take the cheapest online flights as they result into lost luggage for good, and can have delays up to 3 days in exotic travel countries in suburbia emergency hotels booked by a non-english-speaking airport contractor with foreign passengers that might not all be on your side, so much and keeping your passport. So all was arranged, with buffer times and good thought. The trip started nicely, with an email 3 h before departure stating "Congratulations, you were updated to Business Class". Hooray, till I read the fine print of that email. It was essentially a compensation deal for a last minute cancellation by the local airline (I was 1 h away from taking that flight). The net result was that I was re-booked (again, first class) but to arrive 3 h later, and then missing my connecting plane to Asia, and all of its connecting tickets. The way how those tickets are dealt with is, if you miss one section, all of the flight (incoming and return) all fully gone due to separate tickets not connected. I checked, and no replacement flights were possible to obtain, and thus, virtually all 4 subsequent flights were gone. What a loss, financially and for timings, all just because a made-deal was cancelled by my initial airline, and all of this is fully legal (as a customer in the U.S. has no protection against it really). What did I care about protection or liability, I just wanted to catch my connection and do my field work. My university does not support us in such cases, nor did I have a funder to go to asking for help or compensation. It was a rotten deal. So what to do? After spending 3 h on the phone with a calling center in India of that online company to change my flight in North America, or at least having the airline to rebook me, I got it done last minute though, re-routed through another tiny airport (my innovative solution), then waived the first leg of the flight, catching again the initial flight I had anticipated. A classic experience here is that when you want to fly from Los Angeles you get re-routed through San Francisco, and if you start from San Francisco, you end up flying through Los Angeles again. Seattle flights carry similar links and weird connections, and the Vancouver/Canada ones screen you through immigration (I assume these are commercial tricks and also to obtain more passenger information and to book out airline seats, all linked with a presumed national security strategy). Anyways, that trip worked out great, and persistence paid. Anxiety and problems overcome once more. Head games won, deities were my friends, again.

Trip 9 Broken rip and mystery pain: Four days before this trip (a longer planned hike in 4000 m elevation was planned), a lower back rip 'snapped'; just by itself. Perhaps this links to earlier but unrecognized winter accidents when ski'ing, mushing and bike'joring with sled dogs? Anyways, I could hardly breath, walking steps or sleep. The lower rip pain was 'wicked' and biting. Certain body moves were almost impossible. So what to do?

Well, it was decided at least to fly to Nepal, and then see what can be done there within those limits. When there, after 2 days a painful flight, it became a mind game and I got a fever overnight but then was able 'to do'. Two days of busing around into rural Nepal, and then up to the hills, 1,500 m on steps with a backpack on day one. It mysteriously worked all out though. I walked and long-distance many days. Nights were painful, and breathing was not all fun, specifically when coughing (see Textbox on Khumbu Cough in a chapter of this book). But still I could do my work fine. I was up at 4,000 m many days, and got all tasks done; in-and-out. The head won over the body, again (but the pain – and fear of something being seriously injured – stayed with me for at 4 weeks afterwards during an eventual body recovery/'revenge'…).

15.2 Beyond Deaths and Evil Spirits: In the Field, Finally

As a typical case, after 3 days of travel, and over 6 months of preparations, in our heads, other challenges start: field work, extreme weather events, avoidance of losing gear, and negotiations with locals, permitting agencies and banking systems. It's a wise idea in HKH to keep 3 days before, and after, simply to plan, arrange and recover, and prepare, in your head, for next steps.; sleep it out if need to be. Weekends are a real deal there in the HKH region, so are holidays and national strikes. It's nothing unusual in my work to wait things out for a week, or to walk, alone, for 2–5 days and climb 500 m or more a day (we sometimes did 2000 m in elevation a day with the insistence of the locals; a clear health violation in the westerns world btw. Anyways, the gods were with us once more). The deities are watching, but they really seem to like us…thus far. We are grateful (In exchange, I can be found at every prayer mills and monastery that you can find on the way) (Fig. 15.9).

Have we seen death? Yes, we also saw car accidents and many buses in ditches and down the slopes. Some of the roads rank among the most dangerous ones in the world, air travel in HKH is often black-listed internationally, and the airport in Lukla – associated with Everest – is labeled as 'the most dangerous airport in the world'. One has to make up the head accordingly (Fig. 15.10).

The sheer vastness, paired with the said occurrence of 'good' and 'evil spirits' as well as massive weather and geological events create already pure fear among the

Fig. 15.9 Entering road: perhaps now is the time to pray?

Fig. 15.10 The earthquake in front of our feet: What will happen next? Do the gods know?

observers, let alone the project operators. Additional problems brought by political unrest, high population densities and corruption easily add to that angst. What will the eventual outcome be? The take-home message is probably that persistence and innovation matter: how to ‘overcome’, and to never give up in order to progress in a good way? Work in HKH, or life for that matter, cannot be done any other, without the head, nor the deities and gods. The path is the solution, and that is the message and outcome from working in HKH! Use it for life!

Arguably, most people do not really realize at first that such issues are related to work in HKH. I would call them ‘Foremaths’ (vs ‘Aftermaths’). Why those things occur is not really clear to me, but they have been encountered, manifold, and they are not usual to happen in other field work (much) that I did last 30 years. It might be stronger in HKH but can be found globally, and when working on ships and oceans too (Fig. 15.11).

15.3 Aftermaths

There remains another aspect, one that is virtually not addressed by most western scholars working and living in the HKH and its land- and waterscapes (Miehe et al. 2017): the Aftermath’ of working in HKH.[1] I would easily argue that it provides one

[1] This aspect has been widely ignored in most explorations and with people who do field work in remote and wilderness regions. For instance, Alexander for Humbodlt, Felix Sthilmark, Theodore Roosevelt, Aldo Leopold, Reinhold Messner, Maurice Herzog or even Jacques Cousteau and Eugene Cernan all turned during their career very sensitive to global justice questions and became

Fig. 15.11 Deities in central Kathmandu, Nepal. Time to think hard!

of the greatest satisfaction one can appreciate and experience. However, if things go awful, one will find oneself easily on the other side of the spectrum (see for instance Krakauer 1997; Herzog 1997 or Messner 1999 and their life stories). The deities are in one's head, creating imbalances and accounts to be settled still, in HKH. Many people report on it and many people paid this with their lives. and certainly with a loss of much sleep, at best (see Baumgartner 2015 for some climbing injury statistics for the Everest regions); many got somewhat haunted and traumatized for live, including the relatives and families of the victims (see for instance accounts in Krakauer 1997). HKH and large mountains -their gods and deities – have you in their grip, and to deal with it is a life skill. However, I am lucky and glad to have experienced it, and I hope it can be put of good service to others. It's time to think and to reflect deeply: Mind the deities and gods of Mother Earth dearly!

> *Your enemy is your best friend*
> Dalai Lama (in Hellstroem T (2016) The Dalai Lama Book of Quotes. Hatherleigh Publishers, Replika Press, India)

closer, and often united, with Mother Earth and environmental sustainability issues. Often they ran against the attitudes of their respected governments -and even society -of the time.

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Part III
Real-World Policy, Conservation Management of Wildlife, Habitat, and Biodiversity Data

Chapter 16
The Relevance and Significant Role of Mid-elevation for the Watersheds and Biodiversity Conservation in the Hindu Kush-Himalaya: The Case of Nepal in the Anthropocene

Apsana Kafle, Sakar Jha, and Falk Huettmann

16.1 Introduction

Often quoted with the term "Country in the lap of Mountains" Nepal is a landlocked nation surrounded by the powerful People's Republic of China in the North and India in the east, south and west (Sikkim, which borders with Bhutan). With the total area of Nepal being 1,47,181 sq. km (56,827 sq. miles) it holds the 93rd position in terms of landmass. Nepal has roughly a rectangular geometric outline located between Latitudes 26°22′ 30°27′ and Longitudes between 80° 4′ and 88°12′. The average east-west distance is 885 km and the north-south distance is 166 km.

We find Nepal being one of the most majestic countries in terms of the diversity it encompasses. The rich biodiversity, unique geographical features and the attitudinal variation within just a few kilometers are an exemplary verification of that fact. Nepal rises from the lowest elevation of 59 m (194 ft) in the south extending to the highest elevation of the world which is 8848 m above mean sea level. This happens within a distance of just approx. 150 km, the climate varies accordingly from the subtropical to the intense arctic (similar steep gradients are found elsewhere in the HKH region, e.g., in the Kunming area, China, for plant biodiversity, but they do not feature a 8000 m altitudinal difference). Geographically Nepal is divided into three major regions- the snow garland Himalayas or Mountain region in the north, the

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A. Kafle (✉) · S. Jha
Institute of Forestry, Tribhuvan University, Pokhara, Nepal
e-mail: kafleapsana@gmail.com

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department,
University of Alaska Fairbanks, Fairbanks, AK, USA

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lesser Himalaya or mid hill in the center and then the flat, fertile and hot Terai in the South (see Fig. 16.1).

16.2 The Mid-Elevation Region in Nepal: An Introduction

The mid hills, or the "Pahad" region (26°85″–29°85″N and 80°04–88°12″E), is the major area portion of Nepal which actually occupies about 43% of the total area and 32% of its forest area with an attitudinal range between 500 and 3000 m. They form the central belt of Nepal from east to west across the country between the Hindu-Kush Himalaya (HKH) region in the north and the Ganges river plain in the south. These are the part of foothills of the mountains which is mostly tropical and not covered by snow. It is characterized by the great scenery (Fig. 16.2) due to the drastic variation in the climate, vegetation and topography, all within just a few kilometers. The rugged mountain topography may rise up to 3000 m whereas the fertile river valleys fall well below 1000 m resulting into impulsive variation in climate and biodiversity. Hills and valleys dominate the topography resulting into initially isolated areas and having not many main road networks (as otherwise found in the flat terrain and easily detectable in the Terai region, for instance).

With the population of 2,532,041 people (CBS 2012) this region is also a fascinating, unique and complex mix of ethnic groups, subgroups, languages and associ-

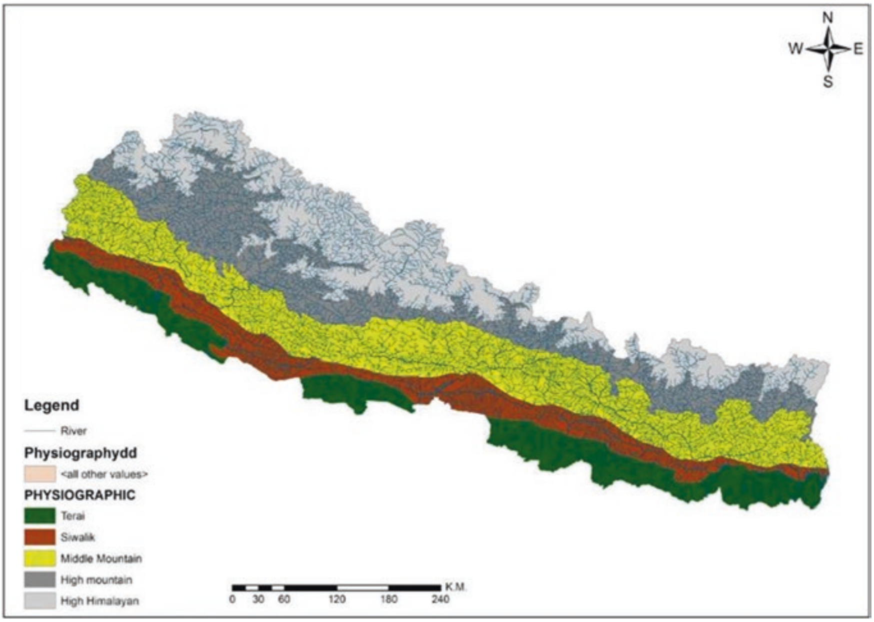

Fig. 16.1 Map of Nepal showing the different physiographic zones and the rivers

Fig. 16.2 Mid-elevation landscape in Nepal. (Source: Author)

Fig. 16.3 Example of cultural diversity: Hospitality and food in a Gurung village. (Photo: FH)

ated cultures. The major caste of people are Bhramin, Chettri, Rai, Limbu, Newar, Gurung, Tamang, Magar and Kami (see Fig. 16.3). The mid hills of Nepal are famous for its rich ethnicity and multi-linguist inhabitants. This region beholds some of the major and ancient cities of Nepali civilization as well as some of the most remote villages. And as a result there is a significant variation in the occupation of people and the way they operate the land and natural resources for livelihoods. Some of the major occupations include for instance agriculture, animal husbandry, trade and business that have evolved in such an environment for hundreds of years; more or less in a sustainable fashion. This region sits at the crossroads between high mountains and the tropics, rivers and deserts, couched between India and China; it must be a major hotspot of, and intersection between global civilizations! By now, rapid migrations from mountainous regions and other parts of the country has been one of the determining cause for increased populations and pressures on natural resource.

16.3 Flora and Fauna in Nepal's Mid-elevation

The term flora and fauna was coined by biologists to refer to a collection of plant and animal specific in a given geographic location. By definition, flora and fauna means a group of indigenous plants and animals in an ecosystem in a geographical region. Nepal's biodiversity is a reflection of its unique geographic position, indigenous management and altitudinal and climatic variations (HMGN/MFSC 2002). It has a great reputation for its beauty. It's bio-diverse ecosystems and the mid-hill forests have played a great role in gaining this reputation (Fig. 16.2). The mid-hill forests provide habitat for a great number of animals which are also listed as Globally threatened in the IUCN's red list (Table 16.1).

Further, forests play a vital role in maintaining an ecological balance and economic development. Human impacts are known for the wider region (Naudiyal and Schmerck 2018). The Floral diversity of Nepal is very rich with different 35 different forest types and 5000 species of flowering plant (Shakya et al. 1997). It incorporates several Palaerctic and Indo-Malayan bio-geographical regions, and six floristic provinces of Asia creating a unique and rich diversity of life and life-zones. The mid-hills incorporate 7 out of 10 forest categories of Nepal (HMGN/MSFC 2002) (Tables 16.2 and 16.3).

Nepal is also famous for its Rhododendron forests which is also the national flower of the country. There are more than 30 species of rhododendron found in Nepal of which three are endemic viz. *Rhododendron dalhousie*, *Rhododendron decipens*, *Rhododendron falconeri*. They occur in dozens of varieties in all sizes and colors. They are found at an altitude between 1200 and 3600 m, are very beautiful (Fig. 16.4) and grow throughout the whole length of Nepal. Along with the asthetic value that it provides, it can also be used as medicine to cure diseases like dysentery for instance.

Table 16.1 A selection of mammals found in mid hills of Nepal (Jnawali et al. 2011; Baral and Shah 2008)

English and scientific name	Elevation found (m)	Estimated population (Nepal)	Preferred habitat	IUCN status	TSN
Assam macaque (*Macaca assamensis*)	380–2350	3000–750	Sub-tropical hill sal forest, mixed decidous and temperate broad leaved forest	Near threatened	573018
Pangolin (*Manis pentadactyla*)	Below 2000	5000	Sub tropical and decidious forest, agricultural land	Critically endangered	584931
Red Panda (*Ailurus fulgens*)	2300–3900	317–582	Mixed broad leaf and conifer forest	Endangered	621846
Clouded Leopard (*Neofelis nebulosa*)	Upto 3000	<100	Ever green to decidious forest	Vulnerable	183809
Common Leopard (*Panthera pardus*)	Below 4400	<1000	Desert to rainforests	Near threatened	183804
Barking Deer (*Muntiacus vaginalis)*	Upto 3000	<10,000	Dense Tropical and Sub-tropical forests	Least concern	898562
Black Bear (*Urus thibetanus*)	1400–4000	500	Mixed broad leaf forest and steep hills	Vulnerable	621848
Leopard Cat (*Prionailurus bengalensis*)	Upto 3254	<2500	Tropical to temperate forest	Least concern	552763

Table 16.2 The forest categories according to HMGN/MFSC (2002) found in the mid-hills of Nepal are shown below

Forest type	Elevation (m)	Dominant species
Subtropical broad-leafed forest	1000–2000	*Schima wallichii/Castanopsis indica, Alnus nepalensis*
Sub-tropical pine forest	1000–2200	*Pinus roxburghii*
Lower temperate broad-leaved forest	2000–2700 in west and 1700–2400 in east	*Alnus nitida, Castanopsis tribuloides, Castanopsis hystrix, Lithocarpus pachyphylla (bada katus)*
Lower temperate mixed broad-leaved forest	2000–2700 in west and 1700–2200 in east	*Tree species belonging to lauraceae family*
Upper temperate broad-leaved forest	2200–3000	*Quercus semecarpifolia*
Upper temperate mixed-broad leaved forest	2700–3100	*Quercus semecarpifolia, acer and juglans* spps., *Rhododendron*
Temperate coniferous forest	2000–3000	*Pinus wallichiana, Cupressus torulosa Tsuga dumosa, Abies pindrow*

Table 16.3 List of valuable medicinal plants found in Mid-hills of Nepal

Scientific Name of Plant	Family
Taxus wallichiana	Taxaceae
Swertia chirata	Gentianaceae
Zanthoxylum armatum	Rutaceae
Embilica officianalis	Phyllanthaceae
Cinnamomun tamala	Lauraceae

Fig. 16.4 Rhododendron forest in the lap of the Mountains. (Credit: Aaditya Pal CDZ)

16.4 Land-Use Systems in Nepal's Mid-elevation

Nepal has a total of 2.97 million hectares of cultivated land of which 27.5% is situated in the mid-hills. The mid-hill region measures not only approx. 1/3 of the Nepali farming area but also has the highest population density per unit cultivated land. Even marginal areas with steep slopes have been encroached for cultivation by constructing proper terraces typical for Nepali landscapes in order to feed the large population (Fig. 16.5; see also Naudiyal and Schmerck 2018). Nowadays, a trend of young people leaving the village for foreign employment has been established in the villages. The remaining people of the villages are either too old or even sick to work on the fields, and the income from remittance helps to survive on the market goods. Hence these overused landscapes are actually being abandoned and which has created major hazards and disasters such as soil erosion and landslides. Modern commercial pressures have greatly added to this problem. In this way, the ecosystem is being continuously degraded and numerous forest species and agricultural crops are under threat by now (Table 16.4).

Fig. 16.5 Local People working in the field. (Source: Author)

Table 16.4 Summary of land use type within the region is given below (LRMP 1986)

	Nepal		Mid-Hills	
Category	,000 ha	%	,000 ha	%
Forest land	5616	38.1	1794	40.4
Grassland	1757	11.9	293	6.6
Scrubland	690	4.7	409	9.2
Cultivated land	2968	20.1	1223	27.5
Non cultivated inclusions	987	6.7	665	15.0
Other land	2730	18.5	61	1.4
Total	14,748		4445	

16.5 Water-Sources in Nepal's Mid-elevation

Nepal's terrain is dissected by many rivers and streams to form a complex arrangement of watersheds (see for instance Fig. 16.6). It has three categories of rivers from east to west (First, Second and Third order). The mid-hills give rise to the second category of rivers. The larger river systems (First category) divide the highest mountains in deep gorges. They flow south through the Middle Hills, crossing the Mahabharat Range (see Fig. 16.1) and emerging onto the plains of the terai. The second category of rivers arise in the mid-hills and Mahabharat range. This region does not have relevant glacial sources, hence the annual flow regimes in these rivers are more variable and most of them dry out during dry season. The livelihood of the people that are dependent on rain-fed based agriculture systems are affected by this,

Fig. 16.6 A typical scene of a river flowing through the valley plain. (Source: Author)

hence they use a different crop during the dry season that needs less water. Apart from rivers, the mid-hills also have many lakes which are of international importance (eg. Ramsar enlisted Mai pokhari of Illam, or the lake cluster of Pokhara) (Bhuju et al. 2007). A significant portion of the population is directly or indirectly dependent on the water sources and the ecosystem services they provide. These sources also affect the distribution of species of plants and animals (particularly amphibians) found in their proximity. They are an important sources for one of their basic habitat components. These water sources affect the local weather regimes and regulate the micro-climate as well.

16.6 The Significant Role of Mid-hills in Biodiversity Conservation

The mid-hills present the single greatest ecosystem and for species diversities in Nepal. They account for the greatest diversity of terrain and the occurrence of subtropical to temperate flora and fauna. The biodiversity profile project (BPPN 1995) lists 3364 species of angiosperms, 493 species of bryophytes, 272 species of pteridophytes and 16 species of Gymnosperm in the mid-hills (Bhuju et al., 2007) Furthermore, 557 species of butterflies, 76 species of fish, 29 species of amphibians, 56 species of reptiles, 691 species of birds, and 110 species of mammals are listed in those mid-hills (Bhuju et al. 2007).

However, the mid-hill ecosystem of Nepal has also seen a decline in the abundance of the rare and endemic species in the recent decades (BPPN 1995). Reasons for such loss can be linked to low levels of public awareness, high population pressure, incidence of poverty, weak institutional planning and administrative capacity, and in the lack of relevant policies on effective strategies for biodiversity conservation. The lack of strong policies can easily be seen in the mid-hill's ecosystem as it is the least represented in the protected area management system of the nation (HMGN 1989, 1993). Community forestry is the main strategy in Nepal's forestry sector. By general definition, community forest means that a part of the National forest is handed over to the communities living around the forest for protection and utilization (HMGN 1993). It has been successful in increasing the greenery of degraded sites, improving the supply of forest products for the people and for improving the environmental situation in the hills of Nepal (Acharya 2004). But it is uncertain whether community forestry has truly contributed towards biodiversity conservation where certain case studies indicate that active forest management by community forest user groups (CFUGs) actually results in the loss of biodiversity (Acharya 2004). As the operational plans of community forests include the prohibition of hunting and it also contributes to increasing the forest cover by controlling deforestation and forest degradation it could be a suitable option to conserve biodiversity. But thus far it focuses less on sustainable forest supply and biodiversity conservation as a priority.

16.7 Anthropogenic Impacts in Mid-hill Ecosystems

16.7.1 Aspects of Human History

Forests are among the most widely used forms of natural resources by human beings since the time immortal (see also Naudiyal and Schmerck 2018). In our context, conversion of forest land into agricultural land was the major objective of government policies from the later half of the eighteenth century onwards after the Shah's had taken the country in the course of unification (Mahat et al. 1986). And so one has to understand that deforestation in the mid-hills is not a recent phenomenon and was caused by the joint attack of the government land-use policy to maximize agricultural surplus and land taxes and subsistence agriculture (Bajracharya 1983). Land was distributed to the officials by the name of "*Birta, Guthi, Keepat*". After the Government declared all the forest as National forest through the forest legislation act of 1957, widespread indiscriminate cutting took place in the following years (Bajracharya 1983) as the people were afraid that the source of their livelihood would be taken from them. A great percentage of the forest cover was compromised because of this and it was only stopped after the Forest Act of 1961 (Mahat et al. 1986) and after resettling some of the hill communities in the Terai to reduce the pressure on the hills. Several decades later the mid-hills were again faced with devastation and denudation when the decade-long Maoist insurgency took place. As the military was busy dealing with the rebel groups, the poachers were busy killing many threatened animals for their trophy. Hundreds of animals suffered death and the biodiversity of the entire country suffered with the mid-hills being the hotspot for poachers.

16.7.2 Fire

It is often said "*Fire is a good servant but a bad master*", Forest fire is a useful tool in regeneration of new grasses but this fire has also been a dominating factor in forest destruction if it occurs too frequently. The soil moisture and watershed plays a big role as a regulator. In the recent decades of global warming, one may now see an increase in landscapes fire as a global phenomenon. The seasonal fires greatly hamper the growth of the seedlings resulting in burnt out patches in the forests and different succession phases. Approximately 99% of the larger forest fires in Nepal are caused by human activities (Sharma 1996). Lightening is a major natural starter of forest fires but such tiny fires often stop themselves after a few hours and remain widely undetected. Whereas humans deliberately burn fire to initiate the production of new grass for livestock. Last years approx. 50 districts and 12,000 community forests were damaged due to forest fire (Gurung 2017).

16.7.3 Landslides

Another of such a calamity is landslides, which causes a tremendous loss of fertile soil every year. Landslides are easily seen in the Nepali landscape and usually they are triggered by overused soils and then heavy rain after the water infiltrates deep into the exposed steep slope and as a result causes landslides and soil erosion. These landslide cause siltation in the rivers, also hampering the water quality and the aquatic ecology. Because of the difficult hill terrain, regular road establishment using the standard set of tools was not possible. However, as we are excelling towards the development era such tools are now available, e.g. cranes and tractors. However, the lack of proper planning and low budgets tend to force these roads to be established along human and animal trails. That way the landscapes are cut open and are then encroached by the landless people ("squatting") which destroys the wilderness from its roots. Landscapes of the mid-hills in Nepal show now many of those impacts (Fig. 16.7).

Fig. 16.7 A mid-elevation landscape in Nepal with an intense human usage: Erosion, used forests, terraces on steep slopes, constructions with roads, hydro dam and electricity lines, and sand and gravel freely taken from the river. (Photo credit: FH)

16.7.4 A Generic Ineffectiveness of Policy

All the development work that takes place in the country first requires a screening phase where the necessity of the assessment of the environmental impact made by the project is determined. However, due to corruption and loopholes in the policy, people are able to get their project sanctioned with ease. Several examples of this can be seen on the river banks of different rivers like the Seti, Manohara etc. where illegal excavation of sand and soil is carried out. Although the Environment Act, and regulations have made necessary provisions for the mitigation and the compensation measures that are to be carried out during the implementation of the project on either the Initial environmental examination (IEE) or the Environmental impact assessment (EIA), the project proponents are often able to somehow avoid them and carry out their work with no regards to the ecosystems of the proposed site.

16.8 Conclusion

The mid-hills of Nepal contribute greatly to its bio-diverse ecosystems including watershed, climate, human health and well-being. However, the population pressure are inhibiting the expansion and in some cases decreasing this diversity. The role played by the mid-hills in biodiversity conservation is significant but overlooked. It exposes the various natural or human induced factors that are degrading its soil, water sources, vegetation and faunal diversity. It eventually affects human cultures and diversity that lived there successfully and somewhat sustainable for hundreds of years as a great civilization. But now, out-migration for foreign as well as urban employment has created a trend of abandoning over-used landscapes. The subsequent conversion of forest land into cultivated agricultural land without proper terraces building has made a majority of mid-hills vulnerable towards erosion resulting into risks and loss of precious farming soil to provide food security, rise in watershed sedimentation and so on. Forest fires are another major problem of the mid-hills which degrade the habitat of several already stressed species and making them more susceptible towards extinction. For conserving the authenticity of the mid-hills in terms of its biodiversity, the government and international community needs to formulate effective laws and regulations to set up a culture which has efficient provisions to conserve the forest, soil and the water sources for mankind and future generations. We think the introduction of protected areas instead of protected forests will be a better way to start. They could even amend the laws and regulations of the present Forest, Environment, NPWC act and make the penalties more strict and better enforced in a fair, balanced and meaningful way for all.

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Chapter 17
Nature and Landscape Governance in Royal Times: Experiences from the Shah and Rana Regimes in Nepal Re-assembled from Literature and Interview Data

Jamuna Prajapati, Tirth Raj Ghimire, Ganga Ram Regmi, and Falk Huettmann

17.1 Introduction

17.1.1 Shah Regime: A Quick Overview

The history of Nepal has been influenced by different ruling periods from the Kiratis to the Shah dynasties and its two neighbors, India and China (Whelpton 2005). This has been also interrelated with the linguistic, cultural, religious, racial, and ethnic diversities of the country. Although the 2011 National Census has listed a total of 123 Nepalese languages spoken including the major ones like Nepali, Maithili, Bhojpuri, Tharu, and Tamang (CBS 2011), the current Constitution of Nepal 2015 (2072 BS) states that all native languages spoken in Nepal are the national languages indicating the broad values of the languages and ethnicity of the country. This constitution has tried to erase the full partialities existed among the various people due to different dynasties in the historical times in this Himalayan nation.

The beginning of the kingship from the Gopal dynasty in Nepal has been documented in the Himalayan history that dated back to the Mahabharata war of Hindu

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J. Prajapati (✉) · G. R. Regmi
Third Pole Conservancy, Kathmandu, Nepal
e-mail: prajapatijamuna51@gmail.com

T. R. Ghimire
Animal Research Laboratory, Faculty of Science, Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur, Nepal

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA

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literature. This dynasty followed the practice of meditation, cow husbandry, and small-scale farming and is credited for the discovery of the Pashupatinath volcanic mound in primitive Nepal, currently the Pashupatinath temple of Kathmandu. It is widely believed that the Gopals were brought and settled in Kathmandu by Lord Krishna during Dwapara Yuga, one of the third sequential ages (first: Satya Yuga; second: Treta Yuga; and fourth: Kali Yuga or the current Yuga) of the universe according to Hindu Vedas, Puranas, Upanishadas, and stories. After Gopal dynasty, Yalamber conquered the Central Nepal and became the first king of the Kirata kingdom around 1500 BC extending his kingdom from Trishuli river in the west to the Teesta river in the east (Chemjong 2003). It is believed that Yalamber was killed by Lord Krishna to get the Pandavas won the war due to his bravery and involvement with Kauravas (Anonymous 2013) .

After the last Kiranti king named 'Khigu' (Galiz in Gopal geneology and Gasti in Wright genealogy) was defeated by the Licchavi rulers, they expanded their states the hills between Trishuli in the west and the Sunkoshi river in the east and ruled over the Kathmandu valley from the first early millennium AD. The Licchavi Dynasty is also known as the Golden Era of the Nepalese rulers because of the development of science and technology in architecture of Kailashkut Bhavan, Mana Griha and other several temples, and many drinking water tunnels yet well-functioned and applications of diplomatic foreign relations particularly with the Tibet, China, and India, that remained highly successful and patriotic for Nepal. However, in eighth century, the dynasty became weakened and Arideva Malla became the first Malla ruler of Nepal (Shrestha and Singh 1972). It is believed that the surname Malla was actually the honorific title that was used to be for the Pallava dynasty of South India.

It is interesting to deal with the history of the Shah dynasty that influenced the country in the context of geography, politics, economics, natural resources, health, and society. During the eighteenth Century, a new state was established by the expansion of the Gorkha, a small hilly part of the western region. Dravya Shah (1559–1570) was the founder of the ruling house of Gorkha. His ninth generation offspring named Prithvi Narayan Shah, the most influential King of the Nepalese history started ruling the Gorkha from 1743 AD. He was one of the most talented, diplomatic, and clever warrior and came to know the local, regional, national, and international politics. Believing the unification of the various states of the country can protect from the British and religious imperialism, he started wars within the country. When he defeated few parts of the country, he captured the Kathmandu Valleys including Kirtipur, Bhaktapur, and Lalitpur. Then, he concurred most of the parts of the country and although not fully accepted, few people believe that his success of post-war is due to the respects for the local culture and religion, his equal values to different ethnic people, and his declaration of the capital city for Kathmandu, now the powerhouse for Nepal (Fig. 17.1).

It is a bitter history that Nepal had to experience a struggle for democracy at several times in the twentieth century and early twenty-first century. After 1999 until 2006, the country was in a civil conflict led by the Maoist party. In the first of June of 2001, King Birendra and eight other members of the royal family were murdered in the royal palace in Kathmandu. Then, Gyanendra Shah, the middle brother of late King Birendra, became the king and it is usually debated that due to

Fig. 17.1 Narayanhity Durbar (Palace) in Kathmandu, Nepal. It's the residence and principal workplace of the reigning Monarch of the Kingdom of Nepal. The current building (now serving as a museum) was built 1963 by King Mahendra

his ambitiousness, he dissolved the House of Representatives or the parliament on May 22, 2002. Democrats believe that due to the progressive thinking and ideology of the Nepali Congress led by late Girija Prasad Koirala, the parliament was revived and a peace treaty was signed with the Maoist party. Nepalese parliament, led by the Prime minister Girija Prasad Koirala, voted to expel the monarchy in June 2006 declaring Nepal to be the Federal Republic. Consequently, the parliamentary decision voted by 560 out of 564 members finally ended the 240-year old Shah dynasty on May 2008 and formally declared the 'Federal Democratic Republic of Nepal'(FDRN). Then, on June 11, 2008, ex-King Gyanendra left the palace. Notably, on July 23, 2008, Ram Baran Yadav, the famous politician of the Nepali Congress from terai, became the first President of the FDRN. Similarly, on August 15, the Constituent Assembly elected Pushpa Kamal Dahal (nick-named as Prachanda) of the Maoist party as the first Prime Minister of the FDRN. In 2015, the constitution of FDRN was formed and passed by the majority of parliamentary members by the Primeministership of Sushil Koirala, a popular, intelligent, and kind politician of the Nepali Congress. In 2017, the local election and the central election within 7 states was successfully held by the leadership of Sher Bahadur Deuba, the prime minister of the country, and the real establishment of federal systems was established then. As a result of the election, the Communist Parties gained popular votes especially due to their foreign policy led by Khadka Prasad (KP) Oli after the border blockade by India. Then, Communist Party of Nepal (Unified Marxist-Leninist, UML) and Maoist Party became unified and KP Oli became the prime minister of the country.

17.1.2 Rana Regime

Jung Bahadur Rana was the first ruler of this regime. Rana rulers were titled "Shri Teen" and "Maharaja", whereas Shah Kings were "Shri Panch" and "Maharajdhiraj". In 1885, the nephews of Jung Bahadur and Ranodwip Singh murdered Ranodwip Singh and the sons of Jung Bahadur, stole the name of Jung Bahadur and took control over Nepal. Nine Rana rulers took the traditional office of Prime Minister.

Although the Rana Regime was critically dictatorship, it was not away from the developmental projects primarily due to Ranas' interests on art, culture, traditions, archaeology, laws, religions, and education, particularly influenced by the British and the European civilization. For example, Jung Bahadur introduced *Muluki Ain* (Country Code), prohibited physical torture, established Durbar School, and initiated the English education. Ranodwip published the First Nepali calendar and established *Sanskrit Pathshalas*. Bir Shamsher established the Bir Hospital, Ghantaghar, Baidhya Khana, water supply in Kathmandu and Bhaktapur. Dev Shamsher started publishing Gorkhapatra, fixed the official hours from 10:00 am to 5:00 am, set up 17 days annual leave, and established 150 schools. Chandra Shumsher ruled for 28 years, and it is believed that he completely abolished the *Sati Pratha* (an obsolete Hindu practice in which a widow burns herself upon her husband's funeral pyre) (Gilmartin 1997) and *Das Pratha* (a life-nasty form of discrimination in which individuals are owned by rich people as their property and do whatever they like). He established the Tri-Chandra College, Bhaktapur Hospital, Tokha TB Sanatorium, Military Hospital, Khokana Leprosy Centre, Singh Durbar, and others. He opened Durbar High School for the general public showing his keen love to democracy. To develop Nepali language and literature, he also established 'Gorkha Bhasa Prakasini Samiti'. He made provisions for drinking water in Patan, Dhankuta, and Pokhara. He banned gambling and use of drugs and the import of foreign wines.

During the end of Rana regime, the political parties such as The Prajaparishad and Nepali Congress were already formed in exile by leaders such as BP Koirala, Ganesh Man Singh, Subarna Sumsher Rana, Krishna Prasad Bhattarai, Girija Prasad Koirala, and many other patriotic-minded Nepalese who initiated the military and political movement against Rana Regime. This ultimately became successful in the 1950s when the powerless King Tribhuvan flew to Delhi and there was negotiation among King, Rana Prime-minister, and the leaders of the movement for democracy. Although the negotiation was lacking full democracy for the public, BP Koirala, a popular politician of the majority gained Nepali Congress party, became the first Prime-minister of the country in 1958 after the election and the duration was the first real dream of the Nepalese people. It is usually believed that the foundation of democratic socialism by BP Koirala was the golden period of the poor people because of the farsighted-vision and the mission to develop the country by the congregation of people of different socio-economic status. Democrats believe that due to the ambitiousness of King Mahendra, he dismissed the power of the prime minister, jailed all democratic leaders, and headed the autocratic government. As a result, the dream of socialism died in its naïve state.

17.1.3 Biodiversity in Nepal: A Quick Overview

Nepal is rich in biodiversity of various flora and fauna. The wide diversity in flora and fauna is due to the various landscapes, diverse geography and geology, and diverse climates. For example, the geology landscape varies from less than 40 m asl to 8848 m asl. The high altitudes of the mountains and hills to the plain areas of the terai have a diverse range of temperature, humidity, air pressure, rain fall, and light radiations. Nepal has a unique geographical location with characteristic deciduous and coniferous forests of subtropical and temperate regions to the sub-alpine and alpine, pastures and snow-capped Himalayan peaks with their cold streams, glaciers, and lakes. Quantification of diversity suggests that the country encompasses 118 ecosystems with over 2% of the flowering plants, 3% of the pteridophytes and 6% of the bryophytes in the world's flora. There are 3.9% of the mammals, 8.9% of the birds, and 3.7% of the world's fauna of butterflies (Paudel et al. 2012). The altitudinal landscape is also credited to the generation and existing of 11 bio-climatic zones ranging from lower tropical below 500 m (1600 ft) to above 5000 m (16,000 ft) in the High Himalayas, encompassing nine terrestrial ecoregions with 36 vegetation types (Paudel et al. 2012).

17.2 Biodiversity Conservation and Governance Efforts in Nepal

Besides the cultural, traditional, linguistic, and geographical diversities, Nepal is a country full of diversity in terms of wild and domestic flora and fauna. Due to the high biodiversity, the Government of Nepal has established a network of protected areas since 1973, consisting of 12 national parks, 1 wildlife reserves, 6 conservation areas and 1 hunting reserve and ecologically crucial parts called Buffer zones which are only 13 in numbers (DNPWC 2018). The 1973 act created the DNPWC out of an office by the same name that was administratively under the Department of Forestry. The departments are now separate under the Ministry of Forestry and Soil Conservation. The DNPWC is solely responsible for enforcing all wildlife laws within parks and reserves, and the Department of Forestry is responsible for enforcement in other forested areas (Heinen and Kattel 1992). Similarly, DNPWC records show that populations of many other protected species has increased in parks and reserves throughout the country, for example, wild buffalo, swamp deer, musk deer, and others). Part of the impetus leading to this rapid success in conservation is due to tourism, Nepal's largest industry. It has been evidenced that Annapurna Conservation Area and Chitwan, Langtang, and Sagarmatha (Mt. Everest) national parks are very popular attractions for foreign tourists (Law 2018).

Nepal is a state member of the International Union for Conservation of Nature (IUCN) and sends experts and generalists to IUCN general assemblies for active participation. The country has prepared a National Conservation Strategy (NCS) with IUCN in 1988 as an overall framework for conservation of nature and natural resources (IUCN 1984, 1988). NCS was actually developed due to the past successes and the need to sustainably manage resources to maintain ecosystem quality, reclaim degraded sources, and restore cultural heritage (NPC and IUCN 2013). Nepal is also host to the eight-nation member International Centre for Integrated Mountain Development (ICIMOD) that began in 1983 and first proposed under the country's Man and the Biosphere Program, sponsored by the United Nations Educational, Scientific, and Cultural Organization (UNESCO). ICIMOD has many accomplishments to date, including co-sponsoring a seminar on Himalayan protected areas (KMTNC and ICIMOD 1985). These all help to protect watersheds, often for other nations and their estuaries! Kathmandu Valley was inscribed in the World Heritage List for its outstanding universal value as the cultural heritage of humankind. It was recognized that Kathmandu Valley, more precisely its seven monument zones – *Kathmandu Durbar Square, Patan Durbar Square, Bhaktapur Durbur Square, Pashupati, Bauddha, Swayambhu* and *Changu Narayan* – embodies the uniquely intricate and yet refined urban fabrics blended with Hindu, Buddhist, and indigenous Newari cultures. This particularity does not exist in any other parts of the world but only in the Valley (UNESCO 2004).

Another contribution on biodiversity of the country is that Nepal has signed the Convention on Biological Diversity in 1992. This convention aims to conserve the world's biodiversity by promoting its sustainable use and the equitable sharing of benefits that arise from the use of genetic resources (Shrestha 1997). This means for instance that Nepal needs to release data on biodiversity in GBIF.org, e.g. done through an ICIMOD node!

The United Nations Conference on Environment and Development (UNCED) has given a prime importance on the agenda of biodiversity conservation to the Earth Summit held in Rio-de Jenerio in June 1992. Similarly, Ministry of Forest and Soil Conservation, Ministry of Agriculture, Ministry of Population and Environment, National Planning Commission, National Agriculture Research Council (NARC), Nepal Academy of Science and Technology (NAST), Central Department of Botany and Central Department of Zoology of Tribhuvan University, Department of Forests (DoF), Nepal Army, Nepal Police, Armed Police Force, National Investigation Department, Department of Plant Resources, Natural History Museum, National Forensic Laboratory, the Department of National Parks and Wildlife Conservation (DNPWC), WWF, National Trust for Nature Conservation (NTNC), and local authorities (Village Development Committee and District Development Committee) are working for the controlling of poaching and other illegal activities related to wildlife and consequently on the conservation of biodiversity (Thapa 2010; Kandel 2013). The Convention on International Trade in Endangered Species (CITES) aims primarily to promote trade but by preventing and controlling the commercial trade of endangered flora and fauna. The strong value on the trade of wildlife and their product is difficult to estimate, however, attempts have been made by several international organizations, including The International Criminal Police Organization (INTERPOL) and WWF to define the scale of international illegal wildlife trade. It has been estimated that illicit wildlife trafficking (including timber and fisheries) comprises the fourth largest global illegal trade after narcotics, humans and counterfeit products (WWF 2012). For the first time, the existing trade of wildlife products in Kathmandu was brought into light by American biologist Larry J. Barnes in 1989 in the report ‘The Overt Illegal Fur Trade in Kathmandu, Nepal’ (Kandel 2013).

17.3 Biodiversity and Wildlife Conservation Status in Rana and Shah Regime

Before the advent of first democracy in the 1950s, particularly in the period of Rana regime, many wildlife and their habitat remained undisturbed due to low human. It is believed that in the Lichhhavi period, there was a ban on the trade of musk. Nevertheless, Ranas were big game hunters. In 1861, Janga Bahadur Rana used to kill 31 tigers, 1 rhino, 4 beard, and 3 leopards in a day (Chitrakar 2010). Janga Bahadur Rana invited the then ‘Prince of Wales’ who then came to western Nepal for a 2-week hunting period. It has been reported that King George hunted 37 tigers, 18 rhinos, and 4 bears (Chitrakar 2010). Juddha Shamsher Rana was another hunter who bagged (=killed) 41 tigers, 13 rhinos from Nawalpur, south-western Nepal. When the big earthquake shook Kathmandu and eastern Nepal in 1934, he had been on a hunting trip in far western Nepal, the present protected area called Suklaphanta (Chitrakar 2010) indicating his huge interests on hunting wild fauna.

Following the Rana regime, the era of modern conservation in Nepal started, particularly after the 1950s. With the progress of the late King Mahendra, the first wildlife law was published in Nepal in 1957 which actually offered legal protection to rhinos and their habitat (Heinen and Kattel 1992). The Rhino sanctuary was established in Chitwan. When there was disappearance of deer and the water buffalo from Chitwan, in 1959, E.P. Gee, the British naturalist from the Fauna Preservation Society, visited Nepal and in 1963, he recommended establishing a network of national park and sanctuaries in Terai and Himal which should be protected by law (http://junglesafarilodge.com/chitwan-national-park/establishment/, accessed on: July 22, 2018). In 1964, a rhino sanctuary was declared by royal decree in part of what is now the Royal Chitwan National Park, and a special guard force, the *Gaida Gasti* (Nepali: Rhino Patrol), was also created in that year (Heinen and Kattel 1992). Due to the increasing public-private partnership and international collaboration, malaria was widely eradicated. People started migration into the terai from the surrounding hills and practiced agricultural works and businesses. There were consequences of clearance of forest especially the sal (*Shorea robusta*) and the concomitant decline of wildlife populations in the Chitwan Valley, a royal hunting reserve (Heinen and Kattel 1992). King Mahendra also supported the initiation of a long-term wildlife project to address the conservation issues all over the country. In his initiation and with the help of the Food and Agriculture Organization (FAO) of the United Nations (UN), and the United Nations Development Program (UNDP) adviser and researchers were requested to visit the country and asked for recommendations for the conservation biology. Subsequently, the HMG/FAO/UNDP National Parks and Wildlife Conservation Project began in 1973 (UNDP/FAO 1973). The 1973 act contained 34 sections and provided broad legislation for the protection of areas and species in Nepal (HMG 1973, 1977). Because the Wildlife Conservation Act of 2015 B.S (1957) afforded protection only to rhinos and their habitat following the application of the 1973 act, HMG had broad legal powers to protect and conserve species and their habitats throughout the nation (Adhikari and Dhungana 2010). The National Parks and Wildlife Conservation (NPWC) Act (1973) is the base for the management of protected areas. In 1973, through the NPWC Act, Chitwan National Park (CNP) was established. In 1974, the Nepalese Army was positioned for protection and in 1975; the Gharial Crocodile center was established in Kasara, CNP. The NPWC Office under the DoF was upgraded into DNPWC under MoFSC in 1980, while Rhino translocation initiated in 1986. Today, animals are protected by law, but they continue to be killed for body parts which are sold in distant countries as medicine, aphrodisiac or just souvenirs. The wealthy and powerful do not hunt anymore, but pay others to do the job. The hunts of the good old days are captured in photographs and oil paintings or such reminders as stuffed animals that decorate drawing rooms as trophies (Chitrakar 2010). Then, the 1985 wildlife reserve regulations also stipulated that children below the age of 5 are admitted free of charge and those between the ages of 5 and 12 are admitted half price. Fees were also imposed for fishing, camping, vehicle use, and bringing domestic livestock through access roads in wildlife reserves (Heinen and Kattel 1992). The other vital acts which are helping directly and indirectly for the conservation of biodiversity like Forest Act (1993), Environmental Protection Act (1996), Soil and Watershed Conservation Act (1982), Water Resource Act (1992), Electricity Act (1992), Livestock Health and Livestock Service Act (1998). The regulations include Himalayan National Park Regulations (1979), Buffer Zone Management Regulations (1996), Environmental Protection Regulations (1997) and others (Thapa 2010).

While several Laws are essential for the conservation management of wild fauna, the health and environment Laws are critical in the survival of these animals. Wild animals (elephants, rhinos, tigers, leopard, snow leopard, bear, wild boar) can move from natural habitats (national forests, national parks, wildlife reserve, and buffer zones) to human settlements and directly damage human life or can have potentialities of transmission of many diseases. Conflict is another problem usually experienced by the conservationist and government. The government does not have provisions for sufficient compensation to the victims of wild animal intrusion. It has led to conflict between the forest/park/reserve and the local administration. The rule of relief for the families of the victim can surely help in the conservation process. Although diseases are problematic in the health, conservationists should think about the long-term effects of few drugs and antibiotic resistivity. For example, a national campaign is essential to control many diseases like foot-and-mouth diseases, canine distemper virus infection, parasitosis, tuberculosis, rabies, and others. Interestingly, the main reason for the death of vultures has been reported by the use of diclofenac, a medicine used to treat animals. The vultures feed on the corpse of the animals with a high level of diclofenac that can eventually lead to their death. The government has banned the use of diclofenac from 2006 onwards. Bird Conservation Nepal said that the 13 districts would be diclofenac free regions (Shakya 2010).

17.4 Challenges for Biodiversity and Wildlife Conservation in Recent Years

Since the second people's movement and the advocacy of democracy, Nepal has been facing many challenges in biodiversity and wildlife conservation. This is particularly problematic because of the actual wildlife crime. This crime is usually defined as taking, trading, exploiting or possessing of the world's wild flora and fauna in contravention of national and international laws (Pandey 2009; Cooper et al. 2009). Wildlife-related crime has generated concern among the global community since the emergence of international environmental law. The United Nation (UN) General Assembly, UN Commission on Crime Prevention and Criminal Justice and INTERPOL have all recognized wildlife crime as a form of severe, organized transnational crime with devastating global effect (Cooper et al. 2009).

Although Nepal is a small country e.g. when compared with China and India, it plays a vital role as a provider of illegal wildlife resources, thereby endangering its biodiversity. It is difficult to understand the prevailing wildlife trade and driving factors due to the secret nature of the illegal wildlife trade (Dongol 2015). India and Nepal have cooperated on several other conservation efforts as well. Beginning in 1985, Nepal provided rhinos for India's translocation program in an effort to start a new population of the species in Dudwa (Talukdar et al. 2008; Dinerstein and McCracken 1990). In exchange, India gave Nepal 16 domestic elephants to become the core of Nepal's elephant breeding program based in Chitwan (Dhungel et al. 1990). Nepal is not regarded as a significant consumer of wildlife; however, it is used as a source and as a transit point for the international wildlife trade. Since the terai belt of Nepal is the most accessible part of the country and has secure transportation link and porous border to India, and it is considered to be the most important trading route for wildlife products (Shakya 2004).

It seems that the majority of people involved in the wildlife crime live in proximity to protected areas and larger cities. The majority of poachers in Nepal are members of local ethnic communities and very often intermediary lure local people into pulling the trigger (Bhuju et al. 2007). TRAFFIC report 2013 has also reported that Nepal is emerging as a significant wildlife trade canal in the region, specifically with Kathmandu as a critical trade hub for tiger parts (Stoner and Pervushina 2013). Dongol (2015) shows that a wide range of species is targeted by illegal trade including some globally threatened species such as tiger, rhino, elephant, musk deer, red panda, bear, and pangolin. Five out of the ten cat species in Nepal are illegally trade in Kathmandu. Products in wildlife trade may include live pets, hunting trophies, fashion accessories, cultural artifacts, ingredients for traditional medicines, wild meat for human consumption (or bush meat), and other products (Kandel 2013). Wildcat species are commonly killed in retaliation for livestock depredation or attacks on humans (Inskip and Zimmermann 2009).

The trade routes also determine the rates of wildlife crime. For example, Tatopani-Sindhupalchok, Kimathanka-Sankhuwasabha, and Tinkar-Darchula boarders were frequently used as an exit point for illegal wildlife trade in North whereas Chadani Dodhara-Kanchanpur border in southern belt illegal wildlife trade is prevalent in Nepal and is decreasing, at least according to the news of seizures and arrests from 2011 to 2015 (Puri 2016). Among 104 crimes published in the Kantipur Daily Newspaper, trade routes involving Tatopani, Chadanidhodhara, Tinkar and Kimathanka borders were declared in the 14 offenses. Similarly, in the Gorkhapatra, 12 crime news had included the used trade routes as similar to the previous boundaries as in the Kantipur Daily Newspaper (Puri 2016).

There are many challenges for us to conserve the wildlife and nature. Different NGOs and INGOs should continuously work and make their efforts to protect wildlife and environment by promoting various tasks that create awareness among people. Local people living in the same habitat of the wildlife should be given education about the importance of wildlife, as well as guidance, should be provided so that they could minimize the human and wildlife conflict. We should make them financially secure so that they could not think of hunting the wildlife or destroying the forest for their livelihood by creating employment opportunities. They should be self-motivated so that poachers can be turned to conservators.

17.5 People's Views on Biodiversity and Wildlife Conservation During Shah and Rana Regime: Assembled from Interviews (4 Voices Are Represented)

17.5.1 A Citizen Perspective (Mr. Sita Ram Sukupayo, 53 Years, Bhaktapur)

I am Sita Ram Sukupayo. I have been living in Bhaktapur since 2021 B.S. I am a farmer and shopkeeper. I have seen many changes in my life till now related with the environment, wildlife and diversity. In our time, money cost more rather than anything else. I value the situation, but I think the increasing population is the main cause of every problem arising in the world. In the past there were no more brick factory and other large scale industries which are now responsible for the clearance of the productive cultivable land and increase in air pollution. There is the use of harmful pesticides in the crops which results in unhealthy productions of crops that welcome various types of disease. I had heard that during the Rana regime, they used to rule over the people. People used to work in their Durbars under compulsion. If they didn't do so, they were kept in the jail. They were treated as the slaves. Rana used to hunt the animals as their game. They go hunting by sitting in the back *of an elephant. They surround the animals with the elephants and the other guards with the weapons in their handmade of the bamboo or wood. They had killed many tigers, elephants, and birds. But now I think, people are well known about the conservation. People are aware of the importance of wildlife in nature. The farmers used to travel to different villages to earn money which is called Jharwaniu. They were not given education and there was no electricity at all. The greenery had been decreased as compared to past as more of the people are not familiar with cultivation as compared to past due to which the level of air pollution also increased. The diversity in vegetation cannot be seen in present days. For example, the titin rice is almost replaced by Chinese rice whose seed cannot be used for the production of the crop again. If this goes on continuously, then a day will come where we will not be able to cultivate without importing the seeds of Chinese rice. There are many types of vegetation which had been replaced or completely lost as people are giving their cultivable land to make houses or roads. Recently a baby was killed in the Suryavinayak by a Common leopard. This may be due to lack of food in the forest or lack of forest area. In the past, my wife had also eaten the meat of leopard as people said that it cures rheumatoid disease. It is said that if female eats the meat of female leopard and rheumatoid disease can be cured.*

17.5.2 A Citizen Perspective (Mr. Asha Kumar Koju, 63 Years, Bhaktapur)

I am Asha Kumar Koju. I am 63 years old. I had experienced many changes in Nepal till now concerning the environment. The cultivable land is slowly changing into roads and houses. The forest and the greenery are decreasing. The wild animals are decreasing whereas the population of human is increasing day by day. The factory and industries numbers had been increased. People were not educated as they were not given education in the past. It was too expensive which was not affordable, but now most of the people provide education to their children. There used to be a pond in my locality at Suryamadi, but it is converted to the ground now. There was on electricity and telephone in the past. Yes, the conservation work is now better than before as people used to kill and hunt the animals and birds for entertainment, for money as well as to cure disease. I think 2015 B.S was the best time for the conservation of wildlife and biodiversity because at that time some of the farmers were sending the students to school. The best time regarding forest and cultivation is in the 1950s. We can see greenery around us, there is no more air and water pollution but if we know the aspect of conservation 2010 and present days are the best. Because in the past or the Rana regime, the Ranas used to hunt the animals for their entertainment. They used to kill many birds and animals to feel good and also to use it as gift and medicine. The status of forest and water resources in the Rana regime may be better than in the Shah regime because the population during the Rana regime is less than in Shah regime as we know that forest is the one that helps in *determining the presence of water in any place. Human health service was not so good in the 1950s, but it has improved from 2012. In the past, there was no more health post, and people were so weak that they could not afford the medicine. I have seen many people die due to diarrhea, fever, and smallpox in the past but they can be cured easily in the present age. Some of the people having a communicable disease called smallpox were an exile from the town. Infant mortality rate was so high that most of the parents give birth to more children as that were not sure about their lifespan. The wildlife in the past was not as safe as I had already told about that. When we visit the field, we used to see many jackals and leopards. We named the jackal as Jambu raja. Sometimes they used to follow us up to the town near home and return. It is said that if somebody harms them, they used to take revenge on them. I had experienced the same when I was 19. Once I threw a stone on them, and next day they destroy my crops. But now a day we cannot hear their voice. I had seen a leopard once, but my friends told that they had killed the leopard twice for meat. But, I have not killed any wild animals yet. No, I have not seen making any of the wildlife trade. The future is just unpredictable, but by understanding the present context, I think the environment will be polluted more in future if it is left uncontrolled now. The number of animals and the biodiversity in Nepal will come to lie in a stable form. All should try to keep the environment clean so they we can maintain healthy earth forever.*

17.5.3 A Citizen Perspective (Mr. Shree Krishna Awal, 48 Years, Bhaktapur)

I am Shree Krishna Awal and I belong to Newar family. I live in Thimi, Bhaktapur. There is nothing same if compared past with the present situations. The forest, as well as cultivable land, had been reduced in this place. I have no more idea about the Rana regime and the wildlife around here. But, it is true that during the Rana regime, there was more cultivable fertile land. The forest area covers most of the property in the past, but now it had been replaced by the houses and cities. Regarding water resources, there were more numbers of rivers in the history which keep on flowing, but nowadays, due to overpopulation, there are more numbers of well, but no water in them, the river is becoming narrower and the water level had decreased. The polluted water flows in the water resource which spread the disease in the locality. The health service was not excellent in the past, but now we can get the medicines readily available in near the health post. I had seen two leopards in the forest present near our locality. Many people have seen them. It is said that the two leopards go in the Suryavinayak forest every Friday and return here every Sunday. There are many witnesses who had seen them. We recognize them by their smell and footprints. I have seen many hunting activities and wildlife trade till now. It may be due to the laws that had been made for protecting the life of wild animals. So I think conservation of wild animals is more important to preserve the nature and to maintain the ecosystem.

17.5.4 A Citizen Perspective (Mrs. Pasang Tamang, 34 Years, Morang)

I live in Morang. My family also lives in Morang which is near to the tea garden. My house is situated near the forest which is highly diversified in various types of fruits. We can find multiple kinds of fruits. The temperature is high, so it's hot over there. I came in Bhaktapur for doing business but return there during festivals like Dashain. The environment and the surroundings have changed a lot. The roads are broad and paved now. I don't have much more idea about wildlife in the Rana regime but since I know about my place hunting is hardly preferred if they destroy the vegetation. The jungle elephant is so huge that it ruins everything which comes in its ways like houses and its vegetation. It also kills many people. It is believed that the jungle elephant kills only to the bad person who goes alone in the forest which is the superstitious belief of people over there. People also use the elephant for riding which is also the source of their income. We believe the elephant as Lord Ganesh and worship it. It is also said that if we bury the dung of elephant near the door of our house, the bad luck runs away. Once we were sleeping, I heard the sound from outside. I thought there is thief outside to steal the food crops kept out in the garden. I took a stick and opened the door, but there were three elephants outside. They were scattering the rice grains. Then, I worshipped them and told them to return. After an hour, they returned to the forest. The number of elephant had decreased as compared to past. We can find various type of cultivation like dal, rice, grapes, litchi, berries, mushroom, banana, mango, and others. In the forest, we can find mushroom which works as a medicine. There is no problem for water resources but the health service was not as well as now. Some people also hunt to get its tusk which is sold in high amount, but besides that, I have not seen any wildlife traders and such activities. My hometown is highly diversified and filled with natural beauty but the problem is pollution, and the increasing population which if not maintained may lead to the destruction of forest and wildlife. So protection of nature and environment should be done by each individual.

17.6 Conclusion

Exploring the history is a significant challenge; it has many smaller changes that make up the big picture and its changes over time. Nepal is full of diverse people having different languages, cultures, races, castes, and traditions. The geographical structure of Nepal is far different than other nations. More biasness and exaggeration on historical facts may create confusion about the history in the future generation. The present world is very much different than in the past regarding the environment, government, population, culture, and education. In the Rana regime, people did not have all the rights to live their life in their way; only royal people used to get an education, the farmers were not compensated well for their labor work. Many large game animals were killed by the royal people purely for entertainment and for the medical purpose which decreased the number of wild animals and consequently decreased the diversity of native flora and fauna in Nepal, but now laws are made to preserve them. Various organizations like DNPWC, NTNC, WWF and other INGOs and NGOs have been established to conserve the wildlife and nature. Though the Rana regime is known to be relatively cruel on those issues and not really modern, many of the developmental activities like the start of modernization at a national scale, the introduction of English schools, and the demolishment of *Sati Pratha* and *Das Pratha* had been taken place (a situation that widely awaits its implementation in India for instance).

During absolute monarchy, a king ruled a nation that was why the government and public had to run under the rules and regulations formulated by the King, the royal family, and their close advisors. Conflict in a country is often about diversity and decentralization of power and authority through ethnic autonomy and right to self-determination. These are concepts widespread in the western world and set forth by the British, French and now American value systems and the influential views from other cultures like Russian, Chinese and Indian. Claims of democracy by any political regime do not make it really democratic. Similarly, claims of being democratic by anyone do not make him/her democrat (Bhattachan 2005). It is important that people of Nepal have gained both a national identity and the political resolution of making their own decisions according to laws. They have right to choose their political leaders. It has significant implications for how natural resources, landscapes, and watersheds are dealt with.

Beyond natural resources, the main challenges for the current political leadership are to bind all people in a representative rule of law system, inspire a shared sense of nationhood, make political parties socially representative and responsible, undertake significant structural reforms to satisfy the legitimate interests of the public and start the peace-building process. The sources of history are the pride and identity of the country; those can be 'read' in the status of landscapes and watersheds. It is the primary duty of the present generation to preserve the real history and handover to the future generation.

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Chapter 18
Swallows and Sparrows in the Human Street-Market Interface of Urban Nepal: Towards a First Open Access GIS Data and Model Inference on the Role of Religion and Culture in Bird Distribution

Lindsay Hansen and Falk Huettmann

18.1 Introduction

Birds are known to be powerful indicators of ecosystem health, as the distribution of generalist compared to specialist avian species can provide insight to overall environmental functionality (Devictor et al. 2007; Bonier et al. 2007; Huhta and Sulkava 2014; Pena et al. 2017). Bird richness and diversity levels have been shown to negatively correlate with the increasingly altered composition of natural habitats in urban areas, which may indicate a reduction in large-scale ecosystem function (Bonier et al. 2007; Magudu and Downs 2015). Endemic species more strongly serve this paradigm. In Nepal, the capital city Kathmandu is expanding at over 4% per year, making it one of the most rapidly urbanizing cities in Southeast Asia (Haack and Rafter 2006; The World Bank 2013). The second largest city in Nepal, Pokhara, is seeing a 5% per annum growth in human population, and towns along

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L. Hansen (✉)
Department of Environmental Science, Policy and Management,
University of California, Berkeley, CA, USA
e-mail: lindsayerikahansen@gmail.com

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department,
University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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Nepali roads and highways are rapidly urbanizing as well (Rimal 2012; The World Bank 2013). Although Nepal is a small country, it has a proportionately high level of biodiversity, and it is highly susceptible to biodiversity loss, making it a 'biodiversity hotspot'(Bird Conservation Nepal (BCN) 2011; Conservation International 2016). Out of over 900 bird species that are currently known to use Nepal as all or part of their home range, 36 are globally threatened (Lepage 2015). A further 15% of these species are nationally threatened; the leading factor in the population decline of these species is human-driven habitat loss (Bird Conservation Nepal 2011; Lepage 2015), with climate change impacts not yet fully accounted for.

Urbanization has been linked to an increase in the homogenization of bird species, pushing native and specialist species out while favoring population growth of generalist, urban-adaptable species (Chace and Walsh 2004; Kover et al. 2014; Sanz and Caula 2015). Further urban ecology studies have shown that species richness and evenness declines with increasing urbanization due to landscape fragmentation and heightened disturbance, while the population density of individuals living in urban areas often increases (Marzluff et al. 2001; McKinney 2002; Chace and Walsh 2004; Devictor et al. 2007; Evans et al. 2009; Huhta and Sulkava 2014; Lee and Carroll 2015; Magudu and Downs 2015; Schütz and Schulze 2015). Human-driven disturbance through habitat alteration, such as habitat fragmentation and drastic change in vegetation type and availability that accompanies increasing urbanization of a habitat, has a major negative impact on bird populations, behavior, and fecundity (Clucas and Marzluff 2012; Huhta and Sulkava 2014). The effects of urbanization on bird species varies along an urban gradient, as disturbance is more prominent in areas of higher urbanization than in areas with more rural or natural spaces (McKinney 2002; Evans et al. 2009; Clucas and Marzluff 2012; Schütz and Schulze 2015). With increasing levels of urban development, functional diversity and species richness decrease in comparison to areas with little or no sign of urbanization, while functional homogenization and proportion of non-native species to native species increases (McKinney 2002; Chace and Walsh 2004; Devictor et al. 2007; Clucas and Marzluff 2012).

Across the urban gradient, different species present a range of reactions to disturbances, with species falling on a spectrum from urban adapters to urban avoiders (Clucas and Marzluff 2015). Species with adaptations and traits more suited to filling urban niche space and survive large environmental and climactic changes, with life history traits and biological adaptations suited for the urban environment, tend to do well in urban spaces (Bonier et al. 2007; Clucas and Marzluff 2015). These species are often herbivorous generalist feeders and cavity nesters, with large and variable spatial ranges (Devictor et al. 2007; Huhta and Sulkava 2014). It has been shown that a few groups, such as rock pigeons (*Columba* sp.) house sparrows (*Passer domesticus*) and some raptors like peregrine falcons (*Falco peregrinus*; Sriram and Huettmann unpublished), benefit from novel niche space available in urban environments, with urban populations of these species growing to numbers otherwise unprecedented in more natural habitats (Chace and Walsh 2004; Fuller et al. 2008; Robb et al. 2008; Clucas and Marzluff 2012, 2015; Huhta and Sulkava 2014; Sanz and Caula 2015).

For specialist bird species, a heightened level of urbanization can be more disruptive than for their generalist counterparts in urbanized spaces, resulting in high local extinction rates of specialist species. Native species extirpation is not uncommon, and often has human causes (McKinney 2002; Devictor et al. 2007; Bonier et al. 2007; Magudu and Downs 2015). Green space fragmentation, environmental pollution, removal of trees and other natural nest space for ground- and tree-nesting species, as well as a contamination of and reduction in insect prey can be devastating for species in these niches (Vincent 2005; Peach et al. 2008; Evans et al. 2009; Šálek et al. 2015). Some of these species are unable to cross urban zones that fragment natural areas, and others exhibit declines in survivability and altered population distribution patterns when the natural habitat serves as an island inside the urban matrix (Evans et al. 2009; Pena et al. 2017). Traffic, human, and other types of noise pollution (including airplanes and motor vehicles) can have an influence on both urban adaptor and urban avoider species, including decreased fledgling survival, decreased parent-offspring communication, and increased overall stress (Schroeder et al. 2012; Pena et al. 2017). Noise from human activity can cut off parent-to-offspring communication, warning calls, and mating songs, thus reducing fitness and changing bird behavior (Schroeder et al. 2012; Pena et al. 2017). Fecundity can also be negatively affected, as clutch size tends to be smaller and fledgling weight and fledge success tends to decrease in areas characterized by high traffic volume than in quieter areas (Schroeder et al. 2012). Endemic species, and species with a small range may be particularly affected by urban habitat change when it is coupled with the small initial population size and small home range of that species (Bonier et al. 2007). Species known to quickly disappear from urbanizing areas are large predators (raptors, owls, vultures) and deep-forest associated species (insectivores) (McKinney 2002).

While a large majority of the literature notes that an increase in urbanization has a negatively correlated effect on avian species richness and functional diversity, some types of urban planning and built habitat can improve survivability and create niche space for certain species (Magudu and Downs 2015). Birds that have adjusted to life in an urban habitat often receive supplementary feeding through bird feeders and human garbage receptacles (Clucas and Marzluff 2012). Buildings, barns, planted trees, gardens, and other urban structures can provide ample nesting space for birds (Chamberlain et al. 2004; Gorenzel and Salmon 2005; Fuller et al. 2008; Robb et al. 2008; Clucas and Marzluff 2012, 2015; Magudu and Downs 2015). Species that fill this niche, such as sparrows and swallows, often show high population numbers, earlier-fledging young, lower predation susceptibility, and a higher survivability during periods of climatic extremes (Clucas and Marzluff 2012, 2015). Species that nest in these highly trafficked human areas have a high rate of direct interaction with humans (Gorenzel and Salmon 2005). Birds in this category exhibit less disruption with direct human contact than urban-avoider species (Cooke 1980; Jerzak 2001; Clucas and Marzluff 2012). Urban bird individuals may also have shorter flight distances than individuals of the same species in rural areas, which decreases predation risk for those birds (Møller 2008). However, although these factors improve survivability of some individuals, learned reliance on human activity for food, water, and nest space can lead to habituation and dependence on humans, with a potential for dangerous effects on bird individuals if human behavior changes and these resources suddenly become unavailable (Robb et al. 2008; Clucas and Marzluff 2012).

Urbanization forces individuals in populations and communities to live in closer proximity to others; for birds, the heightened level of human contact can lead to disturbance that is detrimental for urban-avoider species (McKinney 2002; Clucas and Marzluff 2015). Simultaneously, bird populations living in high densities can introduce dangers to human populations within the community (Illinois Department of Public Health n.d.; Gorenzel and Salmon 2005). Avian borne illnesses, present in feathers, droppings, and other nest debris can in some cases carry diseases that can be transferred to humans (Illinois Department of Public Health n.d.). These diseases include histoplasmosis, cryptococcosis, and candidiasis, conditions that affect the respiratory tract and can in some cases lead to death, and can all be found in bird droppings (Illinois Department of Public Health n.d.; Pure Air Control Services, Inc. 2013). Further, when birds are encouraged into a home, shop, or restaurant, human food and water may become contaminated and cause human health dangers (Gorenzel and Salmon 2005).

The culture of a people and society can greatly influence their opinions of, and attitude toward, birds living in close association with, or entering, human dwellings (Clucas and Marzluff 2012). While western societies tend to have negativistic views about human-wildlife coexistence, exhibiting fear, dislike, and discouragement of wildlife, Nepali people have a more positive view on animal coexistence (BBC 2010; Clucas and Marzluff 2012). The 2011 Nepali Census found that over 80% of Nepali people were Hindu and almost 10% were Buddhist (Central Bureau of Statistics 2012). People leading lifestyles following either of these religions regard animals as divine creatures deserving of full respect; the Hindu Bhagavad Purana says that animals, including birds, “should [be] considered like one’s own children, and [people should] not differentiate between one’s children and these creatures”(Hindu American Foundation n.d.; Agrawal and Bhavan 1983; BBC 2010).

We have noticed during our pre-data collection periods leading to this study that it is common for shop owners in cities and villages across Nepal to encourage birds to visit shops in the mornings via the spreading of bird seed, and it is encouraged to leave alone any bird nests that have been built inside of shops, homes, and restaurants. We noticed a similar behavior at monasteries and religious sites, where birds were actively attracted to birdseed spread by monastics and laypeople.

With this investigation we also aim to fill in some gaps in current urban bird data availability. In urban spaces globally, there has been relatively little research done and shared on the spatial distribution of urban-dwelling species, the impact of street culture dynamics of population diversity, the effects of urban development on birds, and the human health impacts stemming from close associations with bird populations (Devictor et al. 2007; Robb et al. 2008; Evans et al. 2009; Clucas and Marzluff 2012; Sanz and Caula 2015; Šálek et al. 2015; Pena et al. 2017). We found that open-access public data on this topic is very limited. There have been many studies on urban avian biodiversity distribution in cities in Europe and North

America, but the data is widely lacking in Nepal and Asia as a whole. There is also currently limited data regarding human/avian interactions in urban spaces within Nepal. In order to conclude generalized relationships between avian species diversity and urban sprawl, multiple urban areas across the entire landscape must be sampled (Silva et al. 2015). Nepal is a biodiversity hotspot where future management may be crucial to conserve species, and while there have been studies on the most threatened bird species there, there have been very few research studies and data on more commonly occurring species (Inskipp and Baral 2010; Bird Conservation Nepal (BCN) 2011; Clucas and Marzluff 2015; Conservation International 2016). Notably missing from the global literature and data sources are studies from areas with the current highest human population growth rates (Chace and Walsh 2004). There is also a rarity of data from tropical and subtropical urban zones, such as the Nepali Terai Region (See Fig. 18.1), and there is urgent need for comprehensive data on urban associated bird populations in these areas to inform future management and monitoring (Marzluff et al. 2001; Chace and Walsh 2004; Aronson et al. 2014).

Our research focused on variations of avian species along the urban gradient in cities, towns, and rural villages in Nepal, a biodiversity hotspot and region where studies of this nature are rare (Clucas and Marzluff 2015; Conservation International 2016). Because the Nepali landscape has a significant variation in climate (subtropical to alpine) and altitude (60–8848 m) from south to north, we sampled at point locations from varying geographical localities across the country to understand avian urban diversity across parts of the nation (see Figs. 18.1, 18.2, and 18.3) (Bird

Fig. 18.1 Map of major city centers in Nepal. (Map Courtesy of: One World Nations Online n.d.)

Fig. 18.2 Map of Ecological Zones in Nepal. (Map Courtesy of: Government of Nepal 2000)

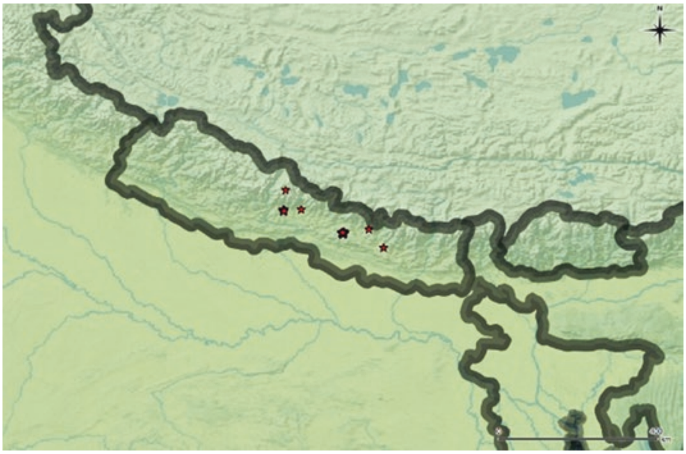

Fig. 18.3 Location of cities and villages sampled in Nepal

Conservation Nepal (BCN) 2011). Due to this significant number of threatened species, it is our hope that this study can provide insight to the level of urbanization preferred by more generalist versus specialist species. This research is intended to provide a first distribution model for avian species inhabiting and nesting in villages, sacred sites, and marketplaces within Nepal to advise for future ecological preservation measures, as well as identify how bird species richness differs on an urban to rural gradient. We aim to create the first Species Distribution Models (SDM's), which show a quantitative measurement of a specie's relationship with its local ecosystem, determine species assemblages and home ranges, and identifying habitat preferences and species interactions. This first rapid assessment will serve to inform future restoration and species management decisions for bird species along the urban gradient in Nepal (*sensu* Kandel et al. 2015).

18.2 Methods

18.2.1 Study Area

This study was conducted in the Kathmandu Valley (27°42′N85°20′E), Pokhara (28°15′50″N83°58′20″E), and a few other rural villages (those specific results reported elsewhere; Fig. 18.3). The altitude of our study sites vary between 826 m (Pokhara), 1,400 (Kathmandu) and 3,518 m (Manang Village). The climate zones of our study sites represent a gradient from tropical to subtropical to temperate to sub-alpine, from lowest to highest elevation. In the Kathmandu Valley, the largest urban metropolis in Nepal (1 million inhabitants), the average daytime temperature during May and June is around 29 °C with high humidity and around 6.35 mm of rainfall per month. Political and ecological maps of these cities, in their context in the country of Nepal, can be found in Figs. 18.1 and 18.2). The most common human land uses of these regions include agriculture, urban use, and forest (Figs. 18.4 and 18.5).

18.2.2 Study Sites and Location Surveys

In the cities of Kathmandu and Pokhara plots were chosen by randomly placing GPS coordinates on roads on GIS maps of the city. Each study site plot was marked by a GPS coordinate, and included a 200 m line transect along roads (100 m from the GPS coordinate to each side). In Nepal, shops and restaurants are commonly designed with an industrial garage door as the main entrance and exit of the building, and as a means to close and lock the business (hinged doors are not so common). We added descriptions of electrical wires along the road. Outdoor wiring is a unique feature in Nepal and it was a prevalent feature on our plots, serving as relevant habitat features used by birds (Figs. 18.6, 18.7, and 18.8).

18.2.3 Bird Surveys

Data was collected during the spring in the Northern Hemisphere, from May 20–June 10, 2016, and May 14–17, 2017. This period was chosen so we could conduct our study late enough to be able to detect all bird nests made in that season, yet early

Fig. 18.4 (**a**) Urban growth in the Kathmandu Valley. This photo was taken on a plot transect from our study in downtown Kathmandu city. (Plot 4LH, Thamel, Kathmandu. 24 May 2016). (**b**) Urban growth in Pokhara City. This photo was taken on a plot transect from our study in downtown Pokhara. (Plot 64LH, West of Fulbari, Pokhara. 4 June 2016)

enough that the monsoons would not impede our study by destroying nests or affecting bird abundance estimates or surveys. Bird nests were surveyed opportunistically. Our base inventory method used a direct count method along line transects (visual perpendicular detections could be constrained by houses or buildings), noting individual birds of every species visually seen or heard (Murgui and Macias 2010). Our search effort focused primarily on road and building habitats, with little searching in the sky for soaring species. We did not sample for bird calls specifically, given the high level of traffic noise in our study area blocked out many of the bird sounds. Sampling was conducted from 08:00 to 18:00 local time during sun-lit hours and in favorable weather conditions (no strong precipitation or wind). Sampling was conducted by only two data collectors (FH, LH) to minimize observer biases.

We randomly selected accessible GPS point locations to serve as the central location of 200 m sampling transects along roads in cities, towns, and villages in Nepal. Data collectors walked the entire length of the randomly selected road transect. The transect begins with the central point and was walked 100 m along the road in one direction, while conducting a visual-only count of all avian species detected along the transect at that time (transect A). Once 100 m was reached, the data collector walked back to the central point while counting associated habitat

Fig. 18.5 Swayambhunath, in Kathmandu. This is known as one of the holiest Buddhist chaityas in Nepal. The Swayambhunath stupa and its grounds are green space 'islands' in the urban matrix of Kathmandu city, and are surrounded by urban sprawl

Fig. 18.6 A typical shop entrance in Nepal, with an industrial garage door. Birds use those specific habitat features. (Plot 13LH, Lazimpat, Kathmandu. 25 May 2016)

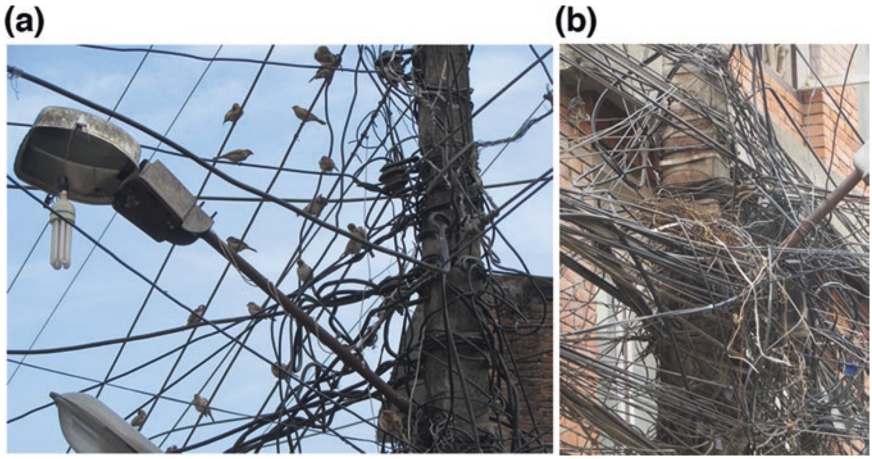

Fig. 18.7 Birds making good use of intense electric wiring, e.g. used for power supply and ‘the WIFI internet.’ (**a**) House sparrows. (**b**) House sparrow nests (colony)

Fig. 18.8 Barn swallow nest in a shop on an electric light

features such as the total number of shops, conducting a nest count, noting building style and electrical wire coverage as well as taking representative photos. The data collector then repeated the same sampling process for 100 m in the opposite direction (transect B). The A and B transects subsampled the same area of a 200 m plot sampling area overall, but allowed us to split the data into a ‘training’ and ‘testing’ subset representative of a 200 m radius plot area during our data analysis phase. Representative plot photos were taken also. The GPS location of the transect center as well as habitat type was recorded for every nest encountered. Each plot took 20–30 min to fully sample. Additionally, we recorded the GPS location and target species (e.g. swallows or sparrows) and other noteworthy sightings directly made on transect during sampling hours. For each plot, we noted in our field database the observer details, whether we took a georeferenced photo at the plot center, the level of electrical wiring running over the transect, if there were nests found inside of shops or buildings, and the total number of shops and known sacred sites on the transect.

We also recorded supplementary personal interviews with merchants and shop owners working along transect roads to learn about their attitude and behavior toward birds and for their views and insights on birds interacting with their shops. We do note that our sampling scope likely resulted in an undersampled urban area but with the help of our research design (transect A and B) and analysis tools (GIS, open access layers and machine learning), we tested whether we can generalize for the entire city-scape.

All field data were entered into Open Office Sheets and are available as MS Excel sheets (see Appendix B and online source) (Fig. 18.9).

18.2.4 GIS Analysis

18.2.4.1 Bird Data

For Kathmandu and Pokhara we geo-referenced all bird data by their center coordinates, and created maps of the center of each transect for point counts and nest counts in Kathmandu and Pokhara. From these points – representing a 200 m radius area – in a GIS we created maps of transect avian abundance and avian diversity. We also created specific maps for nests, and for noteworthy bird species. These GIS layers exist as point data in an ESRI shapefile format (Appendix C1).

18.2.4.2 Urban GIS layers

We obtained OpenStreetMap GIS layers from Trimble Data Marketplace on July 9, 2017, available under the Open Database License. We mapped those layers in ArcGIS and QGIS, and selected the layers of waterways, natural places, shop polygons, landuse, roads and highways as 6 individual predictors to use in our analysis. We did not use layers like ‘offices’ because they are ubiquitous and seem to be less suited as a predictor for birds.

Using the ArcGIS proximity tool we created proximity feature layers as model predictors. All of these predictor layers are shown and presented in Appendix C (as jpgs as well as ESRI grids) for open access use by the global audience, assuring transparent and repeatable inference based on empirical data and analysis methods.

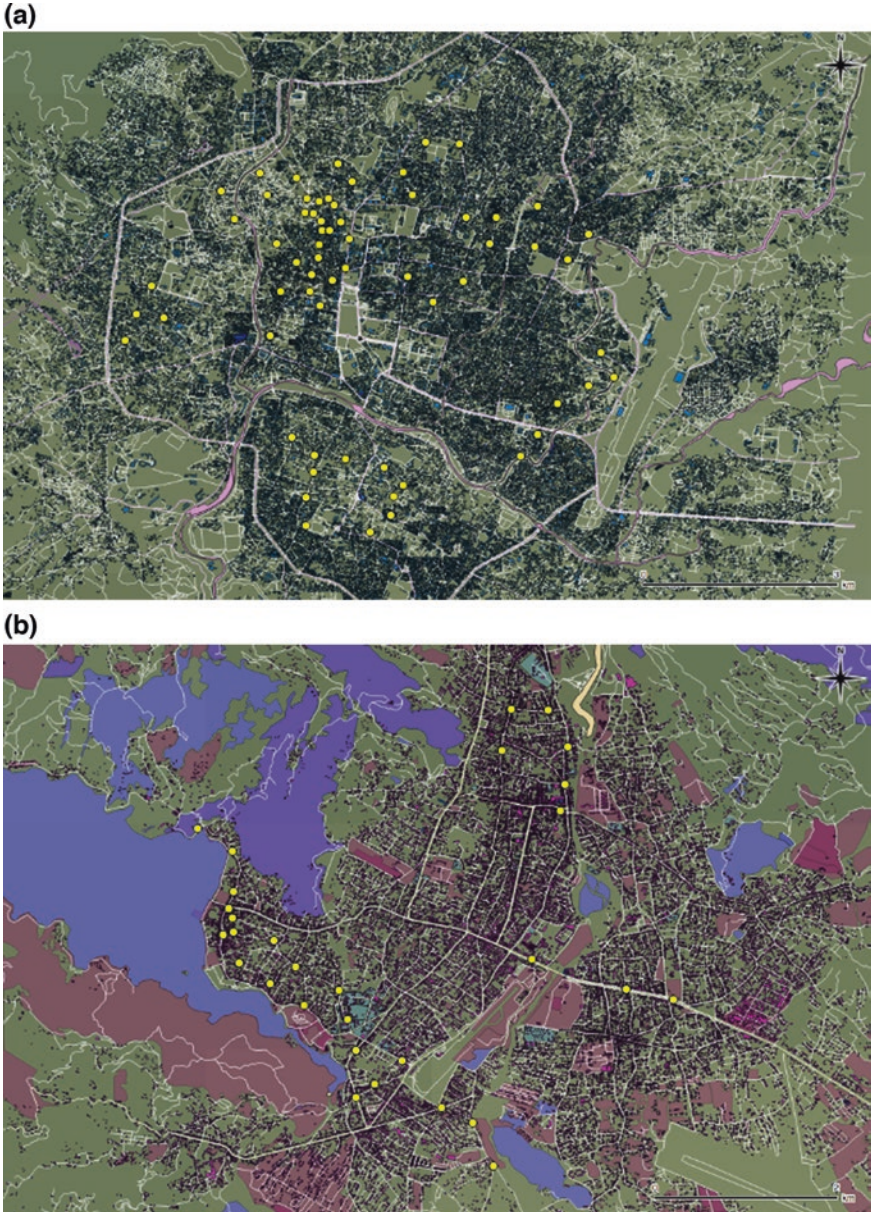

Fig. 18.9 (**a**) Sample plots in Kathmandu, Nepal. Our plots are marked as yellow circles, with white lines representing roads, pink representing waterways and rivers, and black polygons representing shop and building locations and density. (**b**) Sample plots in Pokhara, Nepal. Our plots are marked as yellow circles, with white lines representing roads, purple polygons representing ponds and lakes, and black polygons representing shop and building location density. Pink and maroon polygons are natural areas

18.2.4.3 GIS Overlays and Prediction Lattices

For each survey location we extracted the six attributed predictor attributes, resulting in a table (exported in MS Excel and CSV format) to be used for further modeling. The overlays were done with the ArcGIS 'extract to attribute' tool. For prediction purposes we created a high resolution lattice of 0.01 degree spacing. For each lattice point, we extracted each of the 6 predictors. This also resulted in a table (lattice), which was used in further model-predictions and for extrapolations.

18.2.4.4 Machine Learning Modeling

We used RandomForest and TreeNet algorithms in Salford Predictive Modeling (SPM8; a specific and very high performing boosting algorithm that includes bagging components) to model-predict birds in relation to their environmental predictors (see Baltensperger et al. 2013 for an example) and application. We explored several model algorithm settings. Due to the regression model approach we found the best predictions with TreeNet (regression models are not well supported by Breiman's original randomForest algorithm; Breiman 2001). We used 600 trees and made trees very detailed (n = 2 for final cases and 1- tree levels) to obtain best performance and to find hidden signals in the data. For model training, we only used data from the line transect A. We ran two separate models per city: bird abundance and avian species richness. The tables were imported into SPM as ASCII tables and TreeNet was run with default settings. We saved a grove file for each model and then applied it to the lattice (table; scoring the lattice table). The lattice with the predictions was mapped with ArcGIS to show a predictive layer. We used an IDW smoothing algorithm to create a seamless prediction surface for each response variable.

18.2.4.5 Model Assessment Methods and Evidence

We used line transect B data and overlaid them with our predictions for each model and each city. We used a root mean square error to express how well the continuous data are related. This allowed us to obtain an independent assessment and whether our models predicted reality in the pixel radius of 200 m.

18.3 Results

We established for urban Nepal (n = 66 for Kathmandu and n = 31 for Pokhara) transect sampling sites referenced in space and time that can be used for repeat surveys by the global public. As a result, our data and the ESRI GIS files used for data analysis in this study have been stored in the open-access database, dSPACE (Scholarworks). The link to our raw data can be found in Appendix C.

Maps of the raw abundance and bird diversity data for Kathmanduand Pokharacan be seen in Figs. 18.10 and 18.11.

We found that Kathmandu had a sampled avian bird abundance of 6–73 individuals, with an avian diversity between 1 and 9 species. Whereas Pokhara, a more tropical but smaller city and located on a lake, had a sampled avian bird abundance of 0–64 individuals, with an avian diversity of 0–9 species. The urban species diversity appears similar for both cities but the actual abundance is higher in the more urbanized and bigger city of Kathmandu, the nation's capital and a city with several World Heritage Sites (many with 'green spaces') due its religious importance. We found high numbers of pigeons often affiliated with holy sites in Kathmandu and we think those are drivers of high avian abundances and food chains.

For Kathmandu, we found 20 nest locations on the A transects, with a majority being pigeon nests (14). We also found 7 active house sparrow nests. Often house sparrows nested in similar locations to pigeons in holes or crevasses along the exterior of buildings. In Pokhara, we found evidence of 9 nests (5 Barn Swallows and 4 House Sparrows) (Figs. 18.12 and 18.13).

18.3.1 Predictions

We obtained predictions for avian abundance (Fig. 18.14) and diversity (Fig. 18.15) for each city. The models are stable and acceptable, allowing for 'good' inference, as already judged by the testing data results. However, we are able to ground-truth them (B transects) and found a good agreement (see widely matching colors of predictions, A & B transects in Figs. 18.14 and 18.15).

18.3.2 Habitat Associations

For Kathmandu we found that the predictor 'proximity from natural area polygon' stands out for bird numbers as well as avian diversity; it shows a negative relationship (further distances from those areas showed fewer birds).

For Pokhara we found that the predictor 'natural area polygon' is less relevant (ranked second) but that a peak distance to mapped shops seems to drive the models (Figs. 18.16 and 18.17).

18.3.3 Other Findings

During informal conversations and interviews with residents and shopkeepers representing all levels of the urban gradient, personal opinion of birds was largely positive. Respondents reported setting bird seed out in front of their shops in the

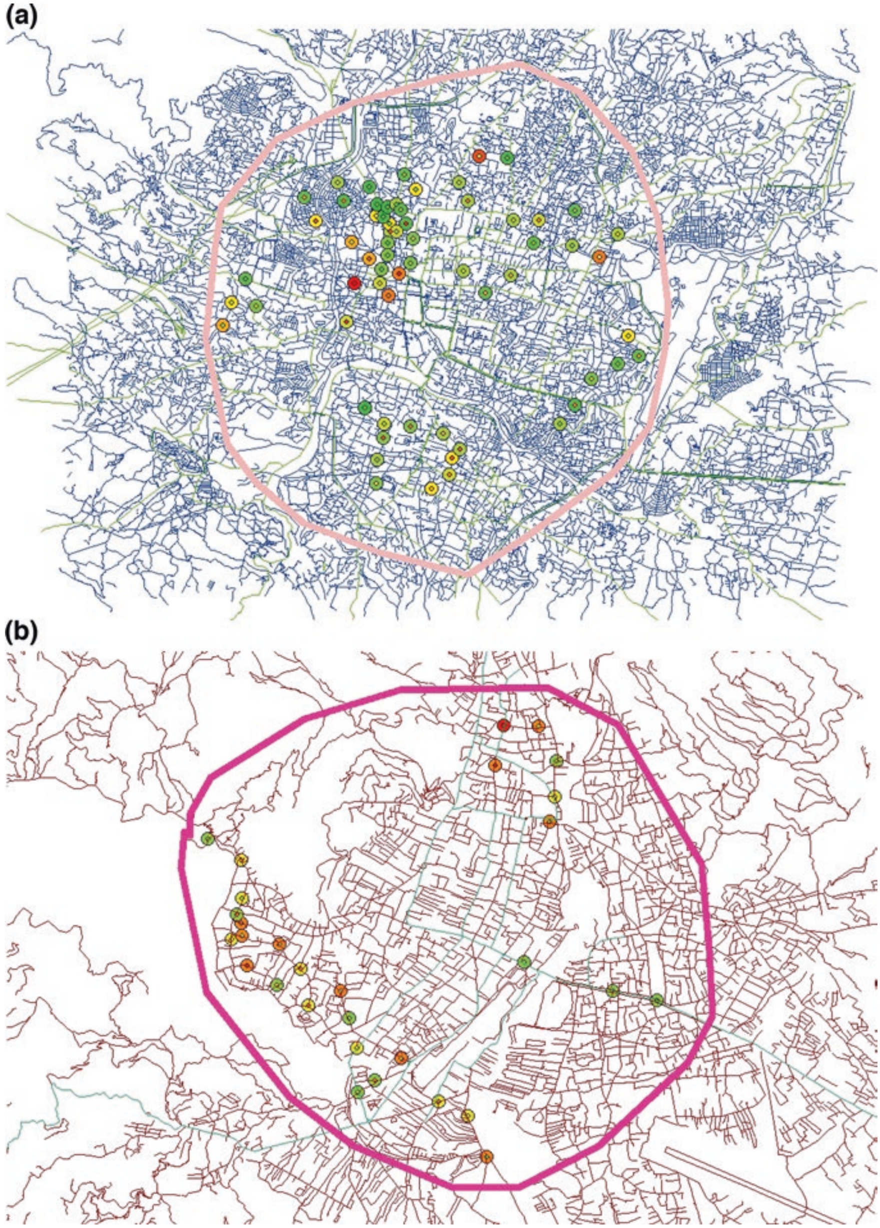

Fig. 18.10 (**a**) Kathmandu bird abundance for transects A. (**b**) Kathmandu bird diversity for transects A

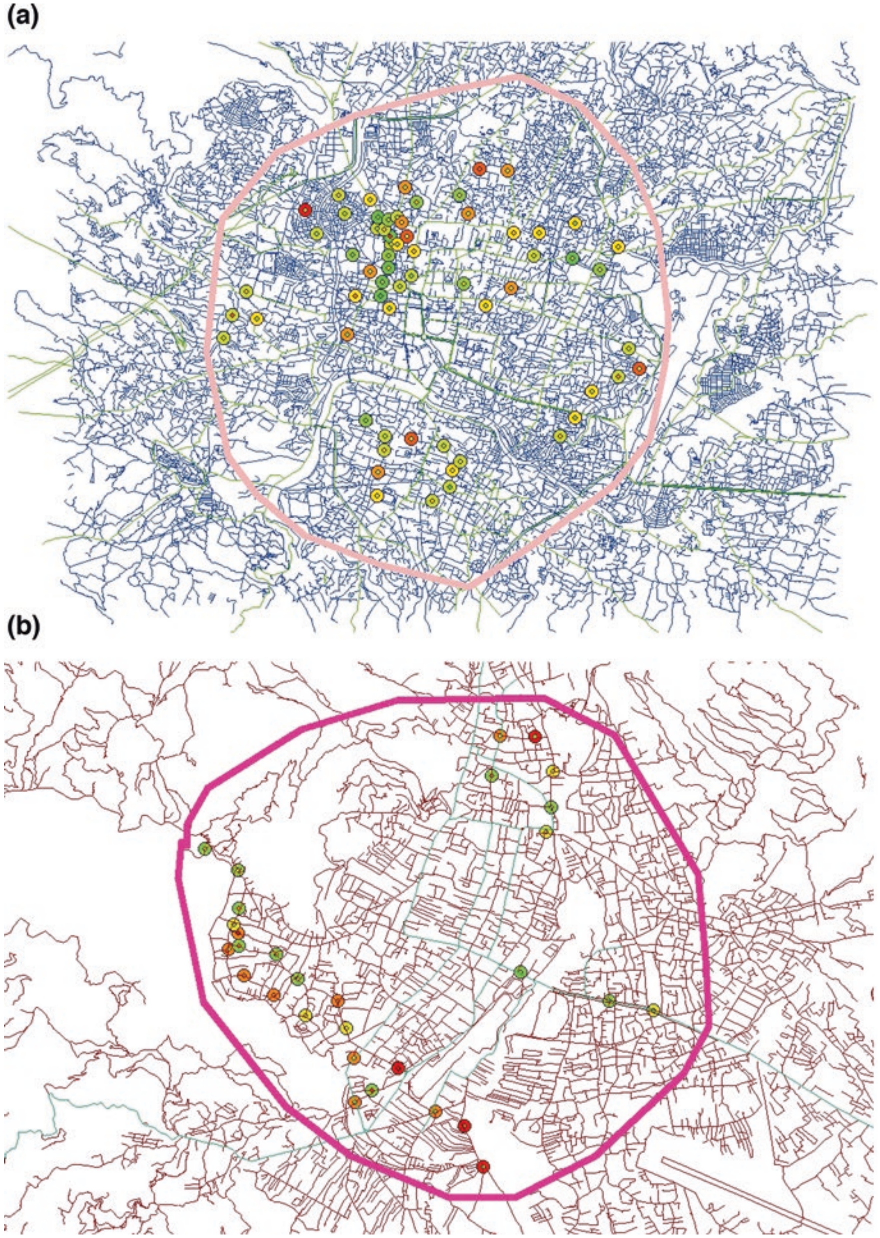

Fig. 18.11 (**a**) Pokhara bird abundance for transects A. (**b**) Pokhara bird diversity for transects A

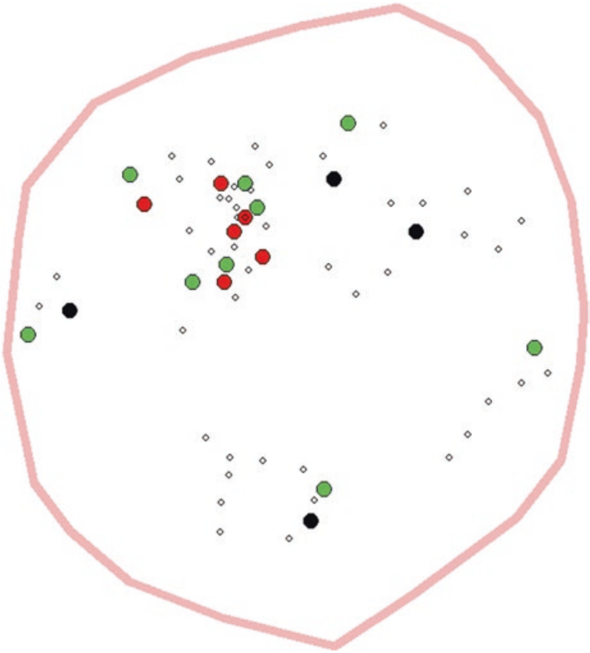

Fig. 18.12 Kathmandu bird nests for transects A

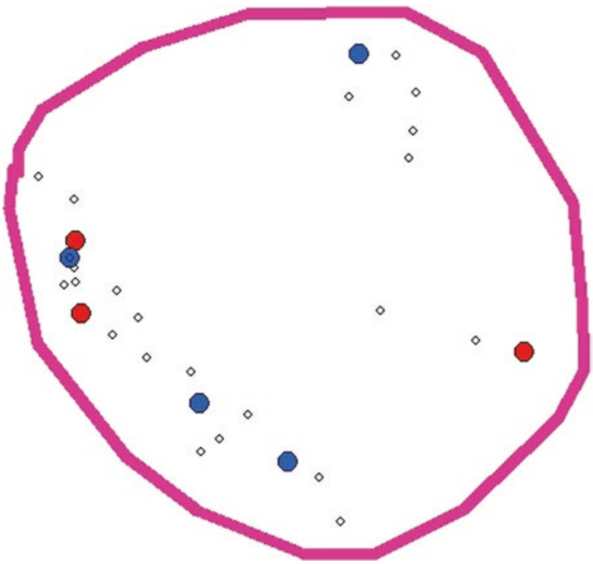

Fig. 18.13 Pokhara bird nests for transects A

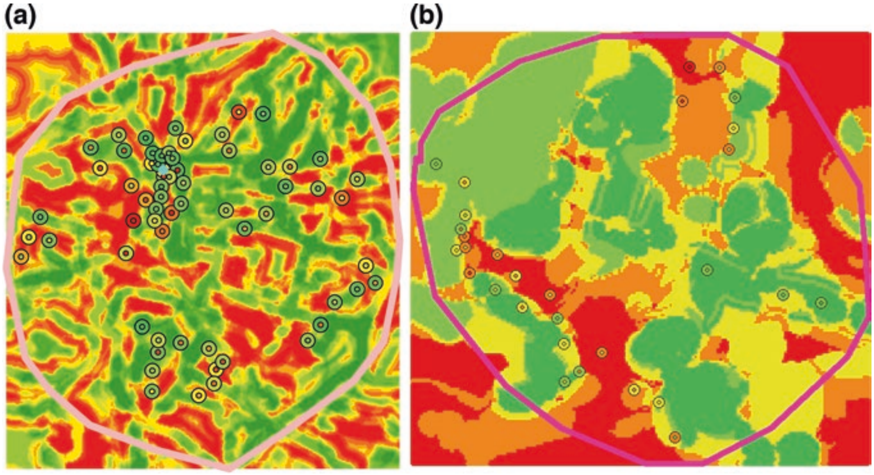

Fig. 18.14 Predicted relative indeces of avian abundance (**a**) Kathmandu, (**b**) Pokhara)

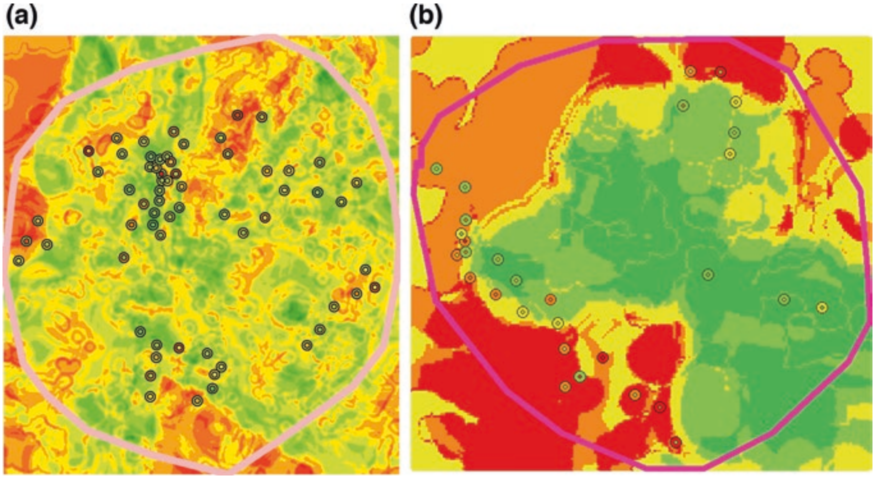

Fig. 18.15 Predicted relative indeces of avian diversity (**a**) Kathmandu, (**b**) Pokhara

mornings to attract birds (Fig. 18.18), and having feelings of happiness and peace when birds would fly around the shop, roost outside of the shop, and nest inside of the shop. Many people reported feeling proud that birds would nest in their shops, often inviting us in to show us nests in the back of shops. A few people offered to take us into their homes to show us bird nests in their bedrooms.

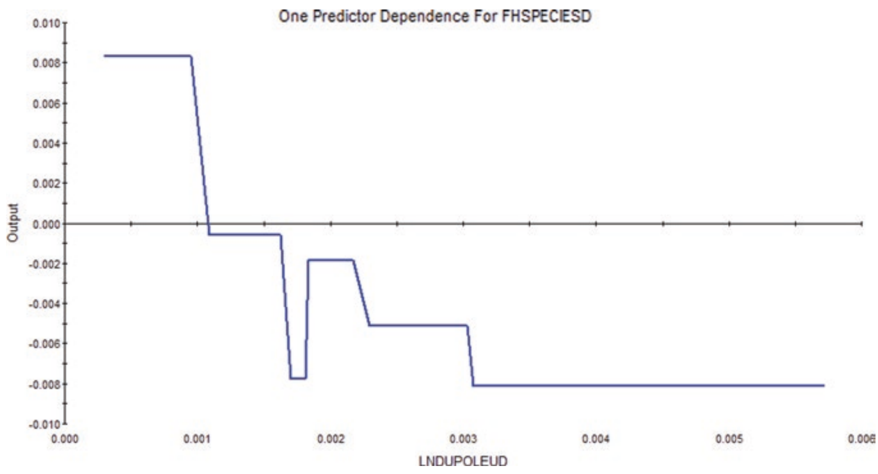

Fig. 18.16 Partial dependence plot of the major predictor for Kathmandu's bird data (species diversity shown here): Proximity to natural area polygons showing a negative relationship

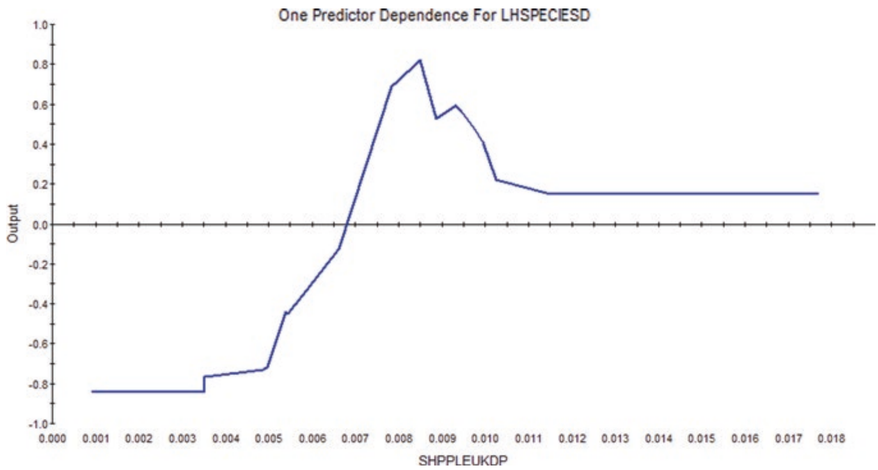

Fig. 18.17 Partial dependence plot of the major predictor for Pokhara's bird data (species diversity shown here): Proximity to mapped shops with a 'peak' region

18.4 Discussion

18.4.1 Urban Bird Abundance and Diversity

We found that Kathmandu is a mid-elevation tropical city being highly urbanized and sprawling. Our map for Kathmandu's avian abundance shows that birds are common in down town. They are associated with roads and waterways but birds specifically link with (mapped) natural areas.

Fig. 18.18 Feeding birds in Nepal; those are often from 'Mercy Releases' at holy sites

Our map for Kathmandu's species diversity shows relatively high values in downtown Kathmandu. This includes Thamel, a busy and world-famous market center and tourist hub, as well as religious areas (for instance near Buddhist temples Swayambunath and Boudhanath, and Hindu temple Pashupatinathamong other places).

Pokhara is another urban center in Nepal but it includes a lake and more tropical vegetation at a ower altitude. Our map for Pokhara's avian abundance shows that birds are not so common in downtown but instead occur near the waterside and in the less urbanized outer areas of town.

Our map for the species diversity shows a similar pattern for Pokhara as for Kathmandu: higher diversity is actually found in downtown areas.

Our models show good accuracy for both metrics and for both cities, and a good match is found with the testing data. However, model accuracy is not in the 90% level.

In the absence of a digital online urban bird atlas for these cities, we think this is a good start and for any environmental urban planning.

18.4.2 Noteworthy Bird Findings

Both cities show tropical species, namely several parrot species (which are usually considered as urbanized).

We think that the pigeons, namely in Kathmandu, are related with religious sites, especially the World Heritage sites where food and some green spaces are easily accessible. Further, we found sparrows to be very common in both cities, and found that barn swallows were more prevalent in Pokhara than in Kathmandu.

A commonly known and widespread urban adaptor species throughout the world is the House Sparrow, a generalist species which has proven very adaptable to human driven disturbance and has established populations both natively in Europe and Asia, and non-natively in North and South America, Africa, and Australia (Chamberlain et al. 2004; Magudu and Downs 2015). Perplexing to many researchers, the House Sparrow has been infamously declining in its native range across Europe since the 1980's, while it is thriving in its non-native habitat in North and South America (Vincent 2005; Shaw et al. 2008; Peach et al. 2008; Šálek et al. 2015). There have been numerous studies on this, and the current working theory for House Sparrow decline is that increased urbanization leads to decreased House Sparrow populations (Šálek et al. 2015). Here we provide the first assessment for urban Nepal. While House Sparrows do use cavities in buildings as a major nesting habitat, their numbers tend to decrease with an increased proportion of larger buildings and higher levels of noise (Peach et al. 2008; Schroeder et al. 2012; Magudu and Downs 2015). Although House Sparrows are native to Nepal and greater Southeast Asia, sufficient research and data on the subject is lacking. We hope this investigation will stimulate to provide more and improved data and model predictions for this species in Nepal with the hope that mitigation effects can be taken early to minimize the likelihood that the Asian House Sparrow population will mimic the generic decline of the European population.

We also found in our study that birds are extremely common and close in the urban-human interface zone. This is due to religious beliefs and the specific, unique (religious) culture in the study area. However, there can be potential negative aspects when it comes to disease contacts and outbreaks. These will require further investigation, as none has really been studied yet and data are not available to the global public.

It should also be noted that there is a strong likelihood that there many (rare) were bird species we missed and did not detect. Black Kite, owls and vultures are among those missed, likely because they soar high in the sky and were not well covered by our survey methods and 'blocked' by many tall buidlings. However, black kites are abundant in both cities, whereas vultures are less common, having gone through a major population decline in recent decades.

18.5 Needed Improvements for Studying Urban Birds in Nepal

There remain many things to be further improved in a study like the one presented here. The GIS data leave much to be desired, as the predictors are abundant but not all are biologically meaningful or accurate. For example, the 'office' layer is for instance ubiquitous and highly dynamic in a city like Kathmandu or Pokhara.

Secondly, layers like ‘shops’ must be meaningless when the only building type along a transect and in an area essentially are shops, such as in very dynamic market areas like Thamel in Kathmandu or the lakeshore in Pokhara where flying vendors occur daily. Further, we were not able to find a layer of all religious sites, to be used as a predictor. Such a map does not currently exist, to our knowledge. Another major layer, not available, are garbage dumps and waste collection sites, as they are known to be major biodiversity hotspots by now. Also, some map layers used in this project might be outdated by now and more ground-truthing is needed. Despite the great progress in Remote Sensing over the last decades, we still lack a valid, freely and readily available, meaningful and well-classified satellite image layer for the study area and studies as presented here (focus on biology, urban planning and sustainability).

We have not carried out a very ‘deep effort’ bird survey with very high number of sample sites and detailed bird identifications (e.g. for some retreated pockets of vegetations in inaccessible urban areas like private gardens with old -growth forest trees and ponds or wetlands). Our species list is therefore only a first rapid assessment type and presumably underestimates the ‘true’ avian metrics out there.

Finally, we are sure that more data exist for the region since the culmination of this project, e.g. in eBIRD.org, and those are to be used and included for a model update once those become publicly available (*sensu* Baltensperger et al. 2013, Kandel et al. 2015). Despite many campaigns, Open Access data sharing is not yet well established, for Asia and for most of the sciences across the world (Carlson 2011, 2013).

18.6 Application for an Effective Conservation Management

Nepal features a new and modern constitution from the year 2017 onwards. However, birds are not on the main agenda there, nor even is relevant urban planning, or are relevant budgets assigned for those topics. It’s a typical modern, western notion that environmental issues are marginalized and not main stream (see Daley and Farley 2010, or Huettmann 2012). With other major problems taking precedent, e.g. earth quakes, watershed pollution, or human population explosion and unrest, and climate change still on the rise and unabated, birds and their management, in rural areas or urban ones, will likely not be addressed any time soon on a relevant manner. Additionally, on a global scale, dealing with the macro-view and international migratory bird aspects remains poorly studied and remains equally ineffective for a successful conservation management (see in Huettmann 2012, or assessed in Huettmann et al. 2011; Table 12). Legally, and from the governmental side of things, the management of (urban) birds must be seen as a global failure by now (see urban crow explosion in Kover et al. 2014 under various regimes of capitalism; also see ICIMOD.org for lacking research and discussion on those issues in the Hindu Kush

Himalaya region). Already the electrification of Nepal's cities, and as fueled by so-called 'green' hydrodams etc, must be addressed. It's not only a major habitat feature but also involves stress, view sheds, injuries and mortalities.

One alternative to this dilemma might be bird management through spirituality and cultural investment on a community level. And as shown here in this study, religion and culture are major players in Nepal when it comes to bird and nest protection in urban spaces. It appears there is a certain Nepali mindset to tolerate and even promote or subsidize birds. With international AID, the UN and governmental efforts failing, here sits still a widely underestimated yet relatively effective approach on a landscape level. Bottom-up and Citizen Science efforts could prove effective and should be considered when planning for conservation and restoration.

18.6.1 Outlook

We think here we provided a reliable first work flow as well as a study template for rapid assessments in urban areas and for urban ecology. One can apply the template and workflow presented here, combining raw data with machine learning prediction metrics, to virtually any city; Open Street Map GIS data and Open Source GIS are globally available, often in 3D even. We think such data should be presented and made available in GBIF.org with ISO-compliant metadata.

Further applications of these predictions could be drawn for other sustainability metrics, including water management and climate change. We hope to expand this process to see the deeper connection between Buddhism, Hinduism, Shamanism etc and nesting swallows, the avifauna and human-well-being and world peace, as well as the difference between those nesting habits of swallows in western world compared to eastern world cities and cultures for instance.

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Appendices

Appendix A

Raw survey data for Kathmandu (a) and Pokhara (b) in MS Excel Sheet and CSV Format (See Supplementary Electronic Material)

Appendix B

Scientific names of bird species mentioned in this paper

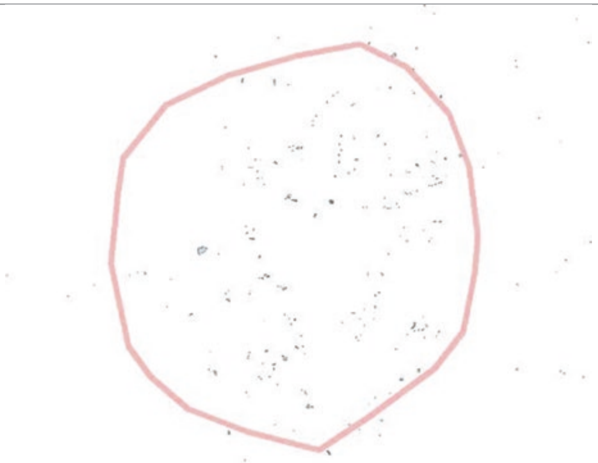
Common name	Scientific name	ITIS taxonomic serial number (TSN)	Seen in KTM	Seen in POKH
Barbet sp.	*Megalaimidae* sp.	553451	No	Yes
Barn Swallow	*Hirundo rustica*	178448	Yes	Yes
Black Kite	*Milvus migrans*	175469	Yes	Yes
Cattle Egret	*Bubulcus ibis*	174803	Yes	Yes
Chicken	*Gallus gallus*	176086	Yes	Yes
Common Myna	*Acridotheres tristis*	554025	Yes	Yes
Crow Sp.	*Corvus* sp.	179724	Yes	Yes
Cuckoo Sp.	*Cuculidae* sp.	177820	No	Yes
Dove Sp.	*Columba* sp.	177062	Yes	Yes
Duck Sp.	*Anas* sp.	175062	Yes	Yes
Egret Sp.	*Ardea* sp.	174772	Yes	Yes
House Crow	*Corvus splendens*	559513	Yes	Yes
House Sparrow	*Passer domesticus*	179628	Yes	Yes
Large Billed Crow (Jungle Crow)	*Corvus macrorhynchos*	559503	Yes	No
Little Pied Flycatcher	*Ficedula hypoleuca*	560081	No	No
Parrot Sp.	*Amazona* sp.	177782	Yes	Yes
Long-tailed Shrike	*Lanius schach*	560731	No	No
Oriental Magpie Robin	*Copsychus saularis*	559432	Yes	Yes
Pigeon Sp.	*Columba* sp.	177062	Yes	Yes
Red Rumped Swallow	*Cecropis daurica*	916675	No	No
Red-vented Bulbul	*Pycnonotus cafer*	178506	Yes	Yes
Redstart	*Muscicapidae* sp.	178663	Yes	No
Rose-winged Parakeet	*Psittacula krameri*	177650	Yes	Yes
Sparrow Sp.	*Passer* sp.	179627	Yes	Yes
Swallow Sp.	*Hirundo* sp.	178447	Yes	Yes
Swift Sp.	*Apus* sp.	178006	No	Yes
Tree Sparrow	*Spizelloides arborea*	997961	Yes	Yes
White Wagtail	*Motacilla alba*	178476	No	No
Yellow-Billed Chough	*Pyrrhocorax graculus*	562652	No	No
Field Sparrow	*Spizella pusilla*	179443	Yes	No
Hooded Crow	*Corvus cornix*	179740	No	Yes

Sourced Via The Cornell Lab of Ornithology Bird Guide (2015)

Appendix C

C1: Raw Data Set, Avian Survey Transects A and B with information on abundance, species diversity and nest location.
C2: Open Street Map Kathmandu GIS layer as jpgs and shapefiles
Waterway polygon for Kathmandu

Shop polygon for Kathmandu

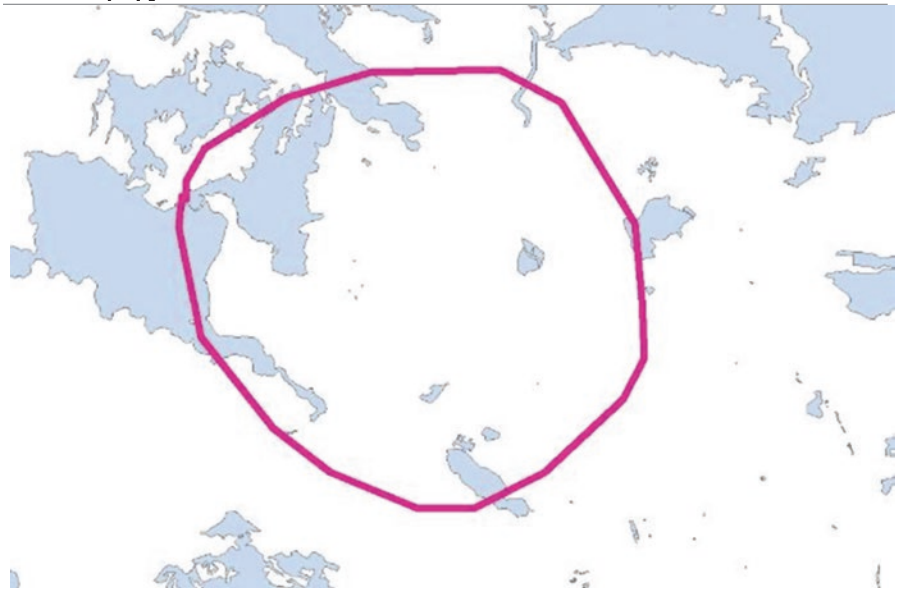


Highways for Kathmandu

Route line polygon for Kathmandu

Landuse polygon for Kathmandu

Natural polygon for Kathmandu



C3: Open Street Map Pokhara GIS layer as jpgs and shapefiles
Waterway polygon for Pokhara

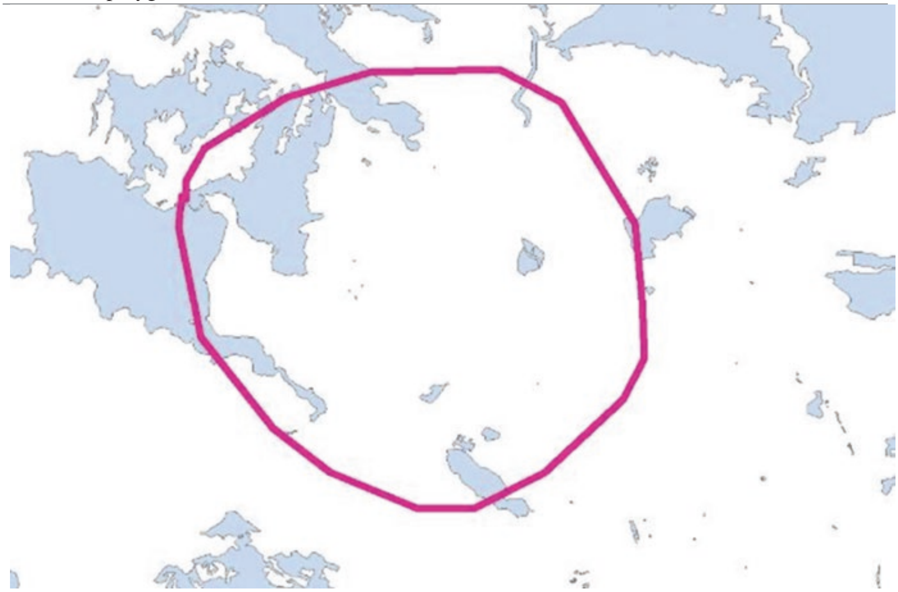
Shop polygon for Pokhara

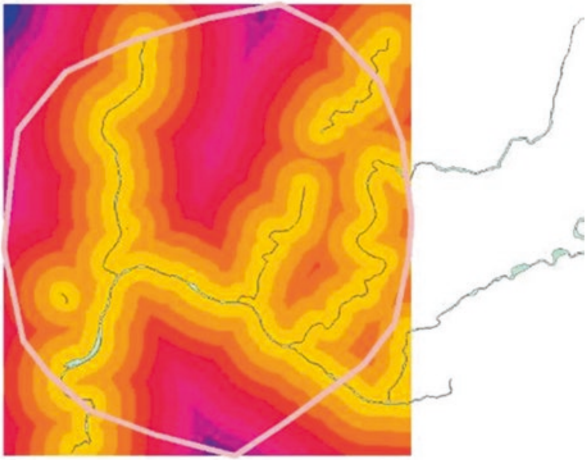
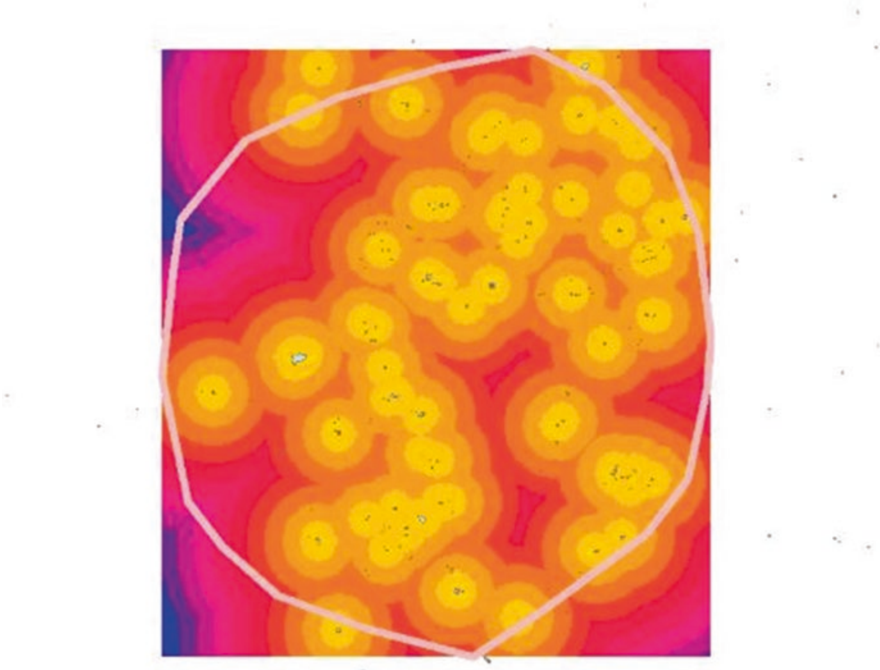

Highways for Pokhara

Route line polygon for Pokhara

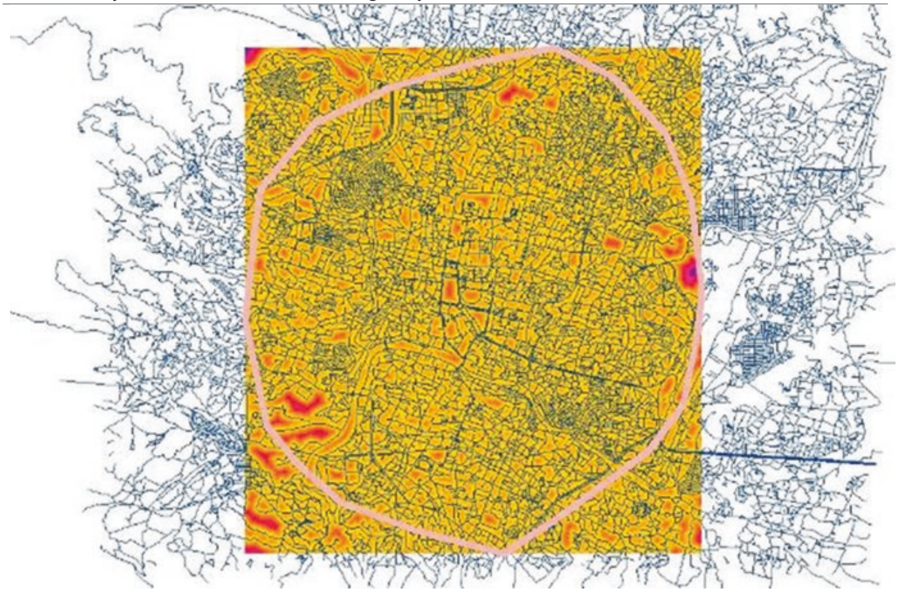
Landuse polygon for Pokhara

Natural polygon for Pokhara

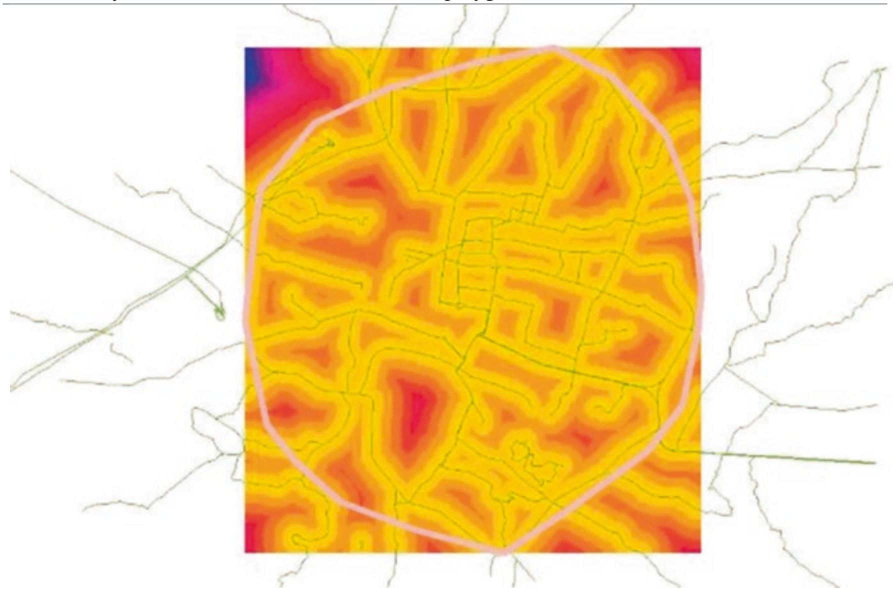


C4: Model predictor layers for Kathmandu study area as jpgs and shapefiles
Proximity (Euclidian Distance) to Waterway polygon for Kathmandu

Proximity (Euclidian Distance) to Shop polygon for Kathmandu


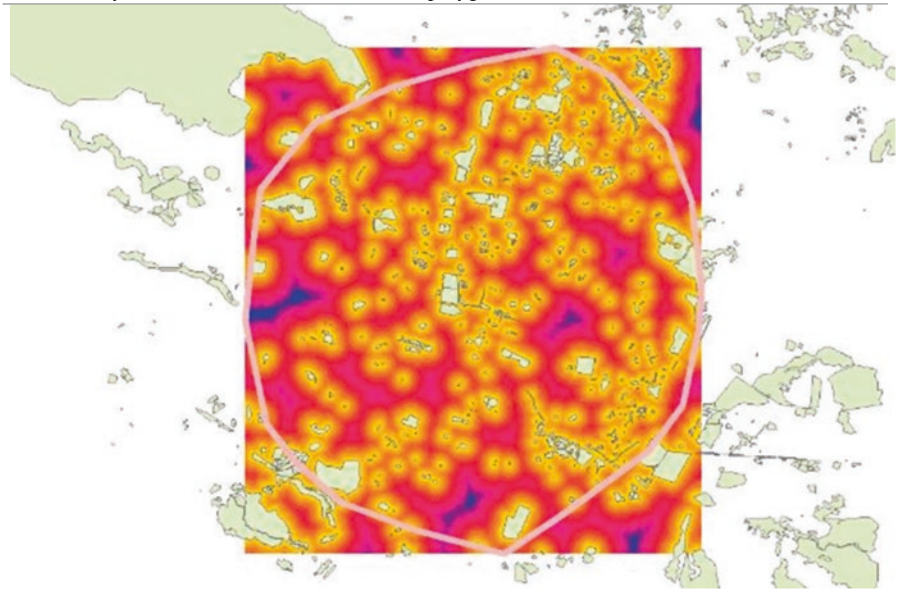
Proximity (Euclidian Distance) to Highways for Kathmandu



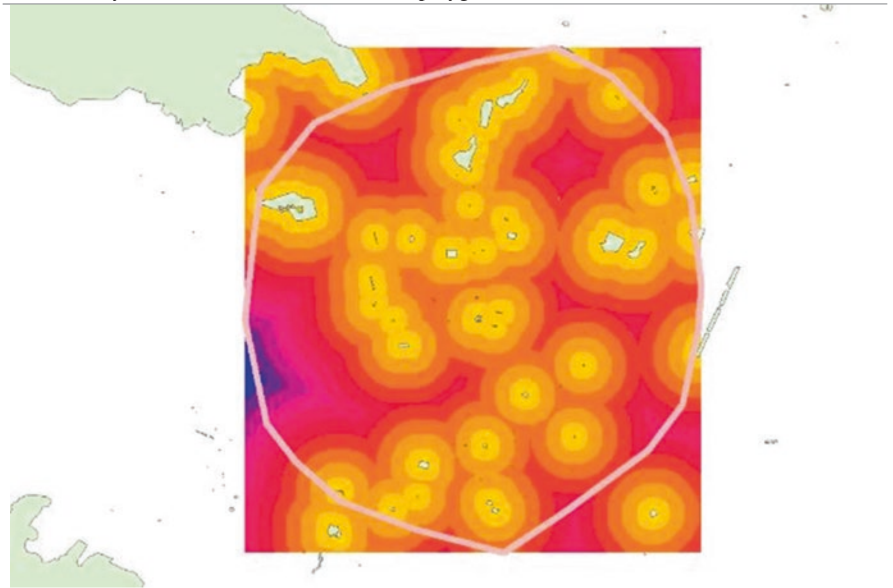
Proximity (Euclidian Distance) to Route line polygon for Kathmandu

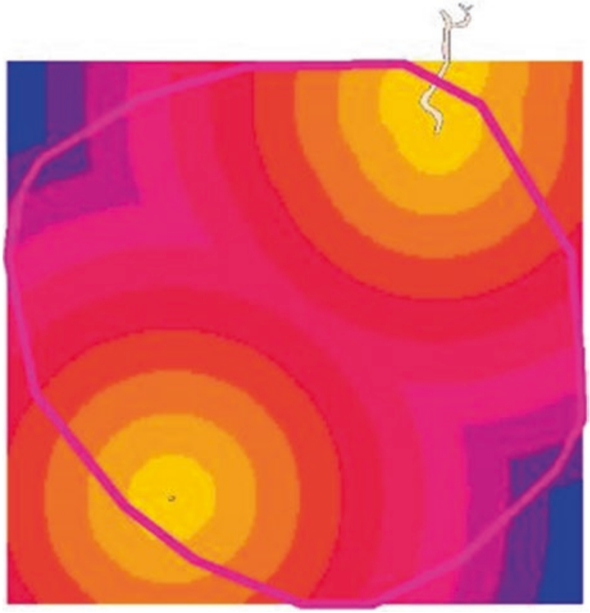
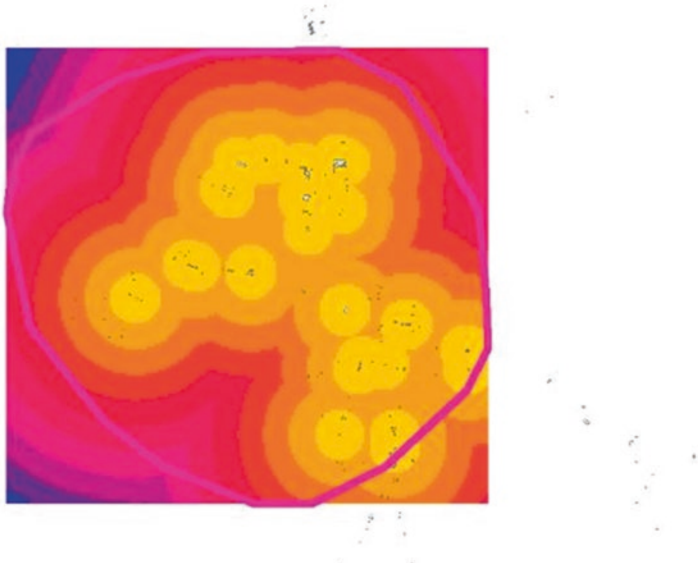


Proximity (Euclidian Distance) to Landuse polygon for Kathmandu

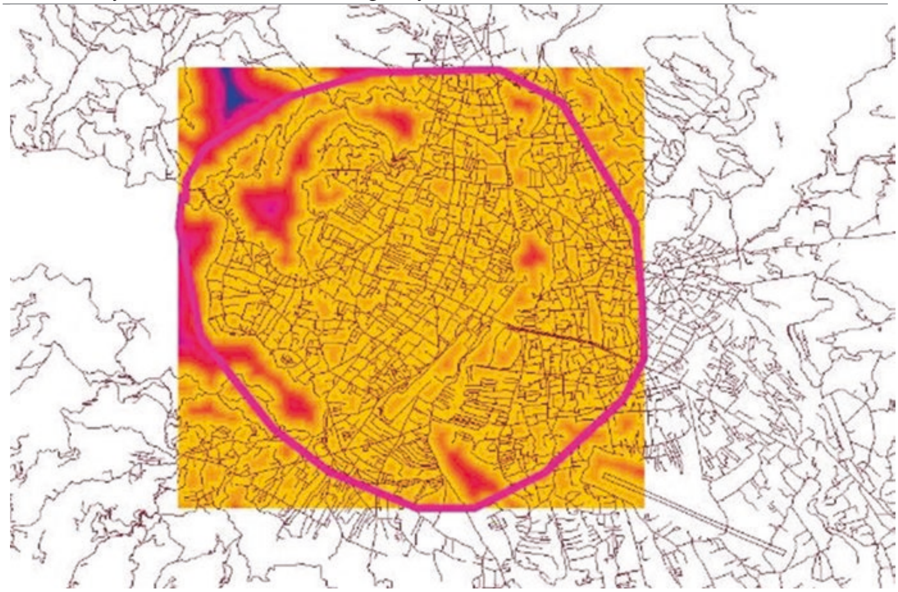


Proximity (Euclidian Distance) to Natural polygon for Kathmandu

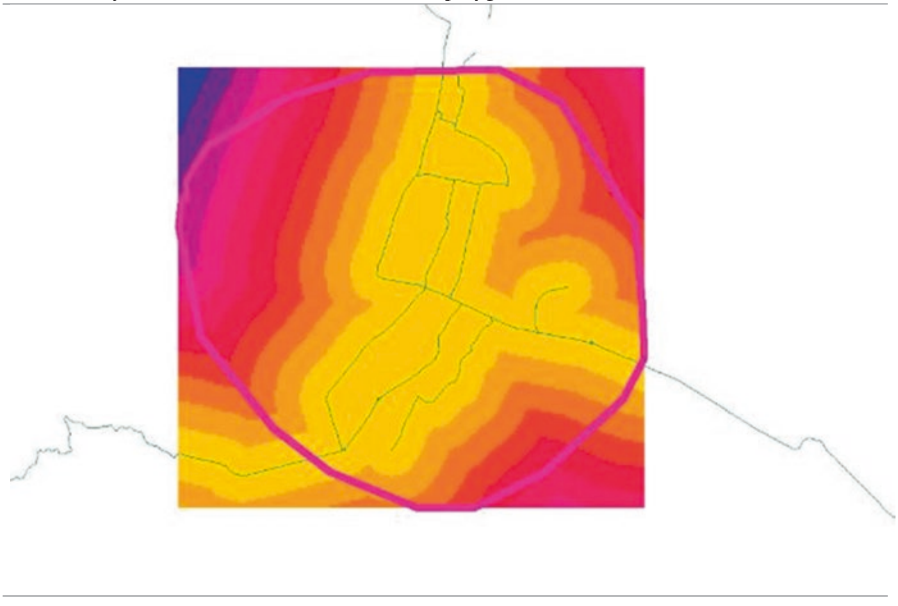


C5: Model predictor layers for Pokhara study area as jpgs and shapefiles
Proximity (Euclidian Distance) to Waterway polygon for Pokhara

Proximity (Euclidian Distance) to Shop polygon for Pokhara


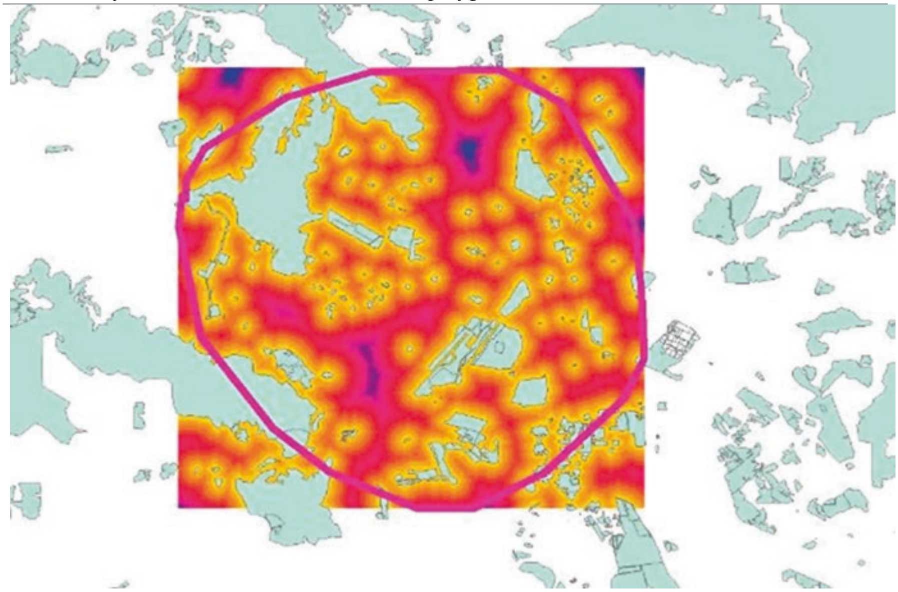
Proximity (Euclidian Distance) to Highways for Pokhara



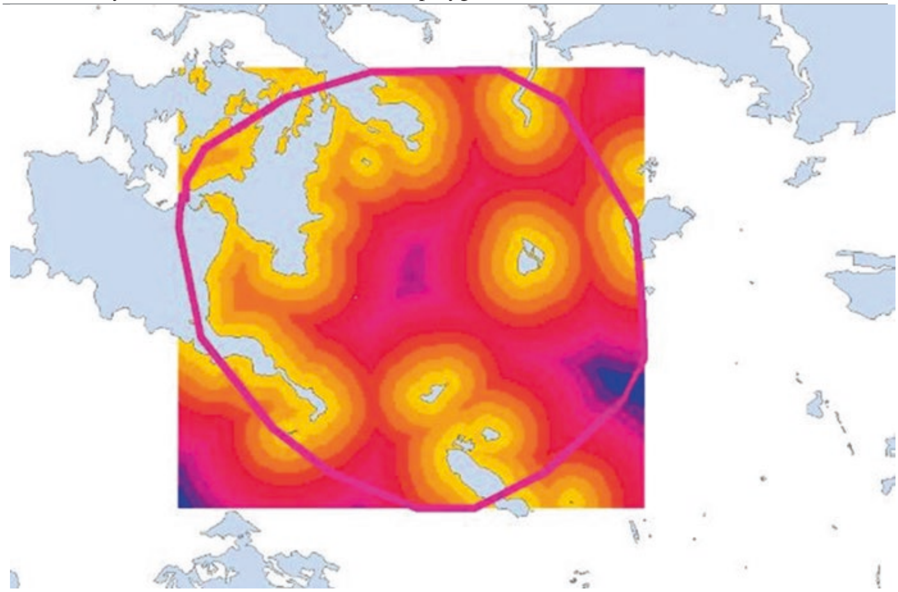
Proximity (Euclidian Distance) to Route line polygon for Pokhara



Proximity (Euclidian Distance) to Landuse polygon for Pokhara



Proximity (Euclidian Distance) to Natural polygon for Pokhara



C6: Model prediction layers for Kathmandu study area as ESRI grid files (these grids and files C6–C9 are shown in the manuscript in figures and listed here for completion of the GIS layers)
IDW grids for predicted species abundance for Kathmandu
IDW grids for predicted species diversity for Kathmandu

C7: Model prediction layers for Pokhara study area as ESRI grid files
IDW grids for predicted species abundance for Pokhara
IDW grids for predicted species diversity for Pokhara
C8: Model infrastructure and base layers for Kathmandu as shapefiles
Study area outline polygon for Kathmandu
Prediction Lattice (regular-spaced point grid) for Kathmandu
C9: Model infrastructure and base layers for Pokhara as shapefiles
Study area outline polygon for Pokhara
Prediction Lattice (regular-spaced point grid) for Pokhara

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Chapter 19
Pallas's Cat in Annapurna, Nepal: What We Know Thus Far and What Is to Come

Ganga Ram Regmi, Falk Huettmann, Tashi Rapte Ghale, and Rinzin Phunjok Lama

19.1 Background

The Pallas's cat (*Otocolobus manul;* Taxonomic Serial Number TSN 183791) is a small wild cat species which is distributed in the grasslands and montane steppe and cold and arid environments of Central Asia but it has relatively specialized requirements within those landscapes. It has been classified as 'Near Threatened' in the IUCN Red List of Threatened Species due its habitat degradation, prey-base decline and hunting (Ross et al. 2008). It has been listed in CITES Appendix II. Likely, in evolutionary terms the Pallas's cat is an early and ancient species and has a rather simple and so-called 'naïve' immune system. That would mean that in modern times it just can survive the new 'onslaught' of stressors and diseases in retreat areas and refugia such as remote deserts and higher altitudes with rugged terrains, e.g. near glacier areas.

19.2 Discovery in Nepal

Pallas's cat, also called the Manul, has been very recently discovered in Annapurna Conservation Area (ACAP), Nepal. In Nepal this elusive cat was discovered by field biologist and citizen scientist Mr. Tashi R. Ghale in Manang in 2012 for the first

G. R. Regmi (✉) · T. R. Ghale · R. P. Lama
Third Pole Conservancy, Kathmandu, Nepal
e-mail: gangarregmi@gmail.com

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department,
University of Alaska Fairbanks, Fairbanks, AK, USA

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time. The Pallas's cat was captured in camera traps set by Tashi R. Ghale for snow leopard monitoring conducted by Snow Leopard Conservancy along with ACAP/NTNC. In honour of discoverer Tashi R. Ghale, we have proposed the Nepali name of the cat as "Tashi Biralo" (Tashi: Good luck; Biralo: Cat). The word Tashi is very well respected in the Himalayan Buddhist culture which refers to 'good fortune or good luck'.

19.3 Status in Nepal

Recent information and photographic evidence of the cat's hide in 1988 (Lama et al. 2016) suggest that the Pallas's cat occurred in Nepal earlier but got lost. It used to be hunted in the past decades in Nepal just like in other range countries too. In Nepal this species is currently recorded only in Manang (Shrestha et al. 2014; Lama et al. 2016) thus making this species very rare and a habitat specialist. Historic records from over 300 years ago might exist but await their confirmation still. Habitat loss due to over-grazing from livestock and increasing human disturbances in Pallas's cat habitat are presumed key threats to this cat in the area. Therefore, it is very urgent to reduce these threats for the Pallas's cat through research and conservation activities in the Annapurna Conservation Area (ACA).

19.4 Pallas's Cat Research and Conservation: History and Current Project in Nepal

19.4.1 Activities and Methodology

19.4.1.1 General Study Design and Grids

Based on the available literature from the other study carried out in Mongolia, Russia and Iran, the Pallas's cat has a wide annual home range. It lives approx. Between 3000 and 5000 m asl in the Himalayas. Based on this information, all areas between 2900 and 5100 m asl in Annapurna Conservation area were divided into 2×2 km^2 bins using ArcGIS. All studies we conducted i.e. interview surveys, sign surveys and camera trappings were carried out within these systemic and well-designed grids for better coverage and for collecting robust and scientifically sound data in this rugged and vast landscape.

19.4.1.2 Interview Surveys

Semi-structured interview surveys were carried out with local nomadic yak herders to generate basic and historical information about the Pallas's cat in the study area. The local nomadic yak herders usually live with their yaks in and around the Pallas's cat habitat to graze their cattle in the highland pastures throughout the entire year. Therefore, they are great source of information about the species in such high-altitudes. It probably is the best survey resource available (Fig. 19.1).

19.4.1.3 Sign Surveys

Transect-restricted sign surveys were carried out to search for the pug marks and snow tracks- the primary signs (Fig. 19.2).

19.4.1.4 Camera-Trapping

We think that camera-trapping might well be the most reliable and the latest available techniques to detect and study cat species in the wild (Ancrenaz et al. 2012). Therefore, automatic infra-red cameras were deployed in the suitable place inside the well-designed bins to obtain first pres/abs data, abundance and activity patterns of the species. The results obtained from camera trapping surveys are expressed as

Fig. 19.1 Interview with a local herder. (Photo Credit: Tashi R. Ghale)

Fig. 19.2 The team searching Pallas's cat tracks in Manang. (Photo: Tashi R. Ghale)

Fig. 19.3 Tashi R. Ghale installing a remote camera to monitor Pallas's cat and other predators in Manang. (Photo: Ganga Ram Regmi)

no. of photo captures/100 trap nights which is also known as RAI - Relative Abundance Index (Henschel and Ray 2003). On the basis of the replicated camera trap events, naïve occupancy for Pallas's cat as well as other sympatric carnivores in the study area was obtained. These are the first estimates ever collected for Nepal and this species (Fig. 19.3).

19.5 Results

19.5.1 Interview Survey

More than 150 locals and herders from nine VDCs (Manang VDC, Tenki Manang VDC, Braka VDC, Khangsar VDC, Pisang VDC, Ngwal VDC, Gyaru VDC, Nar VDC and Phoo VDC) from the wider Manang district were interviewed using colour photo plates regarding presence of Pallas's cat in the area. Only two people; K. Gurung (Male, 59) from Manang village and K. S. Gurung (Male, 55) from Braka village have seen this cat. This makes for important social evidence on the presence of Pallas's cat in Manang district. Through the interview survey we came to confirm the presence of cat only in the Ngyeshang valley and where we focused our entire camera trapping efforts.

19.5.2 Sign Survey

Transect-restricted sign surveys were carried out to search for pug marks and snow tracks- the primary signs of Pallas's cat field occurrence. In total approximately we covered more than 250 km distance throughout the Manang region but no sign of Pallas's cat sign was found. Few suspected scats were found but consultation with other experts suggest those are of mustelides. During the course of transect surveys, abundant snow leopard signs (Scrape, faces, pugmark, kill sites) were also detected. Even though Pallas's cat and snow leopard are sharing habitat in Manang, Pallas's cat is extremely rare making it very difficult to sight.

19.5.3 Camera Trapping

Using remotely-triggered camera traps (Bushnell Cam Trap HD), we explored the Pallas's cat pres/abs and carnivore diversity in trans-Himalayan Manang valley. The camera trap survey was carried out between December 2014 to May 2015 and consisted of a total survey effort of 1940 camera trap days in 20 camera trap sites. The camera trap sites were distributed along the altitudinal gradients ranging from 3512 m asl to 5073 m asl (Table 19.1, Fig. 19.4).

Overall, the study revealed a total of seven carnivore species for the area: Snow leopard (*Panthera uncia*), Golden jackal (*Canis aureus*), Gray Wolf (*Canis lupus*), Red fox (*Vulpes vulpes*), Pallas's cat (*Otocolobus manul*), Beech marten (*Martes foina*) and Mountain weasel (*Mustella altaica*). Pallas's cat is the new cat species detected for Nepal across survey methods. We assumed the independent picture of each species at each camera trap locations for every 60 min (which is called a PERIOD, Sanderson and Harris 2013). Based on the independent pictures (=one

Table 19.1 List of elevations and camera trap locations for Pallas's cat study

SN	Elevation (m asl)	Location	Det/non-det of Pallas's cat
1	3512	Gangapurna Lake	Non-detected
2	3742	Gunsang Base	Non-detected
3	3842	Mephra Ridge	Non-detected
4	3859	Pocho Tong Base	Non-detected
5	3963	Ponga Ridge	Non-detected
6	3988	Tangtisa	Detected
7	3992	Praken	Non-detected
8	4031	Gyanjang	Non-detected
9	4218	Shing Tong	Non-detected
10	4232	Shya Kang	Non-detected
11	4250	Thorkya Ridge	Non-detected
12	4263	Thorkya	Non-detected
13	4340	Kyarken	Detected
14	4436	Puchen Base	Non-detected
15	4523	Gyanjang Po	Non-detected
16	4590	Pripche	Detected
17	4644	Angumilapche	Detected
18	4706	Angumilapche Ridge	Detected
19	4895	Pripche Po Ridge	Non-detected
20	5073	Yaphur	Detected

Fig. 19.4 The Pallas's cat det/non-detected camera trap sites

record of each species per location per PERIOD), the Beech marten appeared to be the species with most abundant relative species index (RAI = 34.02) followed by Red fox (RAI = 29.21), Snow leopard (RAI = 23.71), Pallas's cat (RAI = 7.56), Mountain weasel (2.75), Golden jackal (RAI = 1.37) and Gray wolf (1.37) (Table 19.2, Fig. 19.5).

Table 19.2 Relative Abundance Index (RAI) of Pallas's cat and other sympatric carnivores

SN	Species	Relative Abundance Index (RAI)[a]
1	Beech marten	34.02
2	Golden jackal	1.37
3	Mountain weasel	2.75
4	Pallas's cat	7.56
5	Red fox	29.21
6	Snow leopard	23.71
7	Gray wolf	1.37

[a]Note: RAI = One record of each species per location per PERIOD
PERIOD = Independent picture of each species at each camera trap locations in every 60 min

Fig. 19.5 Pallas's cat photographed by remote cameras. (Photo: Tashi R. Ghale)

19.6 Conclusion and Future Directions

Our camera trap survey has revealed important and new information about the carnivore diversity and their relative abundance index. It shows them in surprisingly high numbers indicating the presence of food to sustain them. A high prey availability can be concluded; a larger and viable ecosystem is found there for them. Knowing distributions will be crucial for planning future surveys and understanding detailed ecology, behavior and conservation threats to these carnivores in the area including the new cat – the Pallas's cat. These first preliminary findings presented here will also be helpful for protected area managers to implement effective conservation actions for these carnivores to regulate the high-altitude ecosystems in the region. More research on that issue is coming forward to benefit this species!

The Pallas's cat is threatened mainly from loss of habitat because of high density of livestock grazing, prey base decline from hunting and competition with livestock. Advanced issues like infanticide, immune deficiencies, dispersal, social structure and turn-over as well as ally effects are not well studied but assumed to occur as well. So far, just very limited studies exist in the region in regards to disease and climate change.

Clearly, the wider Manang valley is the potential habitat for the Pallas's cat. However, due to the year round heavy grazing in its habitat, its habitat has been degraded and modified by people and associated actors. Therefore, the community outreach and conservation programs should be started quickly to ensure the survival of this rare cat in this area. Herder communities should particularly be educated about the Pallas's cat in the region. Since the status and information on this cat is still largely unknown in the Annapurna Conservation Area and other parts of Nepal and in the Himalaya, besides the conservation activities, regular monitoring of the cat using camera traps, sign survey and interviews will help to generate the ecological and behavioral data on the species for a better science-based conservation management in the Anthropocene.

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Chapter 20
Status of Otters in Nepal: A Link with Ancient Waterways and People

Rohit Raj Jha, Thakur Silwal, Grace M. Yoxon, Kabindra Shahi, Harisharan Nepali, and Aashish Kumar Joshi

20.1 Background

One third of vertebrate species in the world are restricted to freshwater habitats, making freshwater ecosystems a requirement for global biodiversity (Dudgeon et al. 2006). But human-driven modifications in natural river systems are strongly affecting aquatic biodiversity (Dudgeon et al. 2006; Vörösmarty et al. 2010). Anthropogenic factors causing severe fragmentation of natural landscape (Rodgers 1985) and the population of animals living in those landscapes are being restricted to small fragmented patches throughout its distribution; they are confined mostly to protected areas (Hussain and Choudhury 1997; Nawab and Hussain 2012). Otters are those wildlife species of river ecosystems which occupy the position of apex predators and they function as the key links in nutrient cycling between aquatic and terrestrial systems (Ben-david et al. 2011). Otters have inhibited the earth for last 30 million years and over the years subtle changes to the carnivore bodies have occurred to exploit the rich aquatic environment (IOSF 2018).

Otters are members of the mammalian family Mustelidae which live a semi-aquatic life (Duplaix and Davis 1981). They are top predators and important biological indicators of the health of the semi-aquatic ecosystems like wetlands and riverine forests (Hussain and Choudhury 1997; Zhang et al. 2018 for Asia). Out of 13 species of otters that are found in the world, 3 species are found in Nepal: (1)

R. R. Jha (✉) · T. Silwal · K. Shahi · H. Nepali · A. K. Joshi
Institute of Forestry, Tribhuvan University, Pokhara, Nepal
e-mail: rohitrajjh@gmail.com

G. M. Yoxon
International Otter Survival Fund, Broadford, UK

G. R. Regmi, F. Huettmann (eds.), *Hindu Kush-Himalaya Watersheds Downhill: Landscape Ecology and Conservation Perspectives*,
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Eurasian otter, *Lutra lutra*; (2) Smooth coated otter, *Lutrogale perspicillata* and (3) Asian small-clawed otter, *Aonyx cinerea* (Acharya 1997). All of those are affiliated with river systems!

20.2 Brief Summary of Otters Found in Nepal

*20.2.1 Smooth Coated Otter (***Lutrogale perspicillata***)*

Smooth coated otter (taxonomic serial number TSN 621919) is the only extant representative of the genus *Lutrogale* and as its name indicates, the fur of this species is smoother and shorter than that of other otters (Myers et al. 2018).

20.2.1.1 Global Distribution

Smooth-coated otters are Palearctic and oriental species (Chanin 1985). They are found throughout much of southern Asia, from India eastward and there is an isolated population found in the marshes of Iraq (Acharya and Rajbhandari 2012).

20.2.1.2 Distribution in Nepal

In Nepal, smooth coated otters have been recorded from major river basins of Nepal namely; Koshi, Narayani, Karnali and Mahakali (BPP 1995; Evans et al. 1985). In Nepal, although the distribution of Smooth coated otter is poorly known (Acharya 2006), Suwal and Verheugt (1995) reported this species from Annapurna Conservation Area, Makalu Barun National Park, Bardiya National Park, Chitwan National Park, Shuklaphata National Park and districts of Kailali and Kanchanpur. Riverine ecosystem represented by Karnali and Geruwa rivers of Bardiya district of Western Nepal including wetland sites: Geruwa, Khaura, Bathani, Patkanau, Banjara Ghat, Gaidamachan area, LamakTaal, Bagaura Phant inside Bardiya national Parks have been found to be good habitats for otters (Thapa 2008).

20.2.1.3 Physical Description

Smooth coated otters, weighing from 7–11 kg as an adult and up to 1.3 m in length are the largest otters in Southeast Asia (Chanin 1985). Their fur is shorter and smoother than other otters appearing velvety and shining and has short, tightly packed under fur and longer water repellent guard hairs (Mason and Macdonald 1986). Smooth coated otters are distinguished from other otters by their rounded heads, prominent naked noses, and flattened tails (Kruuk 1995; Nowak 1991). Their nose resembles an upside down v, or a distorted diamond (Myers et al. 2018). Like other otters, they have webbed feet and strong dexterous paws that are armed with sharp claws (OTTERNET 2018).

20.2.1.4 Conservation Status

Smooth-coated otters are listed as vulnerable on the IUCN Red list of Threatened Species (IUCN 2018a) and are listed in Appendix II of the CITES. Globally, the population of this species of otter is in decreasing trend (de Silva et al. 2015). In Nepal they are protected by Aquatic Life Protection Act, 2002 but Government of Nepal has not yet included this species in protected list of National Park and Wildlife Protection Act, 1973.

*20.2.2 Eurasian Otter (***Lutralutra***)*

Lutralutra (taxonomic serial number TSN 621916) are basically solitary animals with only temporary pairing of mates or mothers with their young, although they are sometimes found in loosely knit groups of up to six animals (Kenendy 2003).

20.2.2.1 Global Distribution

Eurasian otters are Palearctic species and inhibits most of Eurasia south of the tundra line and North Africa (MacDonald 1984). They are distributed in mountain streams, rivers and lakes (Acharya 2006). This particular species of otter is essentially an otters of cold montane conditions (Parter 1971).

20.2.2.2 Distribution in Nepal

In Nepal, this species have been reported from Annapurna Conservation Area, Makalu Barun National Park, Rara National Park, Bardia National Park and from districts Saptari, Chitwan, Kailali, Kanchanpur, Bajura, Bajhang, Ilam, Panchthar, Taplejung and Sankhuwasabha (BPP 1995). This species have also been recorded from Kanchanjunga region and West Seti River (Yonzon 1996, 1998). Along the banks of the lakes which are covered with ferns, the burrows of this species have been discovered (Acharya and Gurung 1991, 1994).

20.2.2.3 Physical Description

The Eurasian otter is the typical species of the otter subfamily (Lutrinae). These long slender creatures with brown above and cream below are well equipped for their aquatic habits (Wikipedia 2018b). This otter differ from North American river otter by its shorter neck, broader visage, the greater space between the ears and its longer tail (Godman 1836). This species is 57–95 cm long, excluding the tail of 35–45 cm. The female being shorter than the male (Kruuk 2007). The average body weight is 7–12 kg although occasionally a large old male may reach up to 17 kg (Wikipedia 2018b).

20.2.2.4 Conservation Status

Eurasian otters are listed as Near Threatened on the IUCN Red List and globally, their population is in decreasing trend at present (IUCN 2018c). They are mentioned under Appendix I of the CITES

*20.2.3 Asian Small-Clawed Otter (***Aonyx cinerea***)*

The Asian small-clawed otter (taxonomic serial number TSN 726276), also known as oriental small clawed otter or simply small-clawed otter, is a semi-aquatic mammal native to South and Southeast Asia (Wikipedia 2018a). It lives in extended family groups with only the alpha pair breeding; offspring from previous years help to raise the young (Wikipedia 2018a).

20.2.3.1 Global Distribution

Asian small-clawed otter is oriental species and is found in coastal regions from southern India to the Malay Peninsula and southern China (Nowak 1991; Timmis 1971). It inhibits freshwater wetland systems such as swamps, meandering rivers, mangroves and tidal pools as well as irrigated rice fields (Wikipedia 2018a).

20.2.3.2 Distribution in Nepal

Occurrence of Asian small-clawed otters were reported in Nepal, China and India but its exact locality in Nepal was not mentioned by Hodgson (1839). Later on BPP (1995) mentioned it to be found in Kailali and Kanchanpur districts. Since the information available about this species is very limited, the actual distribution of the species is still unknown in Nepal.

Photo 20.1 A group of smooth-coated otters swimming in a river in Bardiya National Park (Photo credit: Aashish Kumar Joshi)

20.2.3.3 Physical Description

Asian small-clawed otterweighing between 2.7 and 5.4 kg, have a combined head and body length of 40.6–63.5 cm, and a tail length of 24.6–30.4 cm (Mason and Macdonald 1986). They have dark greyish-brown fur over most of their body, and a lighter cream coloration on their face and neck (Hamman 2004). The paws are only partially webbed, which allows for more dexterity than otters with full webbing (Timmis 1971).

20.2.3.4 Conservation Status

Asian small-clawed otters are listed as Vulnerableon the IUCN Red List and globally, their population is in decreasing trend at present (IUCN 2018b). They are mentioned under Appendix I of the CITES (Photos 20.1, 20.2, and 20.3).

20.3 Threats to Otters

Otters need freshwater ecosystem for feeding and adjacent undisturbed forest and scrub near water for dwelling (Bhandari 2017). Loss of wetland habitats due to construction of large scale hydroelectric projects, encroachment of wetlands for settlements and agriculture, diminishing prey biomass, poaching and contamination of water ways by pesticides are continuously deteriorating freshwater ecosystem

Photo 20.2 Otters use bushy vegetation along the stream for making holts (Photo credit: Aashish Kumar Joshi)

Photo 20.3 Otters inspecting researcher and team after reaching the opposite bank of the river (Photo credit: Aashish Kumar Joshi)

and nearby forest which impose major threats to otters and other freshwater animals (Joshi 2015; Khanal et al. 2016, Zhang et al. 2018). Apart from these, overfishing, poisoning, industrial pollution, sand and boulder extraction are also causative agents assisting in declining otters population (Acharya and Rajbhandari 2012).

Distribution Status of Smooth Coated Otters (*Lutrogale perspicillata*) *and* Anthropogenic Factors (A Case Study from Karnali Corridor, Nepal)

This was a dissertation work done for the partial fulfillment of B. Sc. in Forestry degree at Institute of Forestry, Pokhara. This project was done under the supervision of Thakur Silwal, PhD. (Assistant Professor at IoF Pokhara) and was financially supported by International Otter Survival Fund (IOSF), UK.

"The otter population is rapidly declining due to increasing human pressure on its habitat, particularly in South and Southeast Asia. In Nepal, reliable information on its distribution and factors affecting its distribution is inadequate, hindering conservation measures. This study was carried out to look at the distribution of otters along the Karnali corridor and to assess the anthropogenic factors. This corridor lies both inside and outside of the Bardia National Park.

Forest patches along both rivers banks, where the rivers have a variety of fish species, create an ideal home for the otters. But continuously increasing human population density and the dependency of local *Tharu* and *Sonaha* communities on the forest and rivers is leading to indiscriminate felling of trees and excessive fishing. In addition, river banks are being converted into farm fields so limiting otter habitat to small fragmented patches.

Although there have been studies on otters in this region, these were largely focused inside Bardia National Park and little is known about the distribution and population status of otters in corridor areas and outside the Park. Assessing the influence of different ecological and anthropogenic factors such as habitat type, fishing, and sand excavation from the river bank, etc. on otter distribution is critical to designing effective conservation measures.

The river banks were surveyed for otter signs (e.g. spraints, footprints, tracks, holts, food remains) and habitat types and human activities were also recorded. It was found that the otters prefer dense shoreline vegetation with closed canopy. All the signs recorded were from inside the Park or along the boundary and none were recorded outside the Park, where local indigenous communities live. These people are involved in extensive fishing and hence diminishing prey biomass for otters. Other activities also reduce suitable habitat – over-grazing, tree logging, fodder collection, sand excavation and gold sieving.

Local fishing communities and nature tour guides were interviewed to assess their perception towards conservation and their understanding of otter

(continued)

distribution, potential conservation threats and their recommendations for conservation. Most people had seen smooth-coated otters and they reported a decreasing trend of otter numbers due to the drying out of rivers and food scarcity. They felt that human disturbance in the form of logging, sand excavation and intensive fishing all had a negative effect on otters.

This study suggests that there is a need to create more awareness about the otters and their habitat. In addition, there needs to be regulation of fishing, logging and sand excavation. Research findings need to be taken into consideration when developing Park strategies and management plans for otter conservation.

Training tour guides about the species can be helpful in bringing otters into main stream eco-tourism like other mega species. A useful tool can be tourism advertisement boards displaying otters and celebrating International Otter Day."

20.4 Outlook for Otters in Nepal

The low land rivers of Nepal which mostly associate forest patches along the banks and plentiful of varieties of fish species in the rivers create ideal home for smooth coated otters. Similarly, mid-hills and mountain lakes fulfill the requirements for Eurasian otters in Nepal. For centuries, these rivers and lakes have been well mentioned for freshwater biodiversity including otters. But continuous exploitation of rivers and lakes over years, changing of direction of flow of rivers for hydroelectric and irrigation projects, sedimentation of the rivers, intensive fishing, poisoning have altered the habitat quality and subsequently diminishing the suitable habitats for otters. A study carried out in Koshi Tappu Wildlife Reserve by Acharya in 2002 with UNDP came up with no signs and evidence supporting otter presence in the reserve. The signs obtained through regular field surveys in Narayani River over years have suggested that the otter mobility and distribution in the river is continuously diminishing (Acharya and Rajbhandari 2012). Even in the Karnali River corridor, several studies over years have suggested that in the corridor the otter habitat is spontaneously decreasing and it is being limited in the small fragmented patches inside the boundary of Bardiya National Park (Bhandari 2017; Jha 2018; Joshi 2015). In the lakes of Pokhara valley which are recorded to be good habitats for Eurasian otters is being adversely affected by encroachment and eutrophication of lakes, deposition of waste, invasive species infesting the lakes etc. and as a result population status of otters has been very critical and hence sighting of the species which once was very common is very rare these days (Acharya 1994; Acharya 1997, 2006). Otter occupancy is negatively associated with agriculture and urban cover and thus the remaining natural patches appear to act as critical refuges for otters (Kamjing et al. 2017). The effects of climate change is altering the habitat quality for most of the species including that for otters throughout its habitat (Duplaix and Davis 1981).

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Chapter 21
Wildlife Diplomacy and Gifting in the Hindu Kush-Himalaya Region: A Chronological History and Opinion of Nepalese Literates

Tirth Raj Ghimire, Anita Bhattarai, Nirju Ojha, Pitamber Pant, and Sagar Aryal

21.1 Background

It is a widely believed and misleading myth that animals are the symbols of power (e.g., lion and tiger), strength (e.g. Rhinoceros, Elephant), beauty (e.g. Swan, Red Panda), love (e.g. the Swan, Dolphin, Horse), luck (e.g. Ladybug, Pig), peace (e.g. Dove), wisdom and magic (e.g. Fox), leadership (e.g. Wolf), loyalty (e.g. Dog), intuition (e.g. Owl), freedom (e.g. Horse), fertility (e.g. Rabbit), creativity (e.g. Sea Lion), activity (e.g. Squirrel), purification (e.g. Sheep), bad luck (e.g. Black cat), gentleness (e.g. Deer), and scrutiny (e.g. Mouse). Many of these animals have been used as diplomatic gifts around the world including Nepal since time immemorial. Thus, it is possible to establish that foreign policy of Nepal is linked to Wildlife Diplomacy. To enhance the dignity of the nation through safeguarding sovereignty, territorial integrity, independence, and promoting the economic well-being and

T. R. Ghimire (✉) · A. Bhattarai
Animal Research Laboratory, Faculty of Science, Nepal Academy of Science and Technology (NAST), Lalitpur, Nepal
e-mail: tirth.ghimire@nast.gov.np

N. Ojha
School of Environmental Science and Management (SchEMS), Pokhara University, Kathmandu, Nepal

P. Pant
Tri-Chandra Multiple Campus, Tribhuvan University, Kathmandu, Nepal
e-mail: pant.pitamber@gmail.com

S. Aryal
Central Department of Microbiology, Tribhuvan University, Kirtipur, Kathmandu, Nepal

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prosperity of the country are her fundamental objectives (MoFA 2018). This chapter aims to review such gifts in the world including Nepal and to evaluate whether gifting animals to another world would enhance the current relations or foreign policy. To understand the public views of undergraduates, graduates, and faculty members from various colleges, universities, and academies, a structured questionnaire was prepared and asked them to reply anonymously.

21.2 Wildlife Diplomacy Around the World

Wildlife diplomacy is defined as the generic use of live native flora and fauna for diplomatic purposes, although in this investigation we focused on faunal diplomacy. The use of faunal diversities can, for instance, be achieved via gifts, via exchange as a subtle gesture, or via loans (Hartig 2013). Although fauna and diplomacy have been closely linked throughout a long history, it is not easy to compile all of the chronologic evidence. Ever since the beginning of humankind civilization and history, many countries have used animals, particularly the exotic ones, as a symbol of power and diplomacy. For example, Amarna Letters, written on clay tablets in Akkadian cuneiform in a Mesopotamian style, indicate the recorded instance of animals as diplomatic gifts during 1360–1332 BC (Hartig 2013). Fauna as ceremonial gifts, tributes signaling submission or alliance, bribes or reparations from local rulers were presented in ancient Egypt (Baratay and Hardouin-Fugier 2004). Such animal tributes were practiced by the heads of inferior or less developed states to influence and please the more powerful countries (Veltre 1996). In all periods of history, Egypt was the center for giraffes which then were supplied to the Romans, the emperors of Byzance, the Arab Caliphs, to Spain and Italy in the Middle ages, and to Italy, France, and England in more recent times (Laufer 1928) indicating the existence of its infamous Giraffe Diplomacy. A remarkable example of animal diplomacy called the 'Panda Diplomacy' adopted by China is invaluable in making better relations with Japan to which a pair of Giant Pandas was sent by Empress Wu Zetian (625–705) of Tang Dynasty, and later with the USSR to which only one Panda in 1950s sent by the government of China (Schaller et al. 1985; Rybka-Iwanska 2018). China also gifted a pair of Giant Pandas to the US president Richard Nixon during his historic and strategic visit to Beijing in 1972 (Rybka-Iwanska 2018). Then, the US gifted musk oxen to China (Accessed from: https://www.thehindu.com/todays-paper/tp-in-school/animals-as-diplomats/article17363971.ece, accessed on: August 15, 2018). Although China's Panda Diplomacy was initially confined to other communist countries to strengthen relations as allies, China also gifted the pandas to the UK, France, and many other countries to enhance the relationships. Therefore, the government of China was highly successful in improving relations with the West and in their public diplomacy. However, due to the scarcity of the Giant Pandas, the Chinese government in 1982 decided to follow the Panda Loan Principle rather than already applied Panda Gifting Theory (Hartig 2013). According to this principle, Giant pandas would be available on loan at rates of over

$US1 million a year and a provision that any cub born during the loan is the property of the China (Lumpkin and Seidensticker 2002) (Accessed from: https://www.thehindu.com/todays-paper/tp-in-school/animals-as-diplomats/article17363971.ece, accessed on: August 15, 2018). In this way, the Giant Pandas are regarded as a political symbol and for cooperation between China and the receiving country. They are the tools for enhanced scientific and technologic cooperation, and are the main sources of soft power and public diplomacy. In this case the panda becomes entangled in ideologies, whereas this animal and its biology is as unpolitical as it gets.

Like China's Panda Diplomacy, Australia followed a Koala Diplomacy which was displayed at the 2014 G20 leader's meeting in Brisbane and Koalas were gifted to Barack Obama and Vladimir Putin (Arup 2014). Since then, the Department of Foreign Affairs and Trade produced a 600-page long Koala Diplomacy (Arup 2014).

And an exciting Crocodile Diplomacy has been created by Australia's Northern Territory to enhance the relations with Britain. The Territory's chief minister gifted Prince George (Duchess of Cambridge) with a baby crocodile that had been hatched from its egg the day that Kate publicly announced she was pregnant with George (Brady 2016). As an emblem for engagement of William and Kate, they were presented with a pair of crocodiles by Darwin, the territory's capital (Brady 2016).

Elephant Diplomacy is also famous among the political leaders of South and Southeast Asian countries especially to initiate and enhance diplomatic relations with China. For example, Vietnamese leader Ho Chi Minh gifted Mao Zedong two Asian elephants in 1953 and then one elephant in 1960 (Rybka-Iwanska 2018). The Sri Lankan Government gifted a total of 3 elephants in 1972, 1979, and 2007 indicating its initiation of diplomatic ties with China (Rybka-Iwanska 2018). Although opposed and petitioned by many conservationists and animal rights activists, for the ban of export of elephants outside Sri Lanka (Trevett 2016), its government gifted two elephants to New Zealand in 2015 and 2016.

Dragon Diplomacy was practiced by the Indonesian President, Mr. Suharto, who gifted Komodo dragon to Lee Kuan Yew of Singapore in the 1980s and the then US President George HW Bush in 1990 (Rybka-Iwanska 2018).

Horse Diplomacy is famous in Asia for thousands of years. Turkmen leaders presented Akhal-Teke horses, the breeds from Turkmenistan, to Jiang Zemin in 2000, Hu Jintao in 2006 and Xi Jinping in 2014 (Rybka-Iwanska 2018). The Mongolian Prime minister gifted a horse to Narendra Modi who could not be able to take it to India because, in 2005, the Ministry of Environment and Forests had banned the practice of gifting animals as diplomatic niceties although the government used to practice several two-way exchanges of animals in India previously (Mohan 2015).

The International Association for Falconry and Conservation of Birds of Prey (IAF) has described the history of Falconry and associated diplomacies around the globe (IAF 2018). During the tsarist era, falcon rearing and hunting were popular among Russian nobles because these birds were the symbol of prestige, beauty, and power. These birds were also used as an essential diplomatic tool by the Russian tsar and thus, they were gifted to the East and West to fellow monarchs (Sputnik 2013). In the late Middle Ages, Falconry Diplomacy in Europe was famous because falcons used to be caught from Iceland, Norway, the Arctic parts of Russia, and

Greenland and brought to Europe, e.g. gyrfalcons. They used to be exchanged or gifted, or borrowed for the release of prominent prisoners, the safeguarding of property, and the blessing of the war threat (Hilmar-Jezek 2017).

It has been written that in the thirteenth century, the German Frederick II (1220–1250), Holy Roman Emperor and the King of Sicily employed Arab, English, German, and Italian falconers, and translated Arab and Asia falconry works. His court in Sicily used to get falcons from Flanders, Germany, Russia, Switzerland, Norway, Sicily, Corsica, Sardinia, the Balearic Islands, Spain, Turkey, Alexandria, the Barbary States, and India establishing a link between Arabians with European traditions (IAF 2018). An entire profession and trade developed 'hammering' falcon populations to appease the royals! This also included the use of golden eagles, as wide-spread in Mongolia and Kazakhstan, for instance, for hunting wolfs. Falconry became a means of cultural communication and represented a social and political power, a deadly dangerous pastime, and big business. However, after the seventeenth century, especially after the French revolution putting people and democracy in charge, the use of falcons as diplomatic gifts gradually decreased (IAF 2018). Falconry was combined with legal and military affairs, diplomacy and land colonization and moved accordingly, reaching Korea in 220 BC and Japan much later (IAF 2018). Nowadays it's mostly practiced by the Arabs, e.g. in Saudi Arabia (for bustard hunting for instance) and drives much of the trade and even western science (e.g. https://www.falcons.co.uk/about.asp). In the western word is remains mostly a peculiar hobby for people who can afford it.

It has been believed that Hunting Diplomacy for pride, prestige, and nobility was popular during ancient Romans. For example, under Caligula (37 AD–41 AD), 400 bears in a day, under Claudius (41 AD–54 AD), 300 bears in 2 days, and under Nero (54 AD–68 AD), 400 bears and 300 lions and under Titus (79 AD–81 AD) at the dedication of the Colosseum, 5000 animals in a day were killed (Lecky 1921). Trajan (98 AD–117 AD) murdered 11,000 animals including lions, tigers, elephants, rhinoceroses, hippopotami, giraffes, bulls, stags, crocodiles, and serpents within 123 successive days to celebrate his conquest of Dacia (Jamieson 1985). Their passion for the game was evidenced by their hunting of the first rhinos presented by Indian ruler to Caesar Augustus (27 BC–14 AD) in Rome (Jamieson 1985). They would keep extensive collections of animals as a sign of their power which they would show on occasion by their massacre. In 1719, Elector Augustus II of Dresden killed tigers, lions, bulls, bears, and boars (Jamieson 1985).

Although Wildlife Diplomacy was practiced among various countries, its efficacy to keep peace and harmony was null in some trail of the history. For example, from 1914 to 1918, due to political, territorial, economic conflicts, increased imperialism, the growth of nationalism, and other factors, there was conflict between two rival sets of powers, that is, Germany and Austria-Hungary on one part, and Russia, France, and Great Britain on the other hand although Wildlife Diplomacies were predominant among these countries from the beginning of civilization. Similarly, there the Second World War from 1939 to 1945 among various countries showed that diplomatic relations between many rivalry groups did not maintain the friendship and peace. After the War, despite the different political, religious, and cultural ideologies of the people around the world, their hearts have been gathered by the principle of brotherhood and globalization. It is believed that Wildlife Diplomacy is one of the factors to support and foster this principle, e.g. through zoos!

21.2.1 Wildlife Diplomacy by Nepal

It is interesting to deal with the Wildlife Diplomacy of Nepal because it is perceived as exotic. Also, Nepal had various types of rulers and systems since the beginning of its history. Elephants and horses were critically used as a part of military might for several rulers in the country. During the beginning of the modern era, especially after Prithvi Narayan Shah who initiated the unification of smaller states to present-day Nepal, elephants were widely used during wars. Elephant and Horse Diplomacies were practiced by the Shah Royal Family who donated or gifted these animals to the smaller States of the country. There were two purposes of gifting. Firstly, the Royal family used to please its counterparts so that they would take no further action against the Shah Armies. Second, the Royal Family used to gift those animals to its armies, advisers, supporters, and others because of their direct or indirect role to win the war.

During the 1700s, Prithvi Narayan Shah and his successors restricted trade and diplomatic relations with the British in India and banished foreign traders, missionaries (religious teachers), musicians, and artists influenced by northern India (Zuchora-Walske 2008). His descendants continued the Gurkha expansion and extended Nepal's territory along the Himalayas from southern Kashmir in northwestern India to Sikkim into northeastern India (Zuchora-Walske 2008). However, after the 2-year war with the East-India Company, the Treaty of Sugauli was signed by Nepal and Great Britain in March 1816 and Nepal had to lose most of its lands (Zuchora-Walske 2008; Upadhya 2012). Although it established a diplomatic relationship between these countries, it was the eldest wound and pain for the Nepalese patriots.

History has believed that the survival of Rana families in Nepal is credited to their control of the military power and support and friendship with the British. The association between Nepal and Great Britain was crucial during the reign of Jung Bahadur Rana who theoretically and practically supported the East India Company (Husain 1970). Jung Bahadur used to invite the British guests on hunting parties in the Terai. He asked the Prince of Wales (later King Edward VII) to go hunting in Terai, and he accepted the cordial invitation and visited on January 1876 (Von der Heide 1997). Censoriously, within 2 weeks, the Prince killed and bagged 23 tigers (Chaudhary 2018). After his coronation, King Edward VII, he welcomed Chandra Shamsher, Jung Bahadur's cousin, in 1908 in London where Chandra was accorded with precedence, honors, and salutes as conceded to Jung Bahadur in 1850 (Cowan 2015a). Jung Bahadur also followed the British principles and ideologies to get proper support from England. The first Extradition Treaty was ratified On February 10, 1855, by Jung Bahadur and on February 23, 1855, by Lord Dalhousie and was later signed by Jung Bahadur Rana (Tyagi 1974). Although he was not trusted at the beginning by British, the British Government of India, later on, found that he was intelligent, peaceful, and friendly in spite of his ambitiousness and shrewdness (Tyagi 1974). To keep good relations with the British and to show his power to the British, he sent thousands of troops and restored the British authority over many cities in India (Tyagi 1974). That is why few areas like Banke, Bardiya, Kailali, and Kanchanpur were returned to Nepal as a gift by the British ruler in 1860 indicating the success of Hunting Diplomacy used by Jung Bahadur.

Bir Shumsher believed that ‘England is a power that crushes thrones like potsherds’ (Tyagi 1974). That is why he worked according to the interests of the British resulting in the lack of Nepalese independent foreign policy. In 1890, Bir Shumsher welcomed Prince Albert Victor, the eldest child of the Prince and Princess of Wales and the grandson of Queen Victoria, the British Monarch for an organized hunting expedition in the western end of the Terai (Tyagi 1974; Upadhya 2012). It is believed that when Archduke Franz Ferdinand, the member of the imperial Habsburg Dynasty of Austria and the heir presumptive, wanted to hunt wild fauna in Terai in 1893, Bir Shumsher as a prime minister could not directly welcome him merely due to the pressure to maintain a close tie with Britain and East-India Company (Maratha and Thapa 2016). However, to keep a foreign relation with Austria, in March of that year, Bir Shumsher appointed Commanding Colonel Keshar Singh Thapa to be the chief of the organizing party of hunting expedition for the Archduke (Maratha and Thapa 2016). The Archduke hunted a total of 17 tigers, six leopards, and many swamp deer, boars, antelopes, spotted deer, and blackbucks (Maratha and Thapa 2016). In turn, the Archduke gifted hunting organizers different types of weapons indicating initiation of the right relation with Austria.

During the reign of Dev Shumsher Rana, he sent his brother, Chandra Shumsher, in the hunting expedition of Viceroy of India, Lord Curzon, in Chitwan from March 29 to April 17 in 1901. Subsequently, on June 27, 1901, Chandra seized power from Dev, and this coup has been evidenced that Chandra got permission and supports from Curzon due to their everlasting friendship and a probable deal made during that hunting trip (Upadhya 2012; Cowan 2015a). His policy was loyalty and friendship to East-India Company. Thus, he also assisted Younghusband, head of the Tibet Frontier Commission appointed by Curzon, in invading Tibet by supplying 3000 yaks during an expedition that started on December 1903 (Cowan 2015a). On 2nd January 1905, he was awarded as Knights Grants Commander within the Most Exalted Order of the Star of India (Office 1819).

In 1905, the Prince of Wales, later King George V, would like to visit in Nepal for hunting, however, due to outbreaks of cholera, he could not come in the country. So in 1911, the Nepalese government invited King George V to take part in hunting in the Terai. When the British King George V wanted to visit Terai for hunting in 1911, Chandra Shamsher actually spent months preparing for the King’s visit. For example, 645 elephants were collected for the hunting expedition and bullocks were tied at the edge of thick jungles to allure the tigers. It has been recorded that the team killed 39 tigers, 18 rhinoceros, 4 bears, and several porcupines and leopards within just 10 days (Anonymous 2015; Dunn 2015), and a young rhino was gifted to them by the prime minister of Nepal and subsequently transported to the London Zoo (Rookmaaker et al. 2005).

When the Prince of Wales, later Edward VIII, arrived at Kathmandu for hunting wild animals especially the Tigers in 1921, Chandra Shamsher wanted Nepal to be recognized as an independent and sovereign nation, mainly by modifying few limitations that existed in the Sugauli Treaty. Importantly, the Treaty was discussed in Kathmandu, Delhi, and London for more than a year and a final version (Nepal-Britain Mutual Treaty) was signed on 21 December 1923 in Singha Durbar, Kathmandu indicating a great achievement of the foreign policy of Chandra Shamsher (Husain 1970). Thus, Chandra Shumsher maintained the independent sovereignty of Nepal, loyally assisted by the Viceroy and the British India Company (Tyagi 1974). When Chandra Shumsher heard about the war between Britain and Germany in 1914, Chandra Shumsher sent about 16,500 men and contributed a volunteer expense of war (Tyagi 1974).

When Juddha Shamsher became Prime Minister of Nepal, he continued the Hunting Diplomacy to keep relations with British. Thus, in 1938, with Lord Linlithgow, Viceroy of India, he led a three-week hunting trip to game 120 tigers, 27 leopards, 15 bears, and 38 rhinos (Mulmi 2017).

Hunting diplomacy was not only followed by the Rana Dynasty but also actively used by Shah Kings like Mahendra and Birendra who pursued hunting as a hobby. Both Kings used to kill wild fauna like rhino for a religious ceremony, hunting, and recreational activities (Mishra et al. 2008) although both of them introduced and progressed the laws of wild animals. After returning from the United Kingdom, with the help of the then Royal Nepalese Army, King Mahendra launched his coup on 15 December 1960. He suspended the constitution, dissolved the elected parliament, dismissed the cabinet, and headed the direct ruling system called *a Panchayat hierarchical system of the village*. Although a foreign policy of neutrality between China and India was followed, his relation with the British is believed to be strong. This is because the diplomatic records suggest that although British diplomats used to praise BP Koirala and his ability and quality, rather than concerning over imprisoned Koirala, Britain actually fully supported and cheered the autocratic Panchayat system of the King (Maratha and Thapa 2014). After 15 days of the coup, a big hunting camp, especially for tiger hunt and rhino shooting, was prepared in the Terai for Queen Elizabeth II and Prince Phillip as royal entertainment by King Mahendra during her state visit to Nepal in January 1961 AD (White 2015). It has been reported that none of these royal families shot the tiger, but other associated individuals did it (Rana 2009). It has also been reported that Prince Philip's diplomatically bandaged hand prevented him from taking part, thereby avoiding international controversy. Subsequent royal visits in 1986 strengthened the Nepal-Britain relationship (Choegyal 2016).

Subsequently, hunting companies led by the American John Coapman, African big-game hunter Charles Cottar, and the Irish hunter Peter Byrne were established and Prince Basundhara – the brother of King Mahendra – handed them a hunting concession (Mulmi 2017). However, in 1972, hunting was stopped, with an exception in 1983. The Dhorpatan Hunting Reserve was established gazetting in 1987 to manage a controlled hunting system. The Reserve had been an attractive place for the generals and officials from all over the world and had been usually used for the recreational activities by the foreign delegates. In 1956, a hunting company called Shikar Private Limited was licensed to the retired Commander-in-Chief of Nepal to conduct hunts in selected hunting reserves for the big game hunters coming from abroad (Rana 2009). Although it was a business motive, it is believed that this company somewhat helped to increase the foreign relation. Even though for a conservationist, the Hunting Policy during the Rana and Shah Dynasties was extreme and brutal resulting in the decline of thousands of individuals and numerous species, for a nationalist, the declaration of Nepal as an independent country is excellent and is linked to this very Policy. Another good aspect to be kept in mind is the habitat and landscape protection that was achieved in order to maintain wildlife!

While the government of Nepal has regulated Hunting Diplomacy, another policy called a form of Gifting Diplomacy including the gifts of wild animals like Common leopard (India, Saudi Arabia), Gaur (Saudi Arabia), Tiger (Saudi Arabia), Sambar (Saudi Arabia), Sloth Bear (Saudi Arabia), Peacock (Saudi Arabia), Gharial and Mugger Crocodile (Japan, Germany, France, Bhutan), Himalayan Wolf (Japan) and Red Panda have been practiced (DNPWC 2018a, b). However, Rhinoceros (Rhino) Diplomacy has been taken into action by the government and remains to be regarded as a powerful and honorable tool as public diplomacy. British resident Brian Hodgson recorded the birth of a calf of a rhino in captivity in 1824 (Mulmi 2018). The same calf was first of all used as the Rhino Diplomacy in 1834 and was sent to Calcutta (Mulmi 2018). Subsequently, Nepal has gifted more than 30 rhinoceros to different countries, including the UK, US, India, Thailand, China, Austria, Myanmar, Japan, Germany, and others (Rookmaaker et al. 1998; Rookmaaker et al. 2005; Mishra et al. 2008; DNPWC 2018a, b; Mulmi 2018) (Fig. 21.1). As returns, Nepal has also got several animal gifts from some of these countries (HNS 2018). We are not aware of other kick-backs from these practices, but likely they do exist in various forms of trade and political dealings for instance.

21.3 Gifting Diplomacy in Nepal: Discussion on Survey Results

As shown above, gifting wildlife is believed to establish historical relations between the countries as well as their people because it cannot be considered in the currency form. In Nepal, Rhinoceros (Rhino) Diplomacy has been used believing the fact that it triggers and prolongs the public diplomacy. To understand the views of the efficacy of the Rhino Diplomacy from a total of 565 Nepalese undergraduates, graduates, and postgraduates, we have used questionnaire survey. Most respondents were affiliated with private colleges (56.3%) followed by Tribhuvan University and her affiliated colleges (33.5%), then by colleges affiliated with Pokhara University (9.0%), and finally by Nepal Academy of Science and Technology (1.2%) in

Years

Countries	1834	1907	1911	1912	1922	1923	1924	1930	1933	1934	1938	1959	1962	1966	1967	1970	1980	1985	1986	1987	1990	1993	1998	2002	2006	2018
India(gift)	1M																									
Belgium (purchased)		1U																								
US (purchased)		2U																								
UK (purchased)		1U																								
UK (gift)			1M																							
UK (caught)				1M																						
UK (gift)					1F																					
US (purchased)						3F																				
UK (gift)							1M																			
Germany (purchased)								1F																		
UK (gift)									1F+1M																	
France (caught)										1M																
US (purchased)										1M																
Myanmar (gift)											1M															
China (caught)												1M														
Myanmar (caught)													1F													
US (caught)														1M												
Germany (caught)														1F												
Germany (caught)															1F											
US (caught)																1F+1M										
China (caught)																	1F+1M									
Myanmar (caught)																	1F+1M									
India (gift)																		4U								
Thailand (imported)																			1F+1M							
US (gift)																				3F+1M						
Germany (gift)																					1F					
Singapore (gift)																					1F+1M					
US (gift)																					1F+1M					
Bangladesh (gift)																						2U				
Germany (gift)																						1F				
UK (gift)																							2F			
Japan (gift)																								1F+1M		
Austria (gift)																									1F+1M	
China (gift)																										2F+2M

Fig. 21.1 Numbers of rhino exported to foreign countries either via gifting or purchasing, or via catching in the wild at different years. The beginning of rhino export was in 1835 to India as a gift. Rhino gifting has been recently applied by the government of Nepal for her export to China in 2018. *M* male, *F* female, *U* unknown sex

Kathmandu valley. Most of them (89.6%) were unemployed; few (6.9%) were job-holders in private and government (3.5%) sectors. They had education ranging from class 12 to a Ph.D. degree. Majority of them studied Basic Science (56.3%), followed by Zoology (15.6%), Environmental Sciences (9.2%), Microbiology (8.5%), Botany (7.6%), and others (2.8%) (Table 21.1).

Out of 565 respondents, most of them (58.1%) replied that gifting of wild animals to foreign countries would enhance the relationship with alien powers (Fig. 21.2). In this study, almost half of the respondents (49.6%) stated that the effects on foreign policy depended on the country to which wild animals are gifted by the government (Fig. 21.3). About 18.2% individual believed that gifting would bring positive effects on foreign policy (Fig. 21.3). These data can be evidenced by the success stories of liberal and supportive foreign policy of few countries with Nepal. Global peace, harmony, and security are aimed at Nepal's foreign policy that has objectives of enhancing the dignity of the nation by safeguarding sovereignty, territorial integrity, independence, and others (MoFA 2018). Notably, wildlife like rhino gifting is an essential tool to obtain these aims. Although full of debates – especially among nationalists and conservationists – rhino gifting might actually be one of the best and cheapest options for Nepal to have a good tie-up with developed countries. When Nepal first established diplomatic relations with the UK in 1816, bilateral relations with other countries were created only after the Second World War, and up to September 25, 2019, it comprises a total of 168 countries (https://mofa.gov.np/foreign-policy/bilateral-relation/). From few years, through the experiences of Rhino Diplomacy, Nepal has actually strengthened its relationship with the

Table 21.1 Respondents Characteristics (N = 565)

Characteristics	Numbers	%
Respondent's affiliation		
Private Colleges	318	56.3%
Tribhuvan University & Affiliated colleges	189	33.5%
Pokhara University & Affiliated colleges	51	9.0%
Nepal Academy of Science and Technology (NAST)	7	1.2%
Employment status		
Private	39	6.9%
Government	20	3.5%
Unemployed	506	89.6%
Respondent's educational status		
Eleventh/Twelfth Grades	318	56.3%
Bachelor's Degree	116	20.5%
Master's Degree	126	22.5%
PhD	5	0.9%
Respondent's study background		
Basic Science	318	56.3%
Zoology	88	15.6%
Environmental Sciences	52	9.2%
Microbiology	48	8.5%
Botany	43	7.6%
Others (Physics, Chemistry, Biotechnology, Engineering, and Management)	16	2.8%

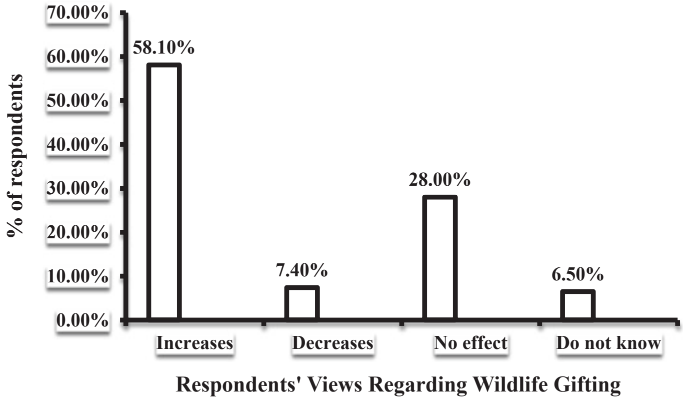

Fig. 21.2 Percentage of respondents with their particular views regarding wildlife gifting. Increases: Foreign relation is enhanced. Decreases: The foreign relation is declined. No effect: Gifting does not affect the foreign relationship. Do not know: unknown to decide about the role of wildlife gifting relationship to foreign

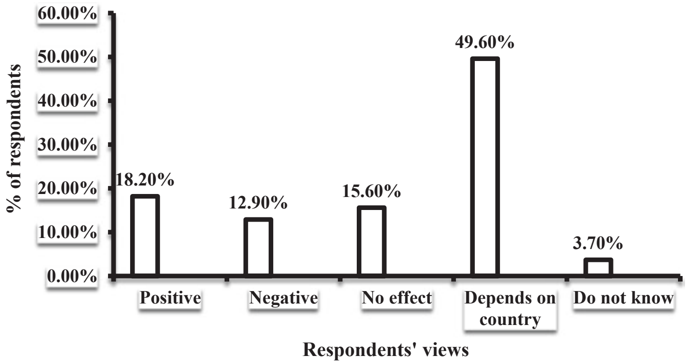

Fig. 21.3 Percentage of respondents with their particular views regarding wildlife gifting and foreign policy. Wildlife gifting may pose (**a**). Positive effects (**b**). Negative effects (**c**). Do not have any impact on foreign policy (**d**). Depends on the country to which animal was gifted (**e**) do not know

UK, USA, Australia, China, and others. In a rhino handover program on July 12, 2018, Nepalese Prime Minister KP Oli expressed that the gift could strengthen the mutual relationship of the neighborhood between Nepal and China and it could contribute for the controlling of illegal trade and import the positive information throughout the world (DNPWC 2018a, b). Besides, the honorable Minister of Forests and Environment, Shakti Basnet, expressed that the program can be more helpful to establish the long-lasting diplomatic relation between two countries as well as provide additional support and coordination for the conservation of wildlife and biodiversity in the coming days (DNPWC 2018a, b). Accepting gifts like arboreal gibbons from Singapore, hippopotamuses from Thailand, and ostriches from Australia by Nepal during absolute monarchial periods (Shahi 2013) has been believed to strengthen the foreign relations with these countries.

Another example from the globe includes Tortoise diplomacy in which the President of Seychelles gifted a giant Tortoise to Indian Prime Minister, Narendra Modi who thanked him and told that the long-lived Tortoise was the symbol of 'ever-lasting relationships' between two countries (PTI 2018a). The gift of six buffaloes of the 'Ravi' breed and four 'Sahiwal' cows from Pakistan to Deputy Chief Minister Sukhbir Singh Badal, 'Nachi' breed goats from Pakistan to Punjab Chief Minister Parkash Singh Badal, eight horses from Sri Lanka to Pakistan, two horses from Saudi Arabia to India, a 'Sahiwal' cow from Pakistan to Indian Congress leader HKL Bhagat, a baby elephant (Indira) from Pandit Jawaharlal Nehru of India to a zoo in Japan (Singh 2015) indicating lots of such gifting diplomacies existed around the world. In June 1961, King Mahendra received his gift of a bull, two cows, three Shetland ponies and a charger from the United Kingdom (Cowan 2015b) mainly to please Mahendra according to his will.

For Nepal, one may easily add here the diplomacy and politics that surround access of Mt. Everest, and the permits, climbing fee structure and waiving fees all together for specific people and expeditions. This is covered elsewhere (see chapters in this book).

Following independence of India from the British, the relation of India and Nepal became to-and-fro which has been evidenced by the land encroachment, border disputes, border blockade, non-official and official invasion, odd treaties, and other several factors (Singh 2009; Upadhya 2012; Deepak 2016; Jha 2017) although several animal exchanges occurred between these countries since the time immemorial. It is believed that foreign diplomacy depends on power, objectives, leadership, military and economic capabilities, and types of government, geopolitical locations, and other issues (Wanjohi 2011) even though the relation between Nepalese and Indian people is long, fresh, and cannot all be explained based on country's diplomacy. Thus, regarding current views of about 50% literates, the effects on foreign policy depended on the state to which the government gifted wild animals.

In the current survey, 28% of respondents stated that there would not be any effect on the relation with foreign countries by wildlife gifting. About 7% of them replied that gifting would decrease the relationship (Fig. 21.2). Few believed that donation would bring negative (12.9%), or zero effects (15.6%) on foreign policy (Fig. 21.3). These views are difficult to interpret and analyze, however, individual with full of conservation education and animal rights usually do not want wildlife gifting. Ecologists and environmentalists (e.g. Beary 2005; Hetem et al. 2014) believe that due to change of climatic conditions and losing natural habitat, many animals including large mammals suffer. Risks to stress, diseases, and dubiousness to cope with the new environment are the usual problems in the new habitat (Ganga Ram Regmi pers. comm.). That is one reason why animal rights activists usually follow the climate change effects on gifted animals. This is particularly true of some of the adverse impacts on gifted animals around the globe. Gastrointestinal illness like impacted guts, enteritis, chronic ulcer and gastritis, few disorders like sarcoma of heart and lung and kidney failure, infectious diseases like tuberculosis, equine viral encephalitis and parasitic malnutrition, and lack of care, for example, ingestion of a tennis ball and even war have been implicated in the death of rhinos around the globe exported from Nepal (Reynolds 1961) (Table 21.2). The deaths are severely

Table 21.2 Etiology, locations, and dates of death of exported rhinos from Nepal

Locations of death	Date of death	Causes	Means of export
Manchester, UK	1917	After swallowing a tennis ball	Purchase
London Zoo, UK	1926	Sarcoma of heart and lung	Gift
London Zoo, UK	1941	Tuberculosis	Gift
Yangon, Myanmar	1942	World War II	Gift
Beijing, China	1978	Chronic ulcer and gastritis	Caught in Nepal
Berlin, Germany	1967	Enteritis	Caught in Nepal
Beijing, China	1981	Parasitical malnutrition	Caught in Nepal
Yangon, Myanmar	1993	Equine viral encephalitis	Caught in Nepal
Chiang Mai, Thailand	1986	Kidney failure	Imported
Singapore	1991	Impacted gut	Gift

and quickly observed for the young rhinos indicating various adverse factors governing the health of these charismatic animals. A 20-month-elephant gifted by Sri-Lanka to the USA died in 19th August 1984 (Weil 1984). However, adverse impacts on gifted animals are not always experienced. Most of the animals get proper care and relaxing life after being gifted. The most beautiful example can be taken from an Indian rescued bull presented to marriage ceremony of British Royals as the wedding gift on May 19, 2018, which can enjoy the relaxing remaining life compared to its experience of pulling heavy carts before (PTI 2018b).

In conclusion, Wildlife Diplomacy remains as one of the essential parts of foreign policy around the globe including Hindu Kush-Himalayan Nations like Nepal. We therefore think that this policy should be studied in detail and discussed more among literates, biologists, economists, conservationists, animal rights activists, and government authorities. Also, its efficacies and good options in foreign policy, foreign relation and for future directions of such a Wildlife Diplomacy should be fully communicated to the public.

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Chapter 22
Birds of Nepal: Their Status and Conservation Especially with Regards to Watershed Perspectives

Hem Sagar Baral and Carol Inskipp

22.1 Introduction

Nepal's unique position in Asia makes it an exceptionally rich country in terms of biodiversity despite its relatively small size, covering just 0.1% of the Earth's land area. Still, the country occupies the central parts of the Himalayan range. Further, Nepal's position marks the meeting point of the Palearctic Realm to the north and the Oriental Realm to the south, represented by the northern and southern regions of the country respectively. The middle region acts as a melting pot for both realms and it shows a mixed fauna and flora. Contrasting landscapes, their watersheds and a highly varied topography contribute to Nepal's biodiversity and provide habitats for a wide and unique array of life forms (Inskipp et al. 2016).

Modern history of ornithological research in Nepal dates back to 1793 (Inskipp and Inskipp 1991) followed by the exceptional contribution from Brian Houghton Hodgson in the first half of the nineteenth century, who recorded over 600 bird species (Cocker and Inskipp 1988). Later bird studies have resulted in the high total of 887 species for Nepal (Grimmett et al. 2016; Inskipp and Chaudhary 2016; Kusi et al. 2017, Anish Timsina verbally 2017 to Hem Sagar Baral). One or more new species are essentially recorded every year. Most of Nepal's birds depend on forest habitats followed by grassland/farmland and wetlands, whereas high mountains are relatively species poor.

H. S. Baral (✉)
Zoological Society of London Nepal Office, Kathmandu, Nepal

School of Environmental Sciences, Charles Sturt University, Albury-Wodonga, Australia
e-mail: hem.baral@zsl.org

C. Inskipp
Patron, Himalayan Nature, Stanhope, Bishop Auckland, Durham, UK

G. R. Regmi, F. Huettmann (eds.), *Hindu Kush-Himalaya Watersheds Downhill: Landscape Ecology and Conservation Perspectives*,
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There are other species that depend on a variety of habitats including open country, rock cliffs, human habitation, etc. Many birds are also dependent on a mixture of several habitats to complete their life cycle. For example, birds that breed in shrubberies in the high Himalayas may winter in grasslands, such as White-tailed Rubythroat *Luscinia pectoralis,* or forests, such as Golden Bush Robin *Tarsiger chrysaeus* in the lowlands. Some bird species that breed in alpine pastures in the mountains winter in lowland wetlands, such as the West Himalayan Bush Warbler *Locustella kashmirensis*.

Birds have co-evolved and been competing with humans for millennia. Competition has taken a fierce form especially in recent years with urbanization on the rise. Some bird species flourish in areas that have been set aside by people for them but they perish if they venture into human domains where most of them may even be unwanted. People are now the most important stressor and predator for birds, and anthropogenic threats are known to drive some species to extinction. Therefore, conservation of birds now depends on the will and actions of people. It's the Anthropocene, which specifically is reflected in the watershed status! Our perception of them in a good light, now and in the future, is vital for their sustainable conservation. Therefore, research findings on birds' have value to human life and to ecosystems on a global scale; they need to be passed on to decision-makers at local, national and international levels.

In this investigation we review Nepal's known birds with four status assessments carried out since 1996 using respective IUCN categories and criteria. Those IUCN categories and criteria have evolved to become better assessment tools over time, and our experience in the national status assessments has also improved over these years. Both authors have been involved in all status assessment as the lead assessors and here this first-hand knowledge is shared.

22.2 Field Observations and Overview

The *Birds of Nepal* field guide – published in 1976 and later supplemented with updates – gave for the first time the status of each bird recorded in Nepal (Fleming et al. 1976, 1979, 1984). This field guide provided information on all birds recorded in Nepal to fill thus far a large vacuum on a complete work of the country's birds. It is still regarded highly as a classical reference book on the study of birds of Nepal by many. The development of bird watching – especially from young Europeans visiting Nepal – was so rapid that the book could not keep up with status updates and the identification of certain more difficult species. Consequently, another major publication followed Fleming's book which was a comprehensive compilation of many thousands of records from visiting bird enthusiasts and researchers alike (Inskipp and Inskipp 1985). This book, *A guide to the birds of Nepal*, presented the bird distribution on a Nepal map divided into different grids, for the first time. To keep up with the new information pouring in, a complete revision of the book was published after 6 years (Inskipp and Inskipp 1991). This book presented the most up-to-date status for birds of Nepal for a number of years. An earlier publication '*Nepal's forest birds: their status and conservation*' gave a detailed analysis of all of the country's forest species (Inskipp 1989). Although some qualitative indicators of status assessment were presented in all these publications (the best available source of information for that time period) they could not really be used to measure population changes and did not follow the IUCN threatened species criteria.

Based on these publications and the fast-growing activity of Nepali birders in the country especially after the mid-1990s, there have been a wide series of systematic assessments on the status of birds of Nepal. The first national assessment was then published in 1996, soon followed by assessments published in 2004 and 2011 and the most recent one in 2016 (Baral et al. 1996; Baral and Inskipp 2004; BCN and DNPWC 2011; Inskipp et al. 2016). However, thus far Inskipp et al. (2016) is the only national assessment which considers every species in detail including changes in distribution, threats, and conservation measures.

22.3 Where Are the Birds of Nepal Heading to?

The recent status assessment on Nepal's birds has been a great source of information to find out the overall status of bird species recorded in Nepal. Eight species have been lost from the country and one may be globally extinct (Pink-headed Duck *Rhodonessa caryophyllacea* (Table 22.1, Inskipp et al. 2016, 2017 for details).

It's not really a surprise that birds that are extirpated from the country even today represent the habitats where our remaining birds continue to face the greatest threats: lowland grasslands, wetlands and subtropical forests. A recent assessment of the status of Nepal's birds has shown that 167 bird species (19% of the total recorded) are threatened on a national level (Inskipp et al. 2016). Red-faced Liocichla *Liocichla phoenicea* which was recorded in Nepal by Brian Hodgson in the nineteenth century and thought to be extirpated from the country, was rediscovered 2017 in the Churia hills, Siraichuli, Chitwan district. However, it's just a tiny area that carries its sighting and this species is considered Critically Endangered as there is only a small and isolated population overall (Baral et al. 2018).

Table 22.1 Extirpated/extinct birds from Nepal

Species	Scientific name
Black-breasted Parrotbill	*Paradoxornis flavirostris*
Brown Bush Warbler	*Bradypterus luteoventris*
Green Cochoa	*Cochoa viridis*
Jungle Bush Quail	*Perdicula asiatica*
Pink-headed Duck	*Rhodonessa caryophyllacea*
Rufous-necked Hornbill	*Aceros nipalensis*
Silver-breasted Broadbill	*Serilophus lunatus*
White-bellied Heron	*Ardea insignis*

Globally around 13% – or one in eight – of all extant bird species are currently listed as threatened. As many as 44 species that have been recorded in Nepal are globally threatened with additional 32 species that are Near-threatened (BirdLife International 2020, Tables 22.2 and 22.3). Nepal follows the global trend of more and more species being listed as threatened on every periodic assessment.

In Table 22.2, five species are vagrants to Nepal: Long-tailed Duck *Clangula hyemalis,* Indian Vulture *Gyps indicus,* Greater Adjutant *Leptoptilus dubius,* and Grey-sided Thrush *Turdus feae* and Rustic Bunting *Emberiza rustica*; and two are extirpated: White-bellied Heron *Ardea insignis* and Rufous-necked Hornbill *Aceros nipalensis*, and one more may be extinct globally: the Pink-headed Duck *Rhodonessa caryophyllacea* (Table 22.3).

At the time, when the first Red List assessment on Nepal's birds was completed, Nepal's human population was just over 20 million people. A total of 129 species of birds was considered threatened then (Baral et al. 1996). Since then the human population of Nepal, as elsewhere, has continued to grow and at the same time this

Table 22.2 Globally threatened species in Nepal with their threat categories

English name	*Scientific name*	Habitat	Global IUCN Red List Category
Baer's Pochard	*Aythya baeri*	Wetlands	CR
Pink-headed Duck	*Rhodonessa caryophyllacea*	Forested wetlands	CR
Bengal Florican	*Houbaropsis bengalensis*	Lowland grasslands	CR
White-bellied Heron	*Ardea insignis*	Forested rivers, wetlands	CR
Red-headed Vulture	*Sarcogyps calvus*	Forests, open places	CR
White-rumped Vulture	*Gyps bengalensis*	Forests, open places	CR
Indian Vulture	*Gyps indicus*	Cliffs, open places	CR
Slender-billed Vulture	*Gyps tenuirostris*	Forests, open places	CR
Yellow-breasted Bunting	*Emberiza aureola*	Lowland grasslands	CR
Lesser Florican	*Sypheotides indicus*	Lowland grasslands	EN
Greater Adjutant	*Leptoptilos dubius*	Open habitats	EN
Black-bellied Tern	*Sterna acuticauda*	Wetlands	EN
Egyptian Vulture	*Neophron percnopterus*	Forests, cliffs, open places	EN
Steppe Eagle	*Aquila nipalensis*	Open places, farmlands and forests	EN
Pallas's Fish-eagle	*Haliaeetus leucoryphus*	Wetlands, forests	EN
Saker Falcon	*Falco cherrug*	Open places, cliffs	EN

(continued)

Table 22.2 (continued)

English name	*Scientific name*	Habitat	Global IUCN Red List Category
[a]Swamp Grass-babbler	*Laticilla cinerascens*	Lowland grasslands	EN
Swamp Francolin	*Francolinus gularis*	Lowland grasslands	VU
Cheer Pheasant	*Catreus wallichii*	Midhill grasslands, forests	VU
Long-tailed Duck	*Clangula hyemalis*	Wetlands	VU
Common Pochard	*Aythya ferina*	Wetlands	VU
Sarus Crane	*Antigone antigone*	Farmlands and wetlands	VU
Black-necked Crane	*Grus nigricollis*	Wetlands	VU
Lesser Adjutant	*Leptoptilos javanicus*	Farmlands and wetlands, forests	VU
Asian Woollyneck	*Ciconia episcopus*	Farmlands and forests	VU
Wood Snipe	*Gallinago nemoricola*	Highland grasslands, shrubs, forests, wetlands	VU
Indian Skimmer	*Rynchops albicollis*	Wetlands	VU
Indian Spotted Eagle	*Clanga hastata*	Farmlands and forests	VU
Greater Spotted Eagle	*Clanga clanga*	Farmlands and forests	VU
Eastern Imperial Eagle	*Aquila heliaca*	Open places	VU
Tawny Eage	*Aquila rapax*	Open places	VU
Rufous-necked Hornbill	*Aceros nipalensis*	Forests	VU
Great Hornbill	*Buceros bicornis*	Forests	VU
Great Slaty Woodpecker	*Mulleripicus pulverulentus*	Forests	VU
Grey-crowned Prinia	*Prinia cinereocapilla*	Lowland grasslands	VU
Bristled Grassbird	*Chaetornis striata*	Lowland grasslands	VU
Black-breasted Parrotbill	*Paradoxornis flavirostris*	Lowland grasslands	VU
Jerdon's Babbler	*Chrysomma altirostre*	Lowland grasslands	VU
Slender-billed Babbler	*Chatarrhaea longirostris*	Lowland grasslands	VU
Kashmir Flycatcher	*Ficedula subrubra*	Forests	VU
Grey-sided Thrush	*Turdus feae*	Forests	VU
White-throated Bushchat	*Saxicola insignis*	Lowland grasslands	VU
Finn's Weaver	*Ploceus megarhynchus*	Lowland grasslands	VU
Rustic Bunting	*Emberiza rustica*	Lowland grasslands	VU

Source: BirdLife International, IUCN 2020

[a]Previously listed as Nepal Rufous-vented Prinia *Prinia burnesii nepalicola*, but due to this recent taxonomic change both the English and Scientific names have been corrected

Table 22.3 Globally Near-threatened species in Nepal

English name	*Scientific name*
Satyr Tragopan	*Tragopan satyra*
Ferruginous Duck	*Aythya nyroca*
Falcated Duck	*Mareca falcata*
Ashy-headed Green-pigeon	*Treron phayrei*
Painted Stork	*Mycteria leucocephala*
Black-necked Stork	*Ephippiorhynchus asiaticus*
Black-headed Ibis	*Threskiornis melanocephalus*
Spot-billed Pelican	*Pelecanus philippensis*
Oriental Darter	*Anhinga melanogaster*
Great Thick-knee	*Esacus recurvirostris*
Eurasian Oystercatcher	*Haematopus ostralegus*
Northern Lapwing	*Vanellus vanellus*
River Lapwing	*Vanellus duvaucelii*
Eurasian Curlew	*Numenius arquata*
Black-tailed Godwit	*Limosa limosa*
Curlew Sandpiper	*Calidris ferruginea*
River Tern	*Sterna aurantia*
Bearded Vulture	*Gypaetus barbatus*
Himalayan Griffon	*Gyps himalayensis*
Cinereous Vulture	*Aegypius monachus*
Pallid Harrier	*Circus macrourus*
Lesser Fish-eagle	*Icthyophaga humilis*
Grey-headed Fish-eagle	*Icthyophaga ichthyaetus*
Yellow-rumped Honeyguide	*Indicator xanthonotus*
Red-headed Falcon	*Falco chicquera*
Laggar Falcon	*Falco jugger*
Blossom-headed Parakeet	*Psittacula roseata*
Red-breasted Parakeet	*Psittacula alexandri*
Alexandrine Parakeet	*Psittacula eupatria*
Tytler's Leaf-warbler	*Phylloscopus tytleri*
Rufous-throated Wren-babbler	*Spelaeornis caudatus*
Blackish-breasted Babbler	*Stachyris humei*

Source: BirdLife International, IUCN 2020
In this table, the Curlew Sandpiper *Calidris ferruginea* is a vagrant

increase has also been reflected in the number of threatened bird species. During the last status assessment of Nepal's birds, 168 species of birds were actually listed as threatened (Inskipp et al. 2016). By 2020, Nepal's human population is predicted to reach over 30 million, does this mean that every increase of ten million human population, another 30 species of birds get threatened in the country? Or will the scenario even get worse? Nepal's population is predicted to increase until it reaches a peak in 2057 and is said to gradually declining and reaching nearly the same level as of today by the year 2100 (Nepal Population 2016). Are we all -birds and humans – running out of space and resources? So how can we ensure that when our population peaks, our birds continue to thrive at least at the level what we have today? We think this is a Himalaya-wide problem, if not a global one (Figs. 22.1 and 22.2).

Our analysis shows that over the years' of national assessment there has been a dramatic increase in Critically Endangered bird species compared to birds in the other threat categories. Land mass is limited, the Earth is finite and so with more people and more consumption we will simply run out of space for either (birds, humans and the earth and atmosphere as well as ecological processes). This indicates that the threatened species scenario of Nepal's birds is much worse than indicated by just comparing the total number of species threatened. On a global scale pyramid of threatened species, those in the Vulnerable category are on the bottom as they are the largest in number, Critically Endangered species are at the pyramid top as they are the smallest in number. The number of Endangered species lie in between. The lack of resources affect all species either way.

Still, our assessment is a bit different! The first assessment in 1996 followed the normal pyramid shape as shown in Fig. 22.3. The second assessment in 2004 was already a bit skewed which showed greater number of critically threatened birds than Endangered. The last two assessments are quite similar in terms of what they represent. The number of bird species considered Critically Endangered has actually increased significantly with each assessment since 1996 (Fig. 22.4 and 22.5).

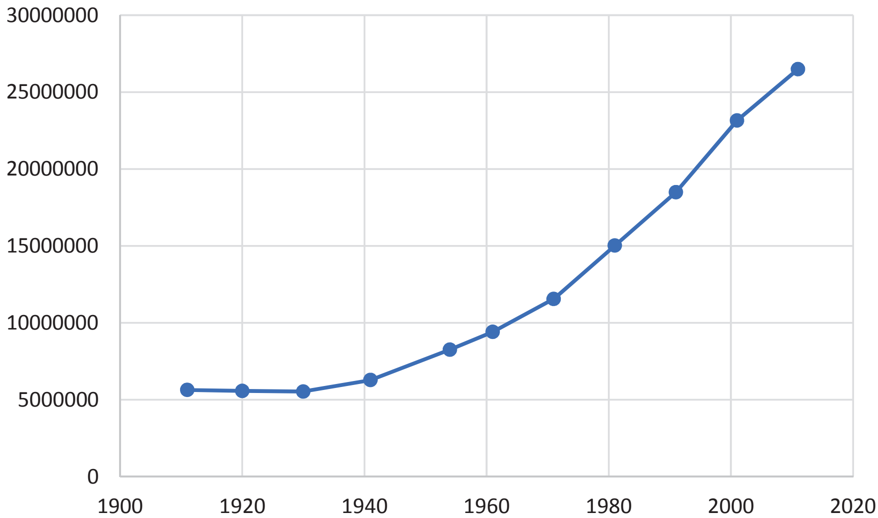

Fig. 22.1 Human population growth in Nepal from 1911 to 2016. (Source: CBS 2002, 2016)

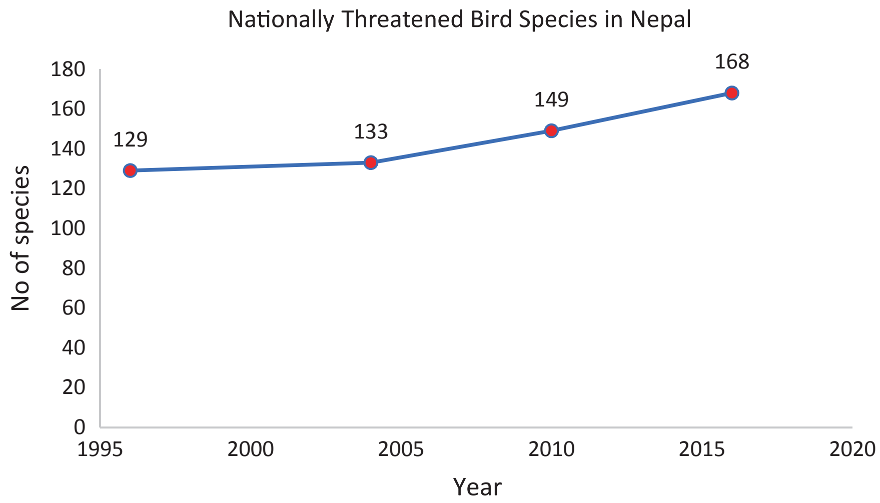

Fig. 22.2 Number of threatened species and the year of assessment

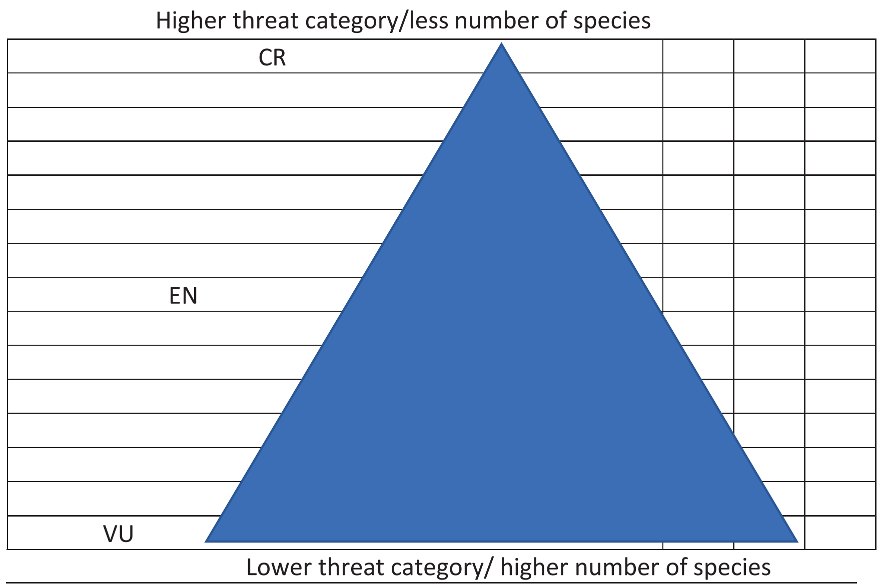

Fig. 22.3 Normal pyramid shape and the various seats for three threatened categories

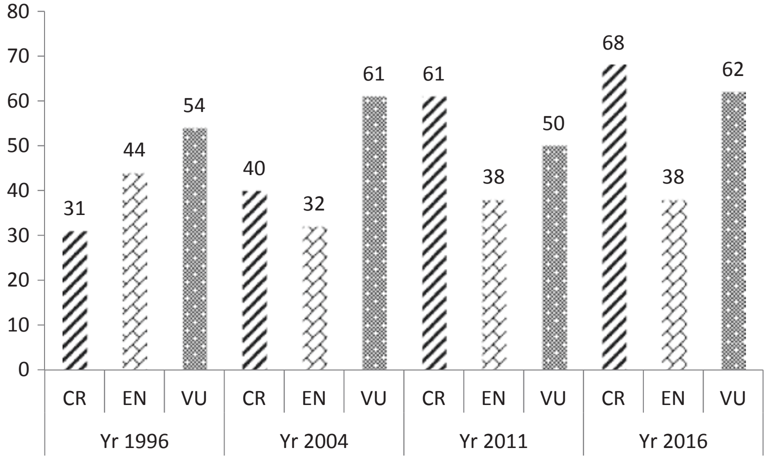

Fig. 22.4 Threatened categories and their numbers during different years of assessment

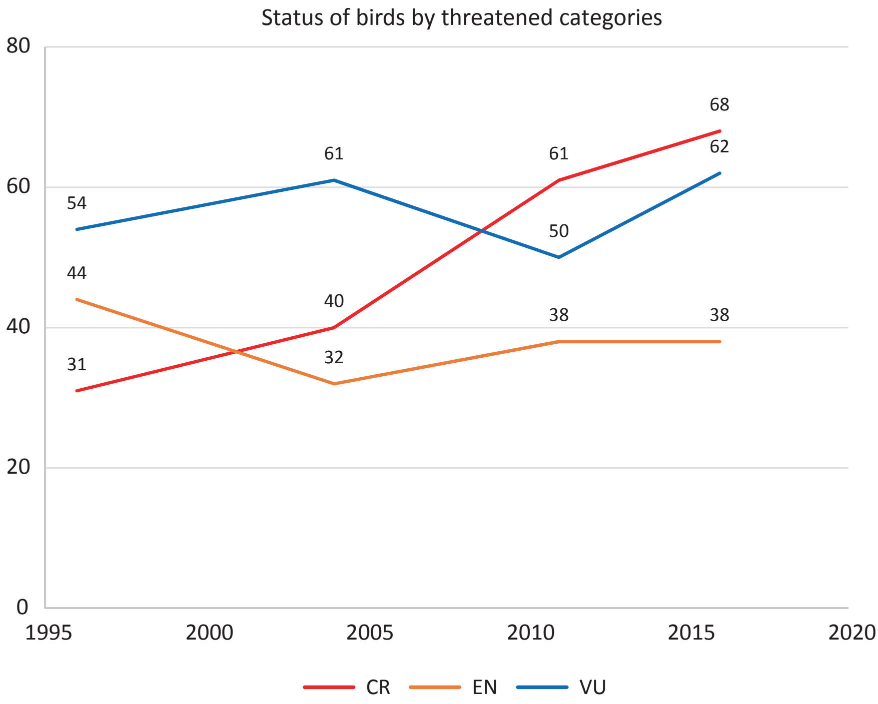

Fig. 22.5 Threatened categories and bird species numbers in them during different year of assessment

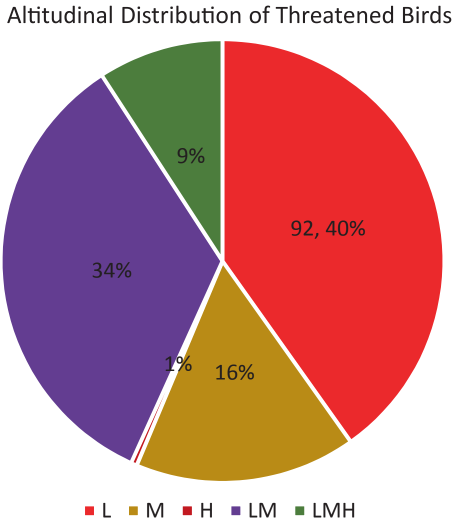

Fig. 22.6 Number of threatened bird species and their occurrence in percentage in different physiographic zones, Nepal. (Source: Inskipp et al. 2016)
L Lowlands, *M* Midhills, *H* Highlands, *LM* Lowland to Midhills, *LMH* Lowland to Midhills and Highlands
Lowlands **upto 800 m**
Midhills **From upper limit of lowlands upto 2500 m**
Highlands **Above 2500 m**

The large majority of threatened species are found in the lowlands and midhills where the majority of the population live, see Fig. 22.6.

22.4 Why Are so Many Species Critically Endangered

The large number of 62 Critically Endangered species (91% of the total of 68 species) are found entirely or almost entirely in the lowlands or lower hills in the tropical and subtropical zones; for details see Fig. 22.7 below. Five species occur mainly in the lower temperate zone (8% of the total) and one species in the upper temperate zone (c.1% of the total). Some species occur in more than one of these zones but have been assigned to the zone where they are mainly found.

A closer look at the Critically Threatened birds reveals that as many as 91% consist of mainly tropical and subtropical species, 8% mainly lower temperate species, 1% mainly upper temperate species. The six species that do not occur mainly in the tropical and subtropical zones are: Coral-billed Scimitar Babbler 2745–3660 m (the upper temperate species) and the following ones are mainly lower temperate species: Rufous-throated Wren Babbler 2135–2440 m, Rufous-backed Sibia

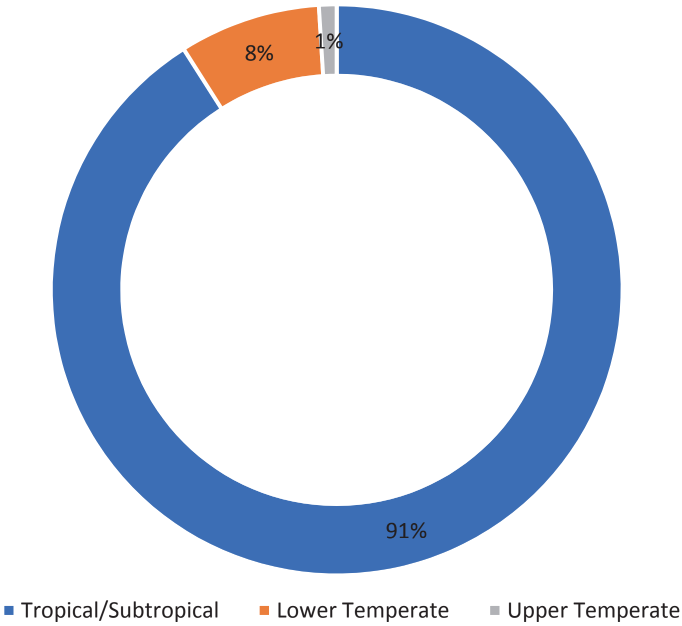

Fig. 22.7 Distribution of Critically Threatened Birds in Different Vegetation Zones

1450–2650 m, Yellow-cheeked Tit 1980–2440 m, Slaty-bellied Tesia 1000–2200 m and White-naped Yuhina 915–2200 m.

As many as 30 new bird species made an entry to the nationally threatened species list in 2016; that's in a time span of only 5 years since the previous assessment (Inskipp et al. 2016). The smaller number of 10 species were added already in the 2010 assessment (BCN and DNPWC 2011) (see Table 22.4).

Habitat loss, damage and fragmentation was found to be the major threat to bird species in all the assessments from 1996 to 2016. All those are essentially human-driven and related to management of land and natural resources, including the underlying watersheds. The latest assessment found that most Critically Endangered species threatened inhabited forests (47%) (see bar chart and table below), but this is somewhat unsurprising as forest is the main habitat for Nepal birds. The large majority of forest species occurred in broadleaved tropical or subtropical forests (40% of all CR species).

Wetland birds include the high total of 37% of Critically Endangered species. Threats to wetland birds and to their habitat are the biggest in terms of number, type and extent. Wetland status reflects many stressors. The barrage of threats to birds include drainage, pollution, overfishing, hydroelectric dams and disturbance (BCN and DNPWC 2011, Inskipp et al. 2016). The most important wetlands for Nepal birds lie in the lowlands and lower hills, and most of these lie outside the protected areas' system, for example Ghodaghodi Tal, Jagdishpur and the Pokhara valley

Table 22.4 New species added to the national red list for birds of Nepal, 2010 and 2016

#	2016	#	2010
1	Baer's Pochard	1	Black-headed Ibis
2	Black Bittern	2	Black-tailed Crake
3	Black-faced Bunting	3	Blue-winged Laughingthrush
4	Black-headed Bunting	4	Himalayan Cutia (Cutia)
5	Black-headed Gull	5	Lesser Shortwing
6	Brown-headed Gull	6	Long-billed Wren Babbler
7	Chestnut Munia	7	Oriental Darter (Darter)
8	Demoiselle Crane	8	Red Junglefowl
9	Dunlin	9	Tawny Eagle
10	Garganey	10	White-tailed Stonechat
11	Golden Eagle		
12	Great Bittern		
13	Greater Necklaced Laughingthrush		
14	Kashmir Flycatcher		
15	Koklass Pheasant		
16	Lesser Necklaced Laughingthrush		
17	Little Bunting		
18	Little Tern		
19	Malayan Night Heron		
20	Montagu's Harrier		
21	Northern Pintail		
22	Pallid Harrier		
23	Red-breasted Parakeet		
24	Red-faced Liocichla		
25	Saker Falcon		
26	Short-eared Owl		
27	Steppe Eagle		
28	Streaked Weaver		
29	Tibetan Serin		
30	Yellow-bellied Warbler		

wetlands, all of which are RAMSAR sites. Badhaiya Tal and Chimdi Lake are two other important, but unprotected lowland sites for wetlands birds.

Lowland grasslands cover only a small proportion of Nepal's natural habitats but are of international importance for birds as they include 13 globally threatened species (Table 22.2, BCN and DNPWC 2011; Inskipp et al. 2016). As many as 15 lowland grassland birds were assessed as Critically Endangered in the last assessment, 22% of the total (Inskipp et al. 2016). Almost all of this habitat now lies within protected areas, but until very recently, management here has just focused on large mammals and not on birds. However, the Department of National Parks and Wildlife Conservation in Nepal is now initiating conservation measures for Bengal Florican *Houbaropsis bengalensis*, a Critically Endangered bustard and a flagship

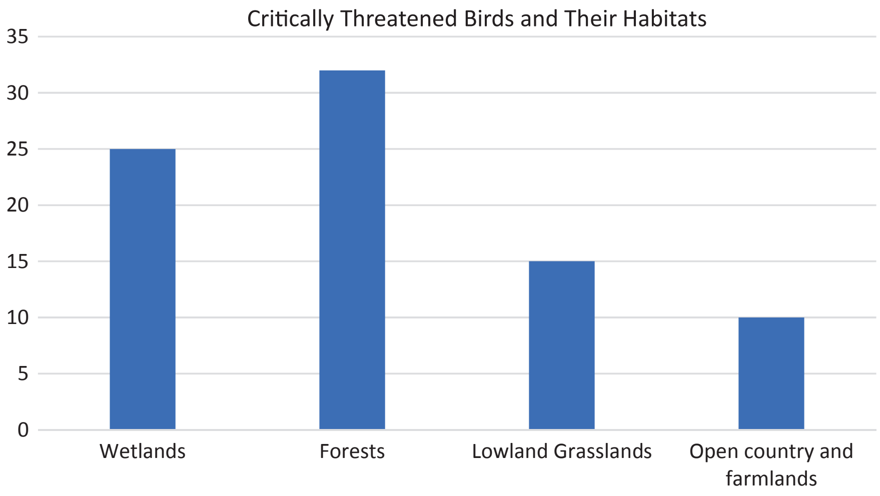

Fig. 22.8 Habitat of critically threatened birds. (Source: Inskipp et al. 2016)

Table 22.5 List of nationally threatened bird species with their threat categories (Inskipp et al. 2016)

Common name	National RDB category	Habitat
Coral-billed Scimitar Babbler	CR	Forests with bamboo
Great Grey Shrike	CR	Grasslands farmlands
Blyth's Kingfisher	CR	Forested rivers
Lesser Fish Eagle	CR	Forested wetlands
Grey-headed Fish Eagle	CR	Forested wetlands
Dusky Eagle Owl	CR	Forested wetlands
Tawny Fish Owl	CR	Forested wetlands
White-hooded Babbler	CR	Forests
Jerdon's Baza	CR	Forests
Rufous-bellied Eagle	CR	Forests
Mountain Imperial Pigeon	CR	Forests
Vernal Hanging Parrot	CR	Forests
Pale-headed Woodpecker	CR	Forests
Blue-eared Barbet	CR	Forests
White-browed Piculet	CR	Forests
Little Spiderhunter	CR	Forests
Yellow-vented Flowerpecker	CR	Forests
Scarlet-backed Flowerpecker	CR	Forests
Long-tailed Sibia	CR	Forests
Asian Fairy Bluebird	CR	Forests
Blackish-breasted Babbler	CR	Forests

(continued)

Table 22.5 (continued)

Common name	National RDB category	Habitat
Rufous-throated Wren Babbler	CR	Forests
Rufous-faced Warbler	CR	Forests
Rufous-backed Sibia	CR	Forests
Yellow-cheeked Tit	CR	Forests
Spotted Elachura	CR	Forests
Slaty-bellied Tesia	CR	Forests
White-naped Yuhina	CR	Forests
Red-faced Liocichla	CR	Forests
Rufous-necked Laughingthrush	CR	Forests, grasslands
Malayan Night Heron	CR	Forests, wetlands
Yellow-breasted Bunting	CR	Grasslands
Bengal Florican	CR	Grasslands
Lesser Florican	CR	Grasslands
Eastern Grass Owl	CR	Grasslands
Jerdon's Babbler	CR	Grasslands
Striated Grassbird	CR	Grasslands
Streaked Weaver	CR	Grasslands
Yellow Weaver	CR	Grasslands
Rufous-vented Prinia	CR	Grasslands
Grey-crowned Prinia	CR	Grasslands
Jerdon's Bushchat	CR	Grasslands
Slender-billed Babbler	CR	Grasslands
Eastern Imperial Eagle	CR	Open Country
Oriental Hobby	CR	Open Country
Montagu's Harrier	CR	Open Country, farmlands
Laggar Falcon	CR	Open Country, farmlands
Slender-billed Vulture	CR	Open Country, farmlands
White-rumped Vulture	CR	Open Country, Forests
Blue Quail	CR	Grasslands
Falcated Duck	CR	Wetlands
Baer's Pochard	CR	Wetlands
White-tailed Eagle	CR	Wetlands
Brahminy Kite	CR	Wetlands
Black-necked Stork	CR	Wetlands
Greater Adjutant	CR	Wetlands
Eurasian Spoonbill	CR	Wetlands
Spot-billed Pelican	CR	Wetlands
Pallas's Fish Eagle	CR	Wetlands
Water Rail	CR	Wetlands
Great Thick-knee	CR	Wetlands
Eurasian Curlew	CR	Wetlands

(continued)

Table 22.5 (continued)

Common name	National RDB category	Habitat
Indian Skimmer	CR	Wetlands
Black-bellied Tern	CR	Wetlands
River Tern	CR	Wetlands
Caspian Tern	CR	Wetlands
Gull-billed Tern	CR	Wetlands
Ruddy Kingfisher	CR	Wetlands in forests
Cinereous Vulture	EN	Open Country, Forests
Ibisbill	EN	Wetlands
Northern Pintail	EN	Wetlands
Red-headed Vulture	EN	Open Country, Forests
Spot-bellied Eagle Owl	EN	Forests
Indian Nightjar	EN	Open Country, Grasslands
Yellow-vented Warbler	EN	Forests
Swamp Francolin	EN	Grasslands
Comb Duck	EN	Wetlands
Great Bittern	EN	Wetlands
Black Bittern	EN	Wetlands
Painted Stork	EN	Wetlands
Red-necked Falcon	EN	Open Country, farmlands
Slaty-legged Crake	EN	Wetlands
Indian Courser	EN	Open heavily grazed grasslands
Thick-billed Green Pigeon	EN	Forests
Red-headed Trogon	EN	Forests
Blue-eared Kingfisher	EN	Forested streams and ponds
Great Hornbill	EN	Forests
Great Slaty Woodpecker	EN	Forests
White-throated Bulbul	EN	Forests
Ruby-cheeked Sunbird	EN	Forests
Tawny-bellied Babbler	EN	Grasslands
Rufous-rumped Grassbird	EN	Grasslands
Silver-eared Mesia	EN	Forests
Chestnut Munia	EN	Grasslands
Abbott's Babbler	EN	Forests
Sultan Tit	EN	Forests
White-throated Bushchat	EN	Grasslands
Saker Falcon	EN	Open Country, Cliffs
Gould's Shortwing	EN	Forests
Cheer Pheasant	EN	Midhill grasslands
Yellow-rumped Honeyguide	EN	Forests
Rusty-fronted Barwing	EN	Forests
Purple Cochoa	EN	Forests

(continued)

Table 22.5 (continued)

Common name	National RDB category	Habitat
Blue-naped Pitta	EN	Forests
Golden Babbler	EN	Forests with bamboo
Broad-billed Warbler	EN	Forests
Steppe Eagle	VU	Open Country, Forests
Himalayan Vulture	VU	Open Country, Cliffs
Egyptian Vulture	VU	Open Country, Forests
Demoiselle Crane	VU	Wetlands
Brown-headed Gull	VU	Wetlands
Garganey	VU	Wetlands
Ferruginous Duck	VU	Wetlands
Black Stork	VU	Wetlands
Greater Spotted Eagle	VU	Open Country
Western Marsh Harrier	VU	Wetlands, farmlands
Northern Harrier	VU	Open Country, farmlands
Pallid Harrier	VU	Open Country, farmlands
Baillon's Crake	VU	Wetlands
Pheasant-tailed Jacana	VU	Wetlands
Black-headed Gull	VU	Wetlands
Rock Eagle Owl	VU	Forests
Brown Fish Owl	VU	Forests
Brown Wood Owl	VU	Forests
Barn Owl	VU	Farmlands
Black-headed Bunting	VU	Grasslands
Little Bunting	VU	Grasslands
Black-faced Bunting	VU	Grasslands
Black-chinned Yuhina	VU	Forests
Grey Francolin	VU	Farmlands
Cotton Pygmy-goose	VU	Wetlands
Asian Openbill	VU	wetlands
Lesser Adjutant	VU	Wetlands
Indian Spotted Eagle	VU	Open country
Pied Harrier	VU	Open country
Sarus Crane	VU	Wetlands, farmlands
Dunlin	VU	Wetlands
Little Tern	VU	Wetlands
Yellow-wattled Lapwing	VU	Open heavily grazed grasslands
Red-breasted Parakeet	VU	Forests
Short-eared Owl	VU	Farmlands, grasslands
Yellow-bellied Warbler	VU	Forests
Pale-footed Bush Warbler	VU	Grasslands
Bristled Grassbird	VU	Grasslands

(continued)

Table 22.5 (continued)

Common name	National RDB category	Habitat
Kashmir Flycatcher	VU	Forests
Lesser Necklaced Laughingthrush	VU	Forests
Greater Necklaced Laughingthrush	VU	Forests
Hooded Pitta	VU	Forests
Black-breasted Weaver	VU	Grasslands
Dark-sided Thrush	VU	Forests
Golden Eagle	VU	Open Country, Cliffs
Lammergeier	VU	Open Country, Cliffs
Wood Snipe	VU	Wet pastures, forests and shrubberies
Great Parrotbill	VU	Bamboo Forests
White-gorgeted Flycatcher	VU	Forests
Golden-naped Finch	VU	Forests
Tibetan Serin	VU	Forests
Koklass Pheasant	VU	Forests
Satyr Tragopan	VU	Forests
Barred Cuckoo Dove	VU	Forests
Golden-breasted Fulvetta	VU	Bamboo Forests
Hume's Bush Warbler	VU	Forests
Grey-sided Laughingthrush	VU	Forests
Fulvous Parrotbill	VU	Bamboo Forests
Brown Parrotbill	VU	Bamboo Forests
Black-headed Shrike Babbler	VU	Forests
Common Babbler	VU	Farmlands, grasslands
Slender-billed Scimitar Babbler	VU	Forests
Tibetan Sandgrouse	VU	Open country

species for lowland grassland birds. An action plan has been made aiming to garner support for the conservation and management of this species (DNPWC 2016), status assessment and a review on the success of this plan is due for 2021. This is the first species-specific action plan endorsed on birds of Nepal by Government of Nepal (Fig. 22.8 and Table 22.5).

22.5 What Might the Future Hold for Nepal's Birds?

Over the 20 years that the assessments of the status of Nepal's birds have been produced, existing threats have been increasing and new threats have emerged. Some of the species that were identified nationally threatened with higher threat categories e.g. Black-bellied Tern, River Tern, Sarus Crane, Pale-headed Woodpecker have now even entered the global red list. Here it is important for global authorities to be more watchful on the status of species whose habitat as a whole and especially in the region are threatened and specifically those species that are specialists also on food items (usually those things go hand-in-hand for a tight correlation). If we could give them enough global attention through regional/national IUCN red lists we may not have to wait and see for the species to decline further and pick up them to list them as globally threatened. In this scenario, the IUCN-led red list of ecosystems may come handy for us (IUCN 2018).

Threats facing lowland wetland birds have now reached an alarming degree (Inskipp et al. 2016). Loss and deterioration of habitat and unsustainable resource use – notably overfishing – continue to increase. In addition, wetlands in the lowlands and lower to midhills are now highly at risk from disturbance outside protected areas. Tracks for vehicle use, some of which just now surfaced, now encircle some important sites, such as the Jagadishpur reservoir, Chimdi lake and the only wetland in the Kathmandu valley – Taudaha lake. In recent years, Badhaiya Tal's biodiversity values have been deteriorated (Ram B Shahi and Hathan Chaudhary Pers. Comm.). There are plans for conservation and development of Ghodaghodi Lake (GLM 2018) as well as for the Jagadishpur Reservoir (Manoj Paudel Pers. Comm.), which need to be watched carefully and supported by experts throughout. That's in order to ensure that it does not further lose biodiversity value and can recover. There is a new and increasing 'picnic culture' where large numbers of families and friends gather with loud music and party 'to picnic', especially at weekends and holidays and these wetlands have turned into popular picnic sites. This is not compatible with birds, especially sensitive and endangered ones. Further, the beds of rivers and streams are widely mined for sand and gravel for construction work. Although we do not have data at hand to prove this in a quantitative way we also think that global phenomena such as the unpredictability in climate and associated changes are driving many lakes towards extinction faster than before. Wetlands drying up have been a major concern in recent days all over Nepal. Farmers have complained about a decreasing level of water-table in the lowlands as evidenced by the decreased flow of water in deep-bored tube wells for irrigation. In the midhills and higher hills the disturbance in watersheds leading to a deteriorated water-holding capacity may be the main reasons for drying up and for the lower level of water. Rivers and streams are already seen to be holding less water during the dry period compared to three decades ago.

Forest losses and such type of associated deterioration are increasing (Inskipp and Baral 2019). For example, according to the Global Forest Resources Assessment (FAO 2010), Nepal lost already 7000 hectares of primary forest per year during 2000–2005, ten times more than between 1990 and 2000. While the national assessment of Nepal's forest cover in 2015 (DFRS 2015) was higher than any previous figure during the previous 40 years, this has been attributed to the creation of community forests and the spread of forest and plantations due to agricultural abandonment, as well as differences in methodologies used (DFRS 2015). However, these forests, are mainly in the mid-hills, while the Terai and Churia hills still continue to lose forests. Important to note in this discussion is the actual loss of forest wilderness and old-growth forest (e.g. where some endangered species fare well)! Further, the new midhill forests lack the richness and variety of primary forests and so are much less valuable for bird species. (Inskipp and Baral 2019).

Relatively new threats facing forests include increasing urban development and the expansion of local markets alongside major roads, which is often illegal. Unplanned and unregulated construction within forests is another major, but quite new problem, for example the building of schools, hospitals, temples and water storage tanks (MoFSC 2014). A network of rural tracks now covers much of central and eastern Nepal in the lowlands and mid-hills, most of which have been constructed without any environmental safeguards and just in the last 20 years. Arguably, those will soon or later turn into paved roads, and/or used by motorbikes, quads, cars and (micro) busses. A total of 82,934 hectares of forest land was under illegal occupation in 2012 (DOF 2012). This is 66 per cent higher than the encroached area in 1994 (MoFSC 2014). It represents another form of land poaching, or squatting and it remains a serious problem as well.

As traditional values wane, hunting, trapping and persecution of birds are increasing and those are all contributing to the decline of many species, even in protected areas. Pheasants and partridges are especially at risk here, including the globally threatened Cheer Pheasant *Catreus wallichii* from the western Himalayas; Nepal supports a high proportion of this species' population (Inskipp et al. 2016). The hunting of owls for meat has been reported in Patariya VDC, Kapilvastu district; they are popular amongst local people as they are cheaper than chicken (Paudel 2016). Owls are also persecuted because of negative social and cultural beliefs, while some young people kill birds, often using catapults purely for entertainment (Acharya and Ghimirey 2009). Some birds are hunted for traditional medicine. For example, the oil from the casque and the beak of the nationally Endangered Great Hornbill *Buceros bicornis* is much valued (Fleming et al. 1984).

In recent decades there has been intentional and unintentional introduction of alien species into Nepal. Invasion and rapid expansion of some alien plant species, such as *Mikania micrantha* have emerged as major threats to birds (Inskipp and Baral 2019). That's because *M. micrantha* grows extremely fast and rapidly it outcompetes and swamps native vegetation (Siwakoti 2007). It can quickly cover the forest floor as well as trees and shrubs; it now blankets many tropical and subtropical forests in central and eastern Nepal. Chitwan National Park and Koshi Tappu Wildlife Reserve are badly affected. At Koshi this has led to a significant decline in some terrestrial-feeding birds such as Orange-headed Thrush *Zoothera citrina* (Baral and Adhikari 2017).

Another new threat to Nepal's birds is the impacts of climate change. Currently these are poorly understood. One of the likely impacts is that the range of many species will shift and it can move upwards in elevation from their current locations. Some species may be able to migrate through fragmented landscapes, but these are likely to be habitat generalists (Inskipp and Baral 2019). Many species will not be able to do so, particularly habitat specialists, which have largely been assessed as nationally threatened (Inskipp et al. 2016).

Another important impact of climate change is that many habitats, notably forests and lowland grasslands will become drier. These could eventually lead to a higher number of nationally threatened species losing their habitats, for instance Sarus Crane Antigone Antigone, Ruddy Kingfisher *Halcyon coromanda,* Blue-eared Barbet *Megalaima australis* and Blue-naped Pitta *Pitta nipalensis* (Baral and Inskipp in prep, Inskipp and Baral 2019, Inskipp et al. 2016).

In the face of these threats there has been a significant rise in conservation initiatives in the country. The Department of National Parks and Wildlife Conservation (DNPWC) has increased protected area coverage to 23.2%. In the last year, Shukla Phanta and Parsa Wildlife Reserves have been upgraded to national parks. Internationally, this a high percentage of land area protected, e.g. Germany or the U.S. have less than 5% truly protected. There are now 12 national parks in Nepal, the others being Banke, Bardia, Khaptad, Langtang, Makalu Barun, Rara, Sagarmatha, Shey-Phoksundo, and Shivapuri Nagarjun. In addition, there are six Conservation Areas: Annapurna, Api Nampa, Blackbuck, Gaurishankar, Kanchenjunga, and Manaslu; one wildlife reserve: Koshi Tappu and one hunting reserve: Dhorpatan. The protected areas' system now includes buffer zones: areas surrounding a park or a reserve encompassing forests, agricultural lands, settlements, village open spaces and many other land use forms. To date buffer zones have been declared for all national parks, Koshi Tappu Wildlife Reserve and Dhorpatan Hunting Reserve. The DNPWC has widely initiated collaboration with local communities within the buffer zones and these initiatives are increasing.

For setting proper foundations, Nepal has actually made great progress on formulating many acts, policies, regulations aiming to conserve biodiversity and environment. Nepal also got recently a new constitution! The endorsement of the National Conservation Strategy (MoFSC 2014) is another milestone. This was followed by the Nepal Biodiversity Strategy Implementation Plan in 2006 (MoFSC 2014). As several new themes and issues emerged or gained prominence the Ministry of Forests and Soil Conservation also prepared the 2014–2020 National Biodiversity Strategy and Action Plan (MoFSC 2014).

However, some of the large number of measures overlap and even conflict with each other, making them pretty difficult to enforce. As found in other nations, lack of resources and lack of coordination between different government departments also create problems for enforcement and for a good conservation outcome.

So far, a total of 37 Important Bird and Biodiversity Areas (IBAs) have been identified in Nepal. While lacking relevant legal powers or a budget really, the IBA programme is a worldwide initiative by BirdLife International aimed at identifying, documenting, prioritizing and working towards the conservation and sustainable development of a network of critical sites for the world's birds and other biodiversity, termed Important Bird and Biodiversity Areas or IBAs. Bird Conservation Nepal (BCN) is leading this initiative in Nepal, aided by the Royal Society for the Protection of Birds, UK and BirdLife International (BCN and DNPWC 2011). In the first IBA assessment in 2005 a total of 27 IBAs were identified in Nepal (Baral and Inskipp 2005). In terms of area, over 85% of IBAs lie within Nepal's current protected areas' system (BCN and DNPWC 2011). Since 2005 BCN has worked on initiatives to conserve Nepal's IBAs throughout Nepal, alongside the Government of Nepal (GoN) departments and NGOs in the country (BCN 2020a).

In 1993–1995, the GoN started to establish community forestry. It represents a rather successful participatory forest management system. The objective is to achieve sustainable management by handing over the management of forest resources to local communities, who tend to know local situations best and who become the own stewards of the resources and its land! This system has achieved high uptake levels; by August 2017 about 35 per cent of the Nepal population was involved in community forestry management programmes in 74 out of 75 districts (DoF 2018). However, most community forests are in the midhills and the programme has been less popular in the Terai and high mountains (MoFSC 2014). Still, formerly degraded forests are gradually being restored and their value for birds must be increasing as a result. It represents a good way of bottom-up conservation involving local people and benefitting birds.

Projects and programmes to raise awareness of birds and the need for their conservation are increasing throughout Nepal. One spectacularly successful annual event has been the Friends of Nature's Owl Festival which has taken place at a different location every year since 2012. In 2017, for instance, many thousands of local people attended and engaged with the festival which was held at Jagadishpur, a wetland RAMSAR site and IBA in western lowland Nepal (Friends of Nature 2018). Himalayan Nature has established Nepal's first bird observatory and field education centre north of the Koshi Tappu Wildlife Reserve, known as Kosi Bird Observatory (KBO). Koshi Tappu is a Ramsar Site and a well-known migration area for birds in the far eastern lowlands (Himalayan Nature 2020). Currently KBO can accommodate more than a dozen people at a time and is able to provide support to researchers who wish to conduct their studies on wetlands and grasslands of Koshi Tappu as well as the forested Churia hills northward and the Dharan-Patnali forests IBA. So far the observatory has been already used by Charles Sturt and Tribhuvan University students of Australia and Nepal respectively, as well as a number of conservation organisations in the country e.g. Resources Himalayan Foundation, Bird Conservation Nepal, Nepalese Ornithological Union, Nepal Biological Society, Biodiversity Conservation Society of Nepal, etc.

In 2015 BirdLife International and Bird Conservation Nepal (BCN) implemented a three-year project to mainstream the topic of biodiversity into community forestry practices. The project aimed to raise awareness of the great values of biodiversity and the many steps that local communities can take to conserve and use it sustainably. BCN worked here with the Department of Forests and local community forest users (BirdLife International 2015).

Conservation awareness also plays an important role in BCN's Vulture Conservation Program (BCN 2020b). Recently, BCN established a bird and biodiversity conservation learning centre in the Ranbari Community Forest in the Kathmandu valley. The aim is to benefit local people from Kathmandu and the adjacent cities of Patan and Bhaktapur in the valley (BCN 2020c).

Conservation activities to prevent the extinction of some globally threatened species have also been carried out, notably the BCN's Vulture Conservation Program.

Four of Nepal's residnt vulture species are globally Critically Endangered: White-rumped Vulture *Gyps bengalensis,* Slender-billed Vulture *G. tenuirostris* and Red-headed Vulture *Sarcogyps calvus* as well as the Egyptian Vulture *Neophron percnopterus* which is globally endangered. The cause of these declines has been shown to be the veterinary drug diclofenac (Oak et al. 2004), although food shortages and loss of nesting trees are also thought to be slowing the species' subsequent recovery, amongst other possible factors. In order to halt the decline of these vultures, the GoN put a ban on the production, import and use of veterinary diclofenac in June 2006, It also endorsed the first Vulture Conservation Action Plan for Nepal (2009–2013), followed by a second Action Plan, 2015–2019. The main objective of the Action Plans is to prevent the extinction of vulture species by ensuring re-introduction, safe food supply, maintenance of suitable habitat and a better understanding of the ecological importance of these birds in Nepal with a goal to revive viable population of vultures in the wild (DNPWC 2015).

There are also ongoing efforts to conserve the globally Critically Endangered Bengal Florican *Houbaropsis bengalensis.* Surveys north of Koshi Tappu Wildlife Reserve carried out in 2011 located a new population of 12 pairs (Baral et al. 2012). A survey in the same area the following year actually found 47 individuals, making this the largest Nepal population (Inskipp et al. 2013). Since 2012 BCN has been carrying out research on the bustard's ecology and habitat management, satellite tagging and monitoring, education awareness, and working with governmental protected area staff and communities in order to manage grasslands in breeding and non-breeding areas (BCN 2020d).

Other single species initiatives include surveys for the globally threatened Swamp Francolin *Francolin gularis*, Lesser Adjutant *Leptoptilos javanicus,* Great Slaty Woodpecker *Mulleripicus pulverulentus* and the Sarus Crane *Antigone antigone.*

Despite the grave and increasing threats, the wide range of efforts to conserve Nepal's birds carried out by the Government of Nepal, international NGOs such as the Zoological Society of London (ZSL), International Union for Conservation of Nature (IUCN) and World Wildlife Fund (WWF) in Nepal, national NGOs, including Friends of Nature, Bird Conservation Nepal, Himalayan Nature, National Trust for Nature Conservation, Pokhara Bird Society, Koshi Bird Society, Bird Education Society, Bardia Nature Conservation Club, Friends of Birds, Nepalese Ornithological Union as well as individuals are most heartening. Citizen science is also playing an increasing significant role in bird conservation, for example local people are being trained to survey some bird species in community forests in order to monitor the condition of forests and some local communities are monitoring some threatened species such as Asian Woollyneck *Ciconia episocpus.* Further, the Nepalese culture and spiritual beliefs encourage a deep-rooted respect for birds and other wildlife – for nature overall-, while there are numerous folk tales about birds which feature the seasons, weather, news and good luck (Baral and Inskipp 2004). Perhaps most encouraging is the burgeoning number of young Nepalese conservationists, birdwatchers and ornithologists who provide us with hope for the future.

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Chapter 23
A Governance Analysis of the Snow Leopard, Its Habitat and (Digital) Data: Who Owns Charismatic Animals and Who Drives and Uses the Agenda for What?

Falk Huettmann

Fly back there and tell them… the real Dragon Warrior… is coming home.
Tai Lung (Snow leopard) speaking to Zeng, Kung Fu Panda.
(Source: http://kungfupanda.wikia.com/wiki/Tai_Lung).

The snow leopard (*Panthera uncia*) is a charismatic species of the Hindu Kush-Himalaya (HKH) region; by now it is a global celebrity (Matthiesen 2008; Schaller 2012). It is naturally occurring in app. 13 nations in central Asia, and 3 subspecies are described but not fully agreed on (like with most mammals). Most famed zoos in the world have snow leopards as captive celebrity animals. But beyond being a modern status symbol of the urbanized society and of the Anthropocene (Steffen et al. 2007), this species is actually known by the local community since deep time (e.g. Karmay and Watt 2007), and it carries large value, including many spiritual believes (Li et al. 2014). Table 23.1 shows modern realities for this species and its habitat.

In modern times, situations are changing for this species though and landscapes get highly commercialized and 'developed' (Paehlke 2003; Daly and Farley 2010, see Steffen et al. 2007 for the Anthropocene, Hallard 1990 and Chaudhary et al. 2007 for Annapurna, NAST 2010 for Sagarmatha (Everest) region, Schaller 2012 and Buckley 2014 for Tibet). The snow leopard almost gets redefined (Matthiesen 2008) while it still has to evolve and habituate, otherwise the snow leopard will become extinct (Theile 2003; Ale and Mishra 2018; Amin et al. 2018). This species

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F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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Table 23.1 Metrics of 13 nations where snow leopards occur

Nation	GDP	Human popu-lation (mill)	GDP per capita ($)	Governance Type	Religion	Rio Con-vention member	Snow leopards in the wild
India	2,250	~1 bn	6, 616	Fed. Parl. Republic	Hinduism	Yes	c. 400
China	11,199	~1 bn	15,399	Communist State	Atheist, Buddhist	Yes	c. 2,250
Russia	1, 238	143	26,490	Semi-presidential Federation	Atheist, Russ. Orthodox	Yes	c. 90
Nepal	20	29	2, 479	Federal Parliamentary Republic led by Maoists	Hindu & Buddhist	Yes	c. 400
Bhutan	2	0.8	8, 227	Constitutional Monarchy	Buddhist	Yes	c. 150
Mongolia	12	3	12,275	Semi-Presidential Republic	Buddhist, Shaman	Yes	c. 750
Pakistan	284	197	5, 106	Fed. Parl. Republic	Islam	Yes	c. 310
Afghanistan	19	35	1, 919	Presidential Islamic Republic	Islam	Yes	c. 150
Kazachstan	216	18	25,145	Presid. Republic	Islam, Christianity	Yes	c.190
Uzbekistan	66	32	6, 563	Presid. Republic	Islam	No	c. 40
Kirgisia	1,103	6	3, 521	Parliam. Republic	Islam	No	c. 325
Tajikistan	925	8.4	3, 008	Presid. Republic	Islam	No	c. 200
Myanmar	64	~53	5, 832	Parliam. Republic	Buddhist	Yes	Present

Source: CIA Factbook

is by now a famed and highly-prized item of research and it gets widely considered that way. But data and information still remain few (Snow Leopard Working Secretariat 2013; Snow Leopard Network 2014; see GBIF.org query described further below). While nations, conservation agencies, NGOs and managers keep battling for the prestige and subsequent funding, in earnest, the snow leopard keeps roaming and needs to handle reality (Ale and Mishra 2018; Amin et al. 2018), namely how to habituate with humans and their lifestock (Bagchi and Mishra 2006) and climate change issues (Aryal et al. 2016). Like most predators these days, snow leopards are subsidized predators. But all of this is directly embedded in a wider global governance scheme (*sensu* Ostrom et al. 1993; Chapin et al. 2011).

As shown in Table 23.1, nations who are in possession of snow leopard habitats cover a wide variety of governance forms and religions, from capitalism and democracy to marxist-lenist over maoism and Buddhism, single-party systems, monarchies, quasi-dictatorships, diverse democracies and nations in transition, or ones that are bouncing between any system (Koshkarev and Vyrypaev 2000). While there is no real single governance that seems to fare best, judged by the conservation problems (Theile 2003; Ale and Mishra 2018), uncertainties and loss of policies and regulations-economic growth - result into a chaos state (details shown further below). So far, the best predictors for snow leopards might be vast wilderness areas, a sound wild prey base and a stable human 'culture' that can life with, and maintain, snow leopards. Arguably, the snow leopard hotspots are currently found in the mountain nations and with Buddhism as the dominant religion. China leads the game when it comes to highest snow leopard populations, with India, Nepal and Mongolia following suit.

Based on the regional recognition, the trend to global fame and exposure of the snow leopard might well have started with books like Schaller (1983), Hillard (1990), Rabinowitz (2001), Matthiesen (2008) and Schaller (2012), who gave this species a narrative, a wider poetry and a high-mountain reputation (this books are now commercial bestsellers found on amazon.com). Cashing in on snow leopards and using them is far from new. Royal families and public leaders used snow leopards for long time as emblems (Table 23.2), and this species is a famed deity in Buddhism (Li et al. 2014; see for Dalai Lama https://www.economist.com/blogs/analects/2013/09/secret-weapon-battle-save-snow-leopard). Likely, the snow leopards would not agree much with how they are used, described and portrayed there (see table 23.2 for contrasting an image with reality). Snow leopards got pursued due to their fame (Theile 2003; Berger et al. 2013). The global celebrity status puts them at risk to be chased, consumed and over-valued, e.g. as tourist or poaching items.

Arguably, snow leopards are not only a species of the Hindu Kush Himalaya (HKH) and of the extreme mountains because they also occur at Lake Baikal (Russia) and in low altitude deserts of Russia, Mongolia etc. While it can live in the very high areas, Everest is not a prime place for this species (NAST 2010); in Nepal, the western dry and relatively low desert areas are the hotspots for this species. The wider question is whether this species just got pushed into the mountains due to human pressure, including cattle and blue sheep (sometimes centered around villages)? Clearly, in lower altitudes the snow leopard has reached a limit and is affected by human activities. Overall, and with so many species, snow leopards and humans do not mix well.

Always in need of high 'viewing' (likes or downloading) figures for boosting PR exposures for income, the modern global media tries to promote snow leopards at all costs (resulting into more commercial adds and products) and thus makes it a global household item linked with Everest, remote wilderness and similar world records. Like virtually all moving wildlife in the world, the snow leopard is a publicly-owned resource but virtually unprotected in the real world, and thus snow leopards carry no copyrights really and subsequently are globally used, seeked after and freely exploited as a global brand ('global' means here primarily U.S. - specifically California as one of the largest business entities in the world, beyond most nations- as a large/dominant captialist market whereas the U.S. actually has no snow leopard in its territory hardly an experience or jurisdiction on the matter; see the MAC operating system OS X Snow Leopard; https://en.wikipedia.org/wiki/Mac_OS_X_Snow_Leopard) or Hollywood and other entertainment shows and commercial enterprises (see for instance Tai Lu, in Kung Fu Panda: http://kungfupanda.wikia.com/wiki/Tai_Lung) whereas relevant science and science-based conservation still is very little. Related democracy, human rights and governance issues

Table 23.2 A selection of logos and emblems that 'use' the snow leopard

Logo item	Nation	Where used
National icon	Kazakhstan	Flag
Bank note	Kazakhstan	Currency
National icon	Uzbekistan	Flag
National icon	Kyrgisia	Flag
Logo	Bishkek	Girl Scouts
Municipal emblem	Shushensky District of Kasrnoyarsk, Russia	Flag

in its habitat nations of occurrence rarely hit the news even (Table 23.1). Instead there is a wide and longstanding ruthless approach to cashing in on snow leopards, and to simply use them for own nationalistic purposes without any relevant constrain or reason (Table 23.2).

But what really set the global stage for the snow leopard's fame is the British Broadcast Corporation (BBC, a public tax-paid media company from the U.K.), specifically the TV and its movie material-seeking subcontractors. British media -directly embedded with it royal governance – was never shy of boosting their colonial assets, wildlife for a green-wash included. As Mills (2016) shows in good detail, the BBC has already been frequently accused of uncritical one-sided reporting. It simply has an industrial- and (oil/nuclear) donor-friendly profile. It was widely coined a British-industrial propaganda news outlet that is provided with a global stage and news room to emit its uncritical messages unconstrained. The consistent media campaigns by the BBC – including the recent movies by Sir David Attenborough trying to present with a self-acclaimed authority – certainly helped to create a globally-known reputation and an image of 'the snow leopard' but one that is easy to challenge (The Guardian 2017; Table 23.3); apart the fact that research details actually are 'few' (Matthiesen 2008). That leaves the snow leopard in the hands of whoever wants to assign details and provide a narrative as needed, and to be used as suitable and without constrains for personal gain. The snow leopard can easily be bought, and consequently the global powers happily make use of this option. There are virtually no ethical taboos on that issue in the media or in the western world overall. It's actually encouraged by most leading politicans to grab public entities for the private good; often with a tax-exemption. Those details, when presented with an authoritive-sounding voice, in TV publically-paid mainstream and repeated many times -through kindergardens and schools- finally creates a gospel (Cockburn 2013 for media examples and its status and outcome); it cannot result into any other. Those concepts are difficult to challenge for most people and who have never been in the landscapes of the snow leopard, and never will. Information on snow leopards can be used for demagogy! These profiles do matter for the research, conservation and funding (Ale and Mishra 2018), and for land management overall, and how we relate as humans to snow leopards, its habitats of the earth (see Chopel 2014 for harmony and balance with nature in Asia and Buddhism). It comes as a self-fulfilling prophecy!

This media-landscape goes hand-in-hand with the power players in the world of snow leopards. Despite 13 nations being involved, there are just a few power

Table 23.3 Snow leopard characteristics that one finds in the media, and some biological facts and context

Statement found about the snow leopard	Biological fact
Virtually impossible to ever detect	Common occurrence in some places, usually related to human activities, e.g. cattle (yak) ranching and herding. Locations with high occurrence are known.
Fierce predator	By definition, all predators do kill (that includes shrews, pandas, wasps, falcons and many virus's).
Single predator	No animal is 'single'; virtually all mammals, certainly cats, life in certain communities and societies. They maintain social interactions and networks (often on a large-scale). Snow Leopard tourism can be booked in India with high guaranteed sightings (=many individuals are clustered and nearby, almost guaranteed). Camera-trapping in Nepal shows sometimes two or more individuals in one photo.
Very high-altitude species	Snow leopards occur in a variety of habitats and altitudes, including lower elevation deserts.
The only predator in the region	Many are found nearby and wider predator communities usually occur Many sites in Nepal have over 10 predators all co-occurring in the same habitat (see also Lama et al. 2017).

brokers, as implemented through Non-Governmental Organizations (NGOs) and international aid donors. A selected list of some relevant NGOs – usually even acting as advisors to those nations – are listed in Table 23.4 (Unfortunately their budget numbers are not really publicly available). Those NGOs need PR and media though to raise more funds and also to justify they spent money well from the funders (Table 23.5). But arguably, those funders are not necessarily in agreement with governmental agencies, with 'science' or with the tax payer and the wider public good (Paehlke 2003; Rosales 2008).

Often budgets are not sufficient and not assigned well for wildlife conservation. Many governments lack awareness and capacity and it does not allow for managing this species well. Like any other species, snow leopards need a national infrastructure to be managed well and for survival (Silva 2012); species that lack such a support tend to become extinct quickly (e.g. Czech et al. 2000). Often, that infrastructure and legislation for snow leopards -as well as for most other animals and plans – is weak, has no power or even is corrupted. Linking it with development aid is even more dubious as the notion of 'aid' is highly debated (e.g. Erler 2001), specifically if it comes to sustainable development. These species get marginalized as an inherent part of the dominating global governance (Paehlke 2003; Daly and Farley 2010; see also Theile 2003). A relevant and effective global science-based snow leopard conservation management plan is widely absent for this migratory species crossing boundaries all the time (see latest IUCN efforts and discussions; Ale and Mishra 2018). There are laws and well-sounding texts and plans dealing with snow leopards (e.g. WWF 2015), but they are either not well enforced or fail to achieve the wider breadth of snow leopard realities, including global governance, human poverty and greed. The track records of those decade-long efforts is rather clear: either animals

Table 23.4 A selection of NGOs and agencies working on snow leopard

NGO	Headquarter	URL	Comments
Snow Leopard Conservancy	Sonoma, California U.S., and Ladakh	http://snowleopard-conservancy.org/	Private NGO
Snow Leopard Trust	Seattle, U.S.	https://www.snowleopard.org/	Private NGO
WWF (Nepal, India, Mongolia, U.S. etc.)	Various capitols	Various websites, see for instance https://www.worldwildlife.org/	A NGO with mixed funding.
Snow Leopard Foundation	Islamabad, Pakistan	http://slf.org.pk/	
IUCN Cat Specialist Group	Muri, Switzerland	http://www.catsg.org/	A United Nation NGO with semi-private funding
Panthera Corporation	New York, U.S.	https://www.panthera.org/	
Defenders of Wildlife	Washington, D.C. U.S.	https://www.defenders.org	
NABU (Nature and Biodiversity Union)	Berlin, Germany	https://en.nabu.de/	One focus is on Kyrgystan, supported by German governance
Wildlife Conservation Society	New York, U.S.	https://www.wcs.org/	
Flora and Fauna International (FFI)	Cambridge, UK	https://www.fauna-flora.org/	
Whitley Fund for Nature	London, UK	https://whitleyaward.org/	A funder closely aligned with the royal family

and habitat are on the decline, or the situation remained somewhat unchanged without relevant improvements.

There are also many protected areas in the snow leopard range, but they are either 'paper parks' (Harris 2008; Buckley 2014) or ignore the fact that human efforts drive prey abundance, which then attract snow leopards in return (see Bagchi and Mishra 2006). Many snow leopards actually live outside of protected areas. Those protected areas are not effectively designed for this species nor is a protected area really a good concept for wide-roaming species anyways. These areas are usually created *ad hoc*, can lack science, done without a relevant and coordinated strategic plan and do not protect the species much in times of climate and global change. They do not comply with best professional practices (e.g. Moilanen et al. 2009). The impact that protected areas have on local people gets widely ignored, and it pushes people increasingly into cities, destroying nomadic lifestyles and cultures and consequently, landscapes (Buckley 2014), and so the snow leopard itself.

To show other ongoing problems with the global governance scheme, Kyrgystan has lost in times of capitalism perhaps more than 50% of its snow leopard population; other nations report similar trends (for latest trends of poaching and traffic see http://www.traffic.org/). Adding the rate of development and the Anthropocene leaves hardly another other result. The global governance also drives a lot of research

Table 23.5 A selection of known funders who support conservation, research, NGOs and events related to snow leopards

Name of funder	Business of the funder	Comment
The World Bank	Global lending and currency and economy	Probably the biggest bank in the world and directly dealing with global sustainability questions
Global Tiger Initiative	Conserve tigers and cats	A World Bank supported initiative
US Agency for International Development	Promote Development with a U.S. focus	Of national and global strategic importance
Global Environment Facility	Support Environmental Issues worldwide	
UNEP	Environmental Program of the United Nations	UNEP has been a hard-core long-term supporter of Economic Growth, Industrial Aid and win-win narratives to promote Sustainable Development worldwide.
GIZ (Deutsche Gesellschaft fuer Internationale Zusammenarbeit)	German Development Service	A rather disputed concept and funder (e.g. see Erler 2001). GIZ is private company in Germany (GMBH) working on global governance issues on behalf of 'Germany'.
WWF (World, Nepal, Pakistan respectively)	A global NGO for conservation	Most big NGOs have c. 80% administration and overhead, thus, are not effective in conservation and science on the ground but focus the most on fund raising, admin and PR

Comment by the author: To my knowledge there is no single global list of funders for snow leopards nor are any donations recorded, exposed or made publicly available, despite being tax-excempt and claiming 'to do good for the snow leopard'. Arguably, without adressing poverty all efforts must ~fail.

questions itself (Table 23.6), and it turns into a circular argument where no relevant progress is provided eventually.

For being effective and for leaving a mark, all information on snow leopards should be shared among all actors and with the public for best-possible joined research and management efforts within the overall range of the species. This aligns with open access policies common in most of the world and mandated for all polar regions, nations and funders, e.g. Zuckerberg et al. (2011). Arguably that did 100% not happen for snow leopards, thus far, and own agendas and policies drive the actions instead. This can easily be seen for any citizen in the lack of open access data sharing for snow leopards, namely in GBIF.org and in Movebank.org. The data points found in GBIF (Fig. 23.1), and with geo-referencing defies the budget spent on such research and management for decades (see for instance WWF India report https://c402277.ssl.cf1.rackcdn.com/publications/1135/files/original/Snow_Leopard_Conservation_Highlights.pdf?1513698556). Where are the data and the outcomes?

Table 23.6 Research schemes that drive a lot of the agenda for snow leopard science

Research characteristic	How applied	Reality problem
Descriptive	Describe existing data	Does not test data or put's them to use and for generalization
Highly fragmented	Context not considered	Results into bias, lacks wider context
Reductionist	AIC model selection	Biased, ignores wider picture
Use of p-values	Based on narrow hypothesis	Nature has no repeats nor is it normal distributed or significant
Camera-traps	Occurrence	Unresolved research design and detection problems
Population trend focus	Capture-mark-recapture and expert knowledge	Narrow focus and which usually has no relevant management follow up
DNA focus	Subspecies splitting and lumping, dispersal	DNA research is not mature yet nor accounts for relevant conservation, e.g. habitat views
Human-conflict	Killing of livestock	Does not resolve the problem that an overcommercialized farming invades wilderness areas. Poverty issues not addressed.
Climate change	Outlook based on warming	Real issue of consumption and oil culture is not addressed

Instead of that obvious reality, the Rio Convention countries actually have fully agreed (=publically agreed and all done in writing globally heralded!) to share all their data open access in GBIF.org. Further, all Best Professional Practices demand for the same, and so does any collegiality among scholars of snow leopards, in case that matters? What is the public benefit and concern? How can a best-available science-based conservation ever be achieved when data and information are not shared and developed further?

Arguably, snow leopard data are owned by the nobody really; a public good. That's because snow leopards are also a public good; they are roaming free across borders. Instead, those data are claimed by entities who insist of their copyrights. Those groups use their publicly provided privilege to work on such a species and with research permits just to further their own advantage, e.g. for raising funds, showing (conservation) progress when there is none (or little), and making a living with claims of working 'for' and 'on behalf of' the snow leopard. Many 'selfies' can be found of those investigators posing with narcotizied snow leopards. Many of those entities and their experts even come tax exempt, and thus even further feasting on public property and a public trusted resource (here an endangered species). The status of this animal and its habitats – namely the atmosphere – shows clearly how it all fails (Aryal et al. 2016). It remains pathetic for the snow leopard and its habitat, and those experts and infrastructures do not make it better, e.g. MoveBank.org where such data are locked up behind passwords online for nobody's use really. It's noteworthy that the current legislations for biodiversity and snow leopards do not make things better, thus far (see below Table 23.7 for some details).

Table 23.7 shows international legislation that is meant to handle aspects of snow leopard well-being, but it actually interferes with national autonomy and people's democracies. And despite of many great plans, experts and policies, often with high budgets,

Fig. 23.1 The global data deluge for snow leopards: A GBIF query for snow leopards worldwide showing 256 data points; most of them are not geo-referenced (leaving 11 pixels of which 5 fall outside of the range in U.S. with zoo locations). This is an abysmal low number for a species that is studied so long and with large national, aid and NGO budgets. It indicates a wide and entrenched lack of data sharing among species experts, agencies, governments and NGOs for snow leopards, their habitats and conservation. It shows a research-based conservation scheme that is widely intransparent and not repeatable, violating all principles of what is referred to as 'science'

Table 23.7 A selection of international treaties that clearly interfere with nation's action and authority

Convention name	Aim	Effectiveness	Budget assigned
Convention on Migratory Species (CMS)	Protect all migratory species	Low	Very low
IUCN	Protect endangered species	Medium	Low
CITES	Promote trade by excluding endangered species	Low	Medium to low
Bishtek Declaration	Conserve snow leopards	Medium to low	Low
Global Snow Leopard & Ecosystem Protection Program	Protect snow leopards and their habitats	Low	Low

Source: Author

mysteriously none of those programs deal with poverty, with consumption, with sustainable development (mining) problems, with the known core causes of climate change (oil, coal) or with modern questions of carrying capacities. That is very disappointing and frustrating because snow leopard habitat gets heavily 'hammered' by all forms of (human) stressors, and specifically in the last decades, e.g. mining in Tibet and Mongolia, over-commercialized life stock in Nepal and Tibet, fences, electrification and climate change, just to name a few issues among many (e.g. https://www.snowleopard. org/mining-permits-in-mongolia-threaten-snow-leopard-habitat-and-local-communities/).

Stakeholders are many (Table 23.8). But who really owns the snow leopard and its habitat, or atmosphere? And those who work and claim this species, obtaining required study permits, how are they making the situation better and 'pay back' the wider community, globally? What ethical guidelines are really used, and how are they assessed? So far, I see only two sets of ethics: weaker religious ones (e.g. Li et al. 2014), and none at all (= atheist and also referred to as ignorance; Bandura 2007).

By now, and like done elsewhere and with topics they cannot relate with, or manage well, the western society has created another mysterious being: the snow leopard. And this has been done before (Lowe 2004 for the Togean Macaque in Indonesia). Such policies become a template and when the world 'out there' is bigger than humans can comprehend. The snow leopard makes such a case. The science around snow leopard and its output and gain is relatively marginal and little, when compared to other research schemes and research machineries like genetics, diseases or even, birds or insects let's say. There are just very few universities, institutes and agencies where snow leopards are actually studied. There is no degree in 'snow leopard science' neither, and many experts are not even located at universities. The coordination of research is even poorer and the management is beyond effective. Great words rule the game, e.g. as so frequently done at international conventions and in the media. The public is so eager to see environmental progress, any progress on conservation. But overall, the research applied to snow leopards presents just another science that is marred by, and further decays in, capitalism and related objectives without relevant progress for conservation, for the species of concern, or the habitat and the atmosphere. More consumption, or economic growth,

Table 23.8 A selection of stakeholders of snow leopard and their habitats and atmosphere

Stakeholder	Type of use and ownerships	Legality and justification
Nomads	Shared land, cattle	Sophisticated sharing since deep time
Settled herders	Claim land and cattle	
Nations	Own the land	Given ownership by the global governance (U.N.)
Urbanites	Media reports etc.	Democracy by mass
Developers	Want to develop wilderness	Power by expectation
Tourists	Want to see animals and habitats	Tourist companies
Banks	Own money that values properties	Power given by government
Lawyers, courts and policy	Regulate property and nation	Power given by government
Global public	Global consumer	None really

Source: Author

-business as usual-will not help (Czech et al. 2000; Czech 2002; Paehlke 2003). Putting animals in captivity will unlikely allow for wilderness and species habitats that this species really needs for being sustained. The focus must be on wilderness if snow leopards – as we know them – are to be maintained (see Rockström et al. 2009 for details and options). Table 23.9 shows some basic concepts widely used and promoted in the public management sphere (Silva 2012; Snow Leopard Working Secretariat 2013; WWF 2015). However, those are contradictory to each other and that can never achieve good conservation of goals for snow leopards.

Table 23.9 A list of concepts and features that stand in the way of effective snow leopard conservation

Underlying concept	What it means	Who promotes it	Why it cannot achieve well
Economic growth	Resource consumption and extraction	Most nations, The World Bank, Asian Development Banks, mining companies	Earth and natural resources are finite and limited; carrying capacity (Daly and Farley 2010). Laws of thermodynamics!
Use industrial profit to pay for science and philanthropy	Money created from natural resources is spent to a lesser degree on environmental issues (the ratio is often 10:1 or much less)	Most nations and international corporations and their foundations, e.g. Volkswagen, Bill Gates and Google	The wealth that created those funds is based on the resources needed by the environment (see for instance Czech 2002).
Sustainable development	Pushing man-made habitat conversion and habitat loss while the environment and wilderness looses	Most nations, The World Bank, Asian Development Banks	One-sided approach to governance; poor global track-record (e.g. Mace et al. 2014).
NGO in the driver seat	NGO funders set the agenda	Funders of NGOs and 'western governance scheme'	One-sided approach driven by funders.
Fragmented research and conservation	Research without much coordination and with many aims not lining up well for a wider goal, vision and mandate even.	Competitive research	Isolated and singular efforts while ignoring the wider context.
Data are not shared	Lack of information for most actors and the public audience	Over-emphasized and mis-understood copyright concepts	Uninformed sub-optimal decision-making.
'Highly competitive' research	Selfish research approach ignoring the wider public good	Most funding agencies	Narrow and biased research agenda not addressing the wider public good. Just a designed pseudo-competion and agreed artefact among funders to look 'good'/ competitive.

(continued)

Table 23.9 (continued)

Underlying concept	What it means	Who promotes it	Why it cannot achieve well
Land use consumption	Habitat and resource consumption	Western governance	Finite resources used up.
Poverty ignored or not mitigated	Poverty left unabated	Globalization	Undemocratic and unfair.
Ignore climate change	Relevant conservation problems were ignored	Current global governance and its ineffective institutions	Leaves out the major, global topic of our time.
Western style globalization	Marginalization of the environment	Most nations, The World Bank, Asian Development Banks, mining companies	Poor track record re. wilderness, conservation and climate change.

In its resource-eating and consumptive ways, the ‘modern’ western world and its governance has already fully consumed the snow leopard. It got widely domesticated, certainly habituated (see Wegge et al. 2012 for an example), mis-judged and mis-labeled. Like with many other species, the western society has claimed it and virtually conquered it. And thus, the snow leopard takes the same fate like the killer whale, or the chimpanzee, the red panda, the great panda and the tiger (Karanth and Nichols 2002). In such a ‘business as usual’, the snow leopard is bound for the way of the dodo (Quammen 1997). By now, snow leopards are used to make rich people richer and confirming some bad ruling elites (see history of ‘modern science and outcome’; Cooner 2005) while the majority of the world’s citizens have not seen this species, cannot protect it in the wild and have other struggles to fight in times of an imposed modern global governance (Chaudhary et al. 2007; Rosales 2008) that is knowingly marginalizing the environment (Daly and Farley 2010) and what-else stands in its way: the atmosphere, wilderness, predators or anything that is not making sufficient money for them in their value system. If this continues and is meant to be a rock-solid policy, the only items we really have left then is hope, humbleness and human effort for change and spirituality. Those can perhaps withstand such a gigantic beast of a globalization that has lost its taboos.

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Chapter 24
The Annapurna Conservation Area Project (ACAP): Towards a Success Story in Landscape Feature and Watershed Conservation Management

Jamuna Prajapati, Falk Huettmann, Tashi Rapte Ghale, and Ganga Ram Regmi

24.1 Introduction

Protected areas (PAs) are essential concepts to conserve wild flora and fauna and for maintaining ecological processes such as the food chain that are expected to contribute for sustainable development and poverty reduction (Neto 2003; Scherl et al. 2004; Rogerson 2011). Numerous PAs throughout the world, however, are not financially self-sufficient; as a result, they are unable to meet either conservation or development objectives (IUCN 2005). Those are commonly referred to as 'paper parks'. Nepal's formal conservation efforts probably began in 1973 when the Department of National Parks and Wildlife Conservation was established. It was vested with power to declare national parks and wildlife reserves (Heinen and Kattel 1992). The Annapurna Conservation Area (ACA) is Nepal's largest protected area covering 7629 km^2 in the Annapurna range of the Himalayas across the Manang, Mustang, Kaski, Myagdi, and Lamjung districts. The area ranges in altitude from 790 m to the peak of Annapurna I at 8091 m. Although ACA has been in place since 1986, it was only legally recognized as a PA only in 1992 with a mandate to protect the environment, manage ecotourism and promote sustainable development. A major goal of ACA in its official management plan is "*to promote nature conservation through sustainable development of tourism*" (ACAP 1997). The Annapurna

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J. Prajapati (✉) · T. R. Ghale · G. R. Regmi
Third Pole Conservancy, Kathmandu, Nepal
e-mail: prajapatijamuna51@gmail.com

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department,
University of Alaska Fairbanks, Fairbanks, AK, USA

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Conservation Area Project (ACAP) operates under the guidance of the National Trust for Nature Conservation (NTNC), Nepal's leading non-profit, non-governmental environmental organisation which is self-funded by entry user fees and has started an innovative and successful approach to natural resource and tourism management in the Annapurna region (UNESCO 2010) (Figs. 24.1 and 24.2).

Fig. 24.1 Photo of Manang village with Mt. Annapurna III & Mt. Gangapurna. (Photo credit: Tashi R. Ghale)

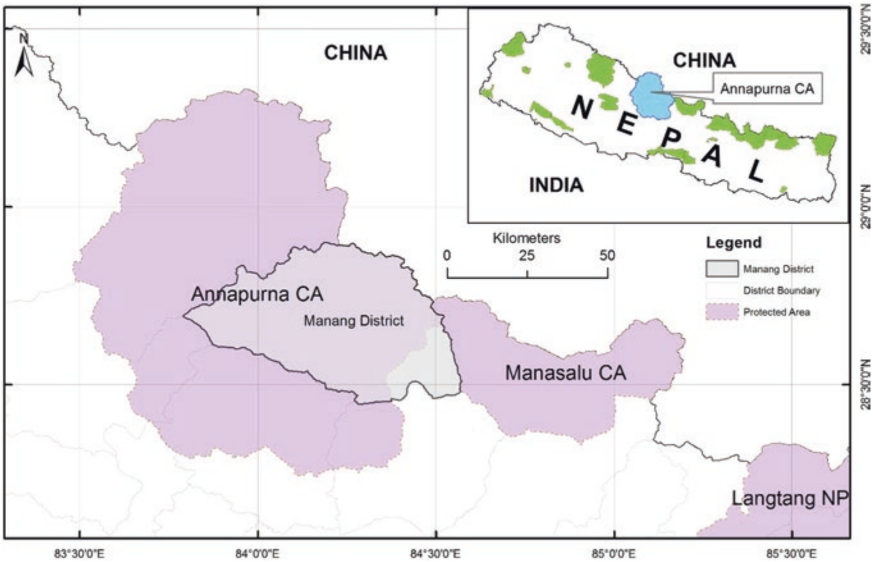

Fig. 24.2 Map of Nepal showing Annapurna Conservation Area (ACA)

24.2 Establishment of Annapurna Conservation Area Project (ACAP)

ACAP was initiated in 1986 from the Ghandruk village as a pilot project integrating nature conservation and community development. ACA is the first initiative in conservation history of Nepal where local communities were directly involved -bottom up – in the management of the protected area. It is the ACA, where NTNC developed and tested an Integrated Conservation and Development Program (ICDP) model of conservation, and which has now become the role model both at national and international level. It was designated as "Conservation Area" by the Government of Nepal in 1992. Since then, NTNC has been managing the area focusing on the ICDP approach. ICDP theorists suggest that longer time frames, careful attention to social structures and organization, and extensive education and capacity-building for independent local planning are keys to successful ICDPs (Brown 2002; Wells et al. 2004; Spiteri and Nepal 2006). ACAP is the largest protected area covering 7629 km^2 in Nepal and spreads in five districts i.e. Manang, Mustang, Kaski, Myagdi and Lamjung. Clearly, recognizing that local participation is a vital key aspect of environmental conservation, And ACAP has been incorporating local communities in all steps of development: from planning to implementation and monitoring (NTNC 2016). Generally, many indigenous communities, settlements and people and cultures were evicted in the process of protected areas creation all over the world and over times, this processes were not economically viable, socially feasible or politically justified for the extension of the protected areas network. Therefore, a pilot project was implemented in the Annapurna region of Nepal to test a new concept in protected area management: conservation with economic development which includes active involvement and management by local people, being self-sustained through tourism entry fees and other economic activities (Sherpa et al. 1986). The conservation area was recognized legally as a protected area only in 1992 after an amendment of the National Parks and Wildlife Conservation Act of 1973 (Heinen and Mehta 1999) (Fig. 24.3).

24.3 Wetlands, Watersheds and Rivers

The wetlands and watersheds are the lifeline for biodiversity and people in such a wider landscape. The Annapurna-Dhaulagiri region is very rich in such watersheds which not only serves as the prime and associated habitat for many wildlife but also hosts the primary sources of livelihood for many indigenous people and communities. The glacier-fed rivers of the Annapurna region are the major sources of drinking water and irrigation in the lowland. The river-valleys such as Marsyangdi and Kaligandaki are the major landscapes for human inhabitants and for agro-pastoralism. The deepest gorge of the world made by the Kaligandaki river over millions of years is one the sensations in the region and the valley itself is used by

Fig. 24.3 Photo of Lo Manthang-Upper Mustang. (Photo credit: Tashi R. Ghale)

Table 24.1 A selection of wetlands of the ACAP region

SN	Name of wetlands	Location	Associated wildlife
1	Damodar Kunda	Surkhang VDC	Snow leopard, brown bear, wild ass, wolves, fox etc.
2	Tso- Longkyok	Chonup VDC	Wolves, snow leopard etc.
3	Gyaka lake (glacier lake)	Lo Manthang VDC	
4	Chung Jung	Chonup	Wolves, snow leopard, etc.
5	Ghami lekh (highland pasture)	Ghami VDC	Snow leopard, wolves, wild yak
6	Kali Gandaki	Mustang	Snow leopard, wolves
7	Gangapurna lake	Manang	
8	Marsayandi	Manang	
9	Ice lake	Manang	Snow leopard, Pallas's cat, wolves etc.
10	Tilicho	Manang	Snow leopard, wolf, red fox etc.
11	Kali Gandaki	Myagdi	
12	Dudhpokhari	Lamjung	
13	Seti	Kaski	

many migratory birds for seasonal migration from Russia and far east Asia. These watersheds are also the good indicators of healthy ecosystems and could be the metrics for measuring climate change impacts (Table 24.1 and Fig. 24.4).

Fig. 24.4 Photo of Tilicho Lake-Manang. (Photo credit: Tashi R. Ghale)

24.4 Climate

The climate fluctuates with altitude and phase. The average daily temperature decreases between the months of December and February. It reaches a maximum between May and July due to the southerly monsoon, which occurs between June and September. The rainfall type is related to aspect, altitude, and the presence of a rain shadow effect. There is always a specific topographical impact in a country like Nepal that consist of two ecological regions: Cis Himalayan region (Madi river, Bhujung region, Lower Kali Gandaki valley, Lower Marsayandi valley, West of Madi areas.) and Trans Himalayan region (Upper Kali Gandaki valley i.e. Upper Mustang to Upper Marsayangdi Valley i.e. Manang and Nar-Phoo). In the cis Himalayan region, the average annual rainfall ranges from 193 mm in the trans Himalaya region of Mustang to 2987 mm at Ghandruk (BCDP 1994).

ACA faces two distinct climatic regions within an extent of just 120 km and an altitude of 1000–8000 m. At that regions, the average annual rainfall was 3000 mm in the south, and less than 500 mm in the north (Bhuju et al. 2007; NTNC 2012). Higher temperatures are shifting Asian monsoon's path though towards the foothills of the Himalayas resulting into extreme rainfall patterns (Lau and Kim 2006). In recent years, winters have been pretty warm and snow is often widely reduced, even in areas of 4000 and 6000 m elevation (FH pers. com). The massively retreating glacier in Manang serves as a good but dramatic-tragic witness of such a global warming trend (Fig. 24.5).

Fig. 24.5 Photo of a recent warm winter in Annapurna (December 2015), elevations of 4000–6000 m are virtually free of snow by now. (Photo credit: Falk Huettmann)

24.5 Mountains of ACAP

Nepal is an inherent part of the Hindu Kush-Himalayas, the highest mountain range in the world. Eight of the fourteen eight-thousands are located in the country, either in whole or shared across the borders with China or India. Nepal has the highest mountain in the world, Mount Everest (east of ACAP). Some of those spectacular mountains in the Annapurna Conservation Area listed below (Table 24.2).

24.6 Religion and Cultures in ACA

The biological diversity of the Annapurna region is equally resembled by the cultural diversity of its people. The dominant groups are Gurung and Magar in the south, whereas Thakali, Manange and Loba are found in the north (NTNC 2017). There are about 120,000 people belonging to various ethnic groups in many villages (Baral et al. 2008). The settlement pattern is usually clumped in most Gurung villages where a more scattered pattern occurs in villages dominated by other ethnic groups. This makes the region culturally and linguistically heterogenous and precious for Anthropologist to study and to understand. Most of people in high

Table 24.2 Mountains in ACA

SN	Name of mountain	Region	Altitude(m)
1	Annapurna I	Annapurna	8091
2	Annapurna II	Annapurna	7937
3	Annapurna III	Annapurna	7555
4	Gangapurna	Annapurna	7455
5	Annapurna South	Annapurna	7219
6	Macchapuchre	Annapurna	6993
7	Tilicho peak	Annapurna	7134
8	Nilgiri	Annapurna	7061
9	Singu Chuli	Annapurna	6501
10	Hiunchuli	Annapurna	6441
11	Pisang peak	Annapurna	6091
12	Tharpu chuli	Annapurna	5663

Fig. 24.6 Photo of the Chosar Monastry, Upper Mustang. (Photo credit: Tashi R. Ghale)

mountain regions are Gurung, Bhotia and Thakali ethnic groups, whereas people living in lower cis Himalayan regions are usually mixed ethnic groups and include both Hindus and Buddhist. This is also one of the main attraction for tourists. The Muktinath temple (Lord Shiva temple) located within the conservation area, is religiously a very important place for both religions and millions of pilgrims from India and Nepal visit Muktinath temple every year (Figs. 24.6, 24.7, 24.8 and 24.9, Tables 24.3 and 24.4).

Fig. 24.7 Photo from the Metha (Archery) Festival, Manang. (Photo credit: Tashi R. Ghale)

Fig. 24.8 Photo from the Tarkya Festival, Manang. (Photo credit: Tashi R. Ghale)

Fig. 24.9 Photo from the Yartung Festival, Manang. (Photo credit: Tashi R. Ghale)

Table 24.3 Temples in ACA

SN	District	Temple	Date of establishment	Address
1	Mustang	Muktinath Temple	1814	Muktinath-1
2	Mustang	Kagbeni Temple	1986	Kagbeni-8
3	Mustang	Krishna Gandaki Temple	2007	Kagbeni-9
4	Mustang	Ganesh Temple	1994	Jomsom-8
5	Mustang	Shiva temple	1995	Marpha-5
6	Mustang	Damodar Kunda Temple	–	Surkhang VDC
7	Mustang	Katyayeni Bhagawati Temple	2012	Jomsom-7, Mustang

The cultural diversity of ACA is only rivalled by its biodiversity, as it is a global treasure house consisting of 1226 flowering plants, 102 mammals, 485 birds, 41 reptiles and 23 amphibian species. The area is one of the most popular trekking destinations for visitors from all over the world. ACAP has been integrating natural resource management with alternative energy, ecotourism, gender development, and other community development programs (NTNC 2016).

Table 24.4 Gombas/Stupas in ACA

SN	District	Stupa and gumbas	Date of establishment	Location
1	Mustang	Tahlung Gumba	7 years old	Kuncho VDC
2	Mustang	Chhulthing Gumba	800 years old	Latay-5
3	Mustang	Makilhangkaang Gumba	1500 years old	Kobang-5
4	Mustang	Mdee Gumba	1500 years old	Kobang-3
5	Mustang	Mahalaxmi Nasong Gumba	Closed	Kobang-6
6	Mustang	Naram Gumba	Closed	Kobang VDC
7	Mustang	Sampa Gumba	700 years old	Tukuche-6
8	Mustang	Mahakali Gumba	1000 years old	Tukuche-2
9	Mustang	Rani Gumba	1000 years old	Tukuche-7
10	Mustang	Chhupar Dogang Chhyoling Gumba	250 years old	Tukuche-5
11	Mustang	Tasi Lhwarwang Gumba	800 years old	Tukuche-6
12	Mustang	Samteling Gumba	1000 years old	Tukuche-2
13	Mustang	Chhero Tibatti Sharanaarthi Camp Gumba	58 years old	Marpha
14	Mustang	Syang Gumba	32 years old	Marpha-6, Syang
15	Mustang	Chhenchhe Naling Gumba	200 years old	Marpha-5
16	Mustang	Chhahara Gumba	Closed	Marpha-5
17	Mustang	Urgen Chhyokoling Gumba	Closed	Marpha-6
18	Mustang	Thini Gumba	800 years old	Jomsom-2
19	Mustang	Mustang Shakya Gumba	4 years old	Jomsom-5
20	Mustang	Dhumba Gumba	Closed	Jomsom-3
21	Mustang	Kaagchhode Thuptel Gumba	1000 years old	Kagbeni-8
22	Mustang	Samduk Chhoiden (Ti. Ti.) Gumba	1200 years old	Kagbeni-1
23	Mustang	Falyak Mondaaling Samduk Gumba	250 years old	Kagbeni-5
24	Mustang	Mokaling Saampaling Gumba	Closed	Kagbeni-3
25	Mustang	Thupten Samteling Gumba	Closed	Kagbeni-8
26	Mustang	Chechhen Kungaacholing Gumba	500 years old	Muktinath-5
27	Mustang	Tharpaa Gumba	5 years old	Muktinath 1
28	Mustang	Ghar Gumba	30 years old	Muktinath-1
29	Mustang	Jwaalaamaai (Ghormabir) Gumba	500 years old	Muktinath-1
30	Mustang	Saambaa (Saangdowu) Gumba	500 years old	Muktinath-1
31	Mustang	Jarsimha Gumba	32 years old	Muktinath-1
32	Mustang	Rigdul Kachokaling Gumba	8 years old	Muktinath-5
33	Mustang	Khingaa Gumba	500 years old	Muktinath-8
34	Mustang	Lupraa Gumbaa	500 years old	Muktinath-9
35	Mustang	Chhilki Gumba	Closed	Muktinath-5
36	Mustang	Fimwuchhe (Muktinaath) Gumba	338 years old	Muktinath-1
37	Mustang	Naamsing Maarme Lhaarwaang Gumba	Closed	Muktinath-1

(continued)

Table 24.4 (continued)

SN	District	Stupa and gumbas	Date of establishment	Location
38	Mustang	Jhinga Chyaade Gumba	Closed	Jhong-4
39	Mustang	Aamde Lhakaang Gumba	Closed	Jhong-1
40	Mustang	Jhojha Gumba	Closed	Jhong-1
41	Mustang	Menkaang Gumba	100 years old	Chusang-1
42	Mustang	Laapraangnaa Gumba	800 years old	Chusang-8
43	Mustang	Thulo Mhendu Gumba	1500 years old	Chusang-6
44	Mustang	Sano Mhendu Gumba	Closed	Chusang-6
45	Mustang	Ghaang Gumba	1500 years old	Chusang-4
46	Mustang	Tarshi Chhorling Gumba	Closed	Chusang VDC
47	Mustang	Chhuknaam Graam Gumba	Closed	Chusang VDC
48	Mustang	Chaile Gumba	Closed	Chusang VDC, Chale
49	Mustang	Chhusaang Mhani Lhwongnga Gumba	Closed	Chusang VDC
50	Mustang	Laapsaang Gumba	1500 years old	Chusang-1
51	Mustang	Dhyaakaar Gumba	800 years old	Chusang-4
52	Mustang	Bhakra Mhekaandu Gumba	Closed	Chusang-3
53	Mustang	Manwi Lhowaang Gumba	1500 years old	Chusang-3
54	Mustang	Chhusaang Gumba	1000 years old	Chusang-3
55	Mustang	Ghiling Udh Wa Gumba	1000 years old	Ghami-1
56	Mustang	Tarshi Cholling Gumba	Closed	Ghami VDC
57	Mustang	Lodhem Saylum Gharkoling Gumba	Closed	Ghami VDC
58	Mustang	Dakmar Gumba	49 years old	Ghami-8
59	Mustang	Gonkhang Gumba	800 years old	Ghami-2
60	Mustang	Tashi Darkayling Gumba	Closed	Ghami-2
61	Mustang	Sibdup Darkayling Gumba	570 years old	Ghami-5
62	Mustang	Jhayaka Gumba	1800 years old	Lomanthang-7
63	Mustang	Ghunchen Gumba	1800 years old	Lomanthang-7
64	Mustang	Choyoday Gumba	1400 years old	Lomanthang-7
65	Mustang	Jhyowamwa Layhakang Gumba	Closed	Lomanthang
66	Mustang	Lo Kunfayan Maynabi Jasang Gumba	Not registered	Lomanthang-7
67	Mustang	Manay Chyo Dhakar Ghayncheyn Gumba	Closed	Lomanthang-7
68	Mustang	Gaphur Gumba	18 years old	Chhoser-1
69	Mustang	Lobomifuk Namdodal	48 years old	Chhoser-2
70	Mustang	Chhoser guru Gumba	1500 years old	Chhoser-1
71	Mustang	Namgyal Gumba	200 years old	Chondup-1
72	Mustang	Luri Gumba	–	Surkhang-6
73	Mustang	Bho Enppo Tathhadhu Kaak Gumba	619 years old	Jomsom-6
74	Mustang	Dhyul Gumba	1000 years old	Marpha, Syang

(continued)

Table 24.4 (continued)

SN	District	Stupa and gumbas	Date of establishment	Location
75	Mustang	Shyaangko Naya Gumba	Closed	Marpha-6
76	Mustang	Marpha Gumba	Closed	Marpha
77	Mustang	Naya Tukuche Gumba	Closed	Tukuche-VDC,
78	Mustang	Kobaang Gumba	Closed	Kobang VDC, Kobang village
79	Mustang	Nharsaang Gumba	Closed	Kunjo, Taglung
80	Mustang	Nyunar Gumba	Closed	Tukuche VDC, Tukuche
81	Mustang	Kubdaaling Bhoyempo Gumba	Closed	Jomsom-6
82	Mustang	Chhechhing Kungaa Chekarling Gumba	Closed	Jomsom-5

24.7 Wider Importance of ACAP

ACAP was established to achieve a sustained balance between nature conservation and socio-economic improvement in the Annapurna Conservation Area (ACA) and thereby assisting the National Trust for Nature Conservation in achieving its goals (NTNC 2017). ACAP is very important as it applies a multiple land use method of resource management, combining environmental protection with sustainable community development, soil erosion avoidance, watershed protection and tourism management. In its concept, ACAP is kind of a perfect ‘matchmaker’ between local communities and sources of appropriate skills, knowledge, technical and financial assistance which supports communities to improve the quality of their lives. ACAP believes that without increasing the level of awareness of both villagers and visitors, lasting environmental protection and cultural diversity cannot really be achieved. This concept is rooted in its structure and policy, but goes back to the wider spirit within ACAP and its people that actually evolved for over 1000 years there. Here sits the real root of landscape conservation management for ACAP! It’s a unique contribution that should be tested and applied elsewhere.

ACAP bases its activities on three principles: They are

(i) people’s participation,
(ii) Catalytic role and
(iii) Sustainability (UNESCO 2010).

According to the Annapurna Conservation Area Project (ACAP), a total of 158,578 foreign tourists visited the Annapurna Region, which is popular for mountain views and some of the best trekking trails in the world! In 2017 the number of visitors is 38.88% higher than the figures of 2016. And this figure is much higher than the other popular trekking destinations in the same ecological zone such as Langtang National Park and Sagarmatha National Park. The elevation ranges here from 1000 m to over 8000 m, contributing to wide gradients in habitats promoting a rich biodiversity. ACA harbors 22 different forest types (including the world’s largest Rhododendron forest) with 1140 plant species (ACAP 1997).

24.8 Programs Organized by ACAP

ACAP has been organizing many programs in order to conserve the wildlife as well as to standardize the economic status of people. Entry fees from tourism are channelled back to villages for various conservation and development activities undertaken by local people; therefore, ACA's socio-economic development is more prominent than in any other protected area in Nepal (Mehta and Heinen 2001). Local Festival Support, Gumba and Mahne Chhorten Support, Rijiling cave trail construction and Archery Play Ground Support program are organized regularly in order to conserve the diverse heritage. The major long-term programs of ACAP are (I) Natural resource conservation program, (II) Alternative energy program (III) Conservation education and extension program (IV) Community Infrastructure Development Program (V) Sustainable tourism management program (V) Agriculture and livestock development program (VII) Women empowerment program (VIII) General health support program, and (IX) Heritage conservation program (NTNC 2016).

24.9 Ecotourism in ACAP

Nepal has probably benefited from ecotourism but still has some uncertainties owing to its environmental impacts and lack of monitoring mechanisms (Forsyth 1991; Nepal 2002). Carbon footprint questions remain unstudied. Whereas ecotourism has been promoted to protect biodiversity, culture and landscape for maintaining tourist attractions, while mobilizing tourism revenues to finance the park and support local livelihoods in the Annapurna Conservation Area (ACA). Recognizing its emphasis on local empowerment for conservation, ACA is generally considered a successful model for meeting conservation goals by addressing local needs (Bajracharya et al. 2005; Baral et al. 2007; Spiteri and Nepal 2008).

Ecotourism, also part of 'green economy', is one of the fastest growing segments of the tourism industry; it focuses on environmental conservation, socio-economic development and capital development. It can be observed that socioeconomic variables had a positive effect on tourism participation as it helps in environmental conservation, socio-economic development, increasing employment and entrepreneurship at a local level. The activities like participation in ecotourism, the education level, an increase in productive human capital and an increase in income had improved and transformed people's livelihoods. So, awareness and education programmes related to tourism, and strategies to increase the length of stay of visitors would be recommended (KC et al. 2015). An evaluation framework needs to include resources, communities and tourists that are interconnected through positive and negative impacts caused by tourism in economic, social and environmental domains (Ross and Wall 1999; Tsaur et al. 2006; Nyaupane and Poudel 2011). Ecotourism is susceptible though to disturbances such as political violence, terrorism, natural disasters, climate change, economic recession and instability in visitor numbers (Novelli and Scarth 2007; Bramwell and Lane 2009).

The demerits can also be observed due to ecotourism in the ACAP region. Both the tourists and local people influence the environment and natural resources in complex and uncertain ways, requiring management responses (Bajracharya et al. 2005; Baral et al. 2007). Therefore, the Annapurna Conservation Area Project (ACAP) and community-based organizations, such as tourism management committees and conservation area management committees, have been striving to develop a tourism that aims to induce minimum negative environmental impacts, educate both visitors and villagers, and generate enough revenues to manage the park, thus reflecting the essence of ecotourism. As it is an area of beautiful nature, people that are local as well as foreigners visit there. They travel many places to simply be awed and to grasp the views of the Himalayas that makes them feel good; but they also create waste and throw plastic bottles and other items in the surroundings which create ongoing pollution of an otherwise relatively natural, pristine environment. The pollution is unfavourable to the species present in the surroundings which leads to the disturbance and slowly extinct of flora and fauna. The queen of Himalaya (Snow leopard), Wolf, Beech martin, Pallas cat and other beautiful species of that area get pushed out, or affected in many ways. Ecological disturbance and habitat destruction easily takes place. Culture and religion differs across the world, and is always evolving. While western people get exposed to Nepali cultures and learn from theme, there may also be the chance of flow of the western culture among the local people that result in the loss of originality of the ancient culture. But all visitors cannot be considered as of same character, and bad behaviour could also occur. Some of the visitors for instance perform smuggling of valuable resource like Yarsagumba, and other herbal plants, insects etc. (Fig. 24.10, Table 24.5).

Fig. 24.10 Photo of a stupa near Naar village. (Photo credit: Tashi R. Ghale)

Table 24.5 Major wildlife in ACA

SN	Scientific name	Common name	TSN	IUCN	CITES	Geography
1	*Panthera uncia*	Snow leopard	183,811	Vulnerable	Appendix I	Europe & Northern Asia (excluding China) Southern Asia
2	*Panthera pardus*	Leopard	183,804	Endangered	Appendix I	Europe & Northern Asia (excluding China) African Southern Asia
3	*Canis aureus*	Golden jackal	183,817	Least concern	Appendix III	Europe & Northern Asia (excluding China) Southern Asia
4	*Vulpes vulpes*	Red fox	180,604	Least concern	Appendix III	Australia Europe & Northern Asia (excluding China) Southern Asia North America
5	*Mustela altaica*	Mountain weasel	621,947	Least concern	Appendix III	Europe & Northern Asia (excluding China) Southern Asia
6	*Otocolobus manul*	Pallas cat	552,765		Appendix	Southern Asia Europe & Northern Asia (excluding China)
7	*Ochotona daurica*	Pika			Appendix	
8	*Pantholops hodgsonii*	Tibetan Antelope	625,113	Endangered	Appendix I	Southern Asia
9	*Pseudois nayaur*	Blue sheep/ Bharal	625,156	Least concern		Europe & Northern Asia (excluding China) Southern Asia
10	*Moschus chrysogaster*	Alpine musk deer	625,039	Least concern	Appendix I in Bhutan, India and Nepal; otherwise appendix II	Southern Asia

(continued)

Table 24.5 (continued)

SN	Scientific name	Common name	TSN	IUCN	CITES	Geography
11	*Equus kiang*	Tibetan Wild ass	624,994	Least concern	Appendix II	Southern Asia
12	*Ursus arctos*	Brown bear	180,543	Least concern	Appendix I as U. arctos (Mexico, Bhutan, China, and Mongolia populations) and U. a. isabellinus; otherwise appendix II.	Europe & Northern Asia (excluding China) Southern Asia North America
13	*Marmota himalayana*	Himalayan marmot	180,136	Least concern	Appendix III	Southern Asia
14	*Naemorhedus goral*	Goral	625,149	Least concern	Appendix I	Southern Asia
15		Beech martin				
16	*Hemitragus jemlahicus*	Himalayan tahr	625,146	Vulnerable		Australia Southern Asia Africa
17	*Muntiacus muntjak*	Barking deer	625,060	Least concern		Southern Asia
18	*Capricornis sumatraensis*	Serew	898,233	Endangered	Appendix I	Southern Asia
19	*Selenarctos thibetanus*	Himalayan bear				
20	*Ailurus fulgens*	Red panda	621,846	Endangered	Appendix I	Southern Asia
21	*Felis lynx*	Lynx				
22	*Ovis ammon*	Argali	625,153	Endangered	Appendix II	Europe & Northern Asia (excluding China) Southern Asia
23	*Lepus oiostolus*	Woolly hare	625,350	Least concern		Southern Asia
24	*Procapra picticaudata*	Tibetan gazelle	625,115	Least concern		Southern Asia

24.10 Management Details of ACAP

ACA is the first protected area that has allowed local residents to actually live within the boundaries as well as own their private property, maintaining their traditional rights and access to use of natural resources. It invests whatever financial resources are available for community development and social capital building in the region (NTNC 2017). One serious drawback of community-based conservation, such as that witnessed in ACA, is the implementation of protected area legislation. ACA bases its primary strategy upon the assumption that providing development incentives will encourage people to abide by rules that are favourable to conservation. While this approach can sometimes be less effective than a regulatory approach to conservation because benefits accrue to society while costs of conservation are borne by individuals (Baral et al. 2007; Heinen and Low 1992; Heinen 1996, 2009), the community involvement in ACA has so far advanced conservation activities in many regards.

As dictated by the rules and policies, the NTNC manages ACA with the help of 56 legally instituted grass roots level Conservation Area Management Committees (CAMCs) (Baral 2009). In ACA, each of those Conservation Area Management Committee consists of 15 members; 9 members are elected by village assemblies, five are nominated by the Unit Conservation Officer (UCO) of the ACAP from special groups such as women, occupational castes and social workers, and the Village Development Committee (VDC)[1] chair is an ex-officio member. Each committee's members elect a chair and a secretary. The chair instructs the secretary to call meetings and presides over them. Committee decisions are prepared by simple majority, and the chair casts deciding votes in the case of ties; management decisions are made in regular meetings. The tenure of CAMC members is 5 years. ACAP staff provides technical support to the CAMCs for drafting management plans, complying with area regulations, developing forest inventories, and designing and budgeting for development projects. They also foster capacity building of CAMCs by providing various trainings and provide support in enforcing ACA regulations. The empowerment of CAMCs has been essential in the successful delivery of conservation benefits to local people in ACA (Bajracharya et al. 2005).

1. Village Development Committee (VDC) = VDC was used to be the lowest administrative unit of the Government of Nepal but after implementation of the new constitution and re-structured administrative structure, VDC was collapsed. Now, Gaun Palika (Rural Municipality) is the lowest administrative unit of Government of Nepal. There are currently 481 such rural municipalities in Nepal.

For better management purposes, ACA is divided into seven Unit Conservation Offices (UCO): Ghandruk, Lwang, Sikles, Bhujung, Manang, Jomsom and Lo-Manthang to ease its management (NTNC 2016). The first management mandate given by the Government to NTNC to manage ACA actually ended in 2002. But the government of Nepal has given another management mandate of additional 10 years to the Trust and again extended 10 years and now the government has given the mandate to NTNC to manage ACAP up to 2020. NTNC believes though that areas such as the ACA will ultimately have to be managed by the local people themselves.

Therefore, the focus is on building local capacity, both at the institutional and individual levels, to meet all the conservation and development goals of the people (NTNC 2017). The ACAP management in the coming years is still uncertain whether continued by NTNC for just a few years or fully handed over to local council soon. Perhaps the newly elected central and local government will decide on this matter very soon! So far, it can be seen as a success story, and when judged by other models of protected areas and the status of mother earth elsewhere.

24.11 Local Challenges and Global Opportunities in the Annapurna Conservation Area

24.11.1 Local Challenges

Nepal is predominantly an agricultural country with many subsistence farmers depending on marginal lands, fast depleting forests for fuel, fodder and timber for their immediate livelihood. The situation has been further aggravated by commercial logging, shifting cultivation, uncontrolled grazing and encroachment of forest lands all of which resulted in increased soil erosion, sedimentation, floods and landslides. Globalization has not made those things better but added stress. Similarly, the inadequate ecological consideration in development activities by western agencies and their big INGOs, and the uncontrolled influx of visitors in ecologically fragile regions have further intensified environmental degradation (Nature and People 2017).

Further, Himalayan glaciers are shrinking more rapidly than elsewhere. ACA is located at a high altitude of the Himalayas. There is a lot of impact already and coming due to man-made climate change. Because of climate change there is a rapid rate of glacier melting which affects the water resources in that area. Melting glaciers have additional major effects on the earth and its atmosphere. In the Hindu Kush-Himalayas, the melting of glaciers will affect thousands of people and many wildlife species who depend on melt water rivers for drinking and other uses. In the same way, the rise in water levels may cause floods that can sweep away people and their properties. This leads to the out-migration of wildlife as well as human which is a big loss of the area as it changes the ecology and environment – the inherent fabric – of the Hindu Kush-Himalayas.

This also leads to changes in the environment, and that change in environment may affiliate with the loss and change of biodiversity, usually on a landscape-sale. High rainfall can also lead towards flood disasters that destroy the livelihood of people and their sophisticated and evolved lifestyles. Lack of health posts and other infrastructure development directly harms people's life and the wider ecology of the life-support system. The fishes get stressed and threats due to the ongoing hydroelectricity project in the area is a targeted threat to biodiversity like Mahaseer or Sahar (*Tor* spp.), Asla or Snow trout (*Schizothorax* spp.), Katle (*Neolissocheilus* spp.), Jalkapoor (*Clupeisoma* spp.), Gonch or Bagarid catfish (*Bagarius* spp.), Rajbam or fresh water eel (*Anguilla* spp.). People also cut down trees and convert forest into the firewood in everyday's life. There is often no proper security of livelihood and food sources in these modern events. In order to have a decent salary they involve in poaching the endanger species like snow leopard, wolf, and Pallas's cat for instance, which harms the diversity of the Hindu Kush-Himalayan region further.

The Hindu Kush-Himalayan countries overall are facing unexpected risks due to the degradation of forests, biodiversity, rangelands and pasture. A high dependence on nature make them helpless and exposes them to various risks and fears. Sound and long-term research and comprehensive data are needed on causes and outcomes to plan adaptation and effective mitigation programs to deal with future changes (Karki 2010). The Maoist protestors destroyed three CAMC offices, killed three committee members, bombed ACAP's four-unit conservation offices and destroyed nine tourist check posts. Although about 18% of members received threats from the rebels, none of them resigned (Baral et al. 2007). However, no foreign visitor was kidnapped, murdered or robbed in the ACA or within the country as a whole. This may have given a positive message about the safety of foreign visitors in the area, although visitors were aware of the ongoing insurgency and travel advice (Baral 2014).

Most of the people in the Hindu Kush-Himalaya region have the problem to obtain a good education. Due to the extreme cold in the altitude they only get the chance to attain the classes for 6 months and the remaining 6 months they need to struggle for their bare existence. Some students walk with their family in search of the expensive herbal medicine called as Yarsagumba, and many other students have to look after their households while left behind. They are deprived of a healthy educational environment. We know that Nepal is the country having a beautiful but dangerous geography. The landscape and rich soil is not evenly distributed. Due to this geography, we are lucky to have the mountains like Sagarmatha, Annapurna and many mountains, but on the other hand there is, thus far, a lack of infrastructure development and scarcity of proper facilities for a decent and modern living.

The people living in the ACAP region have a generic complain that herders are not getting their compensation when the livestock were killed by wild predators. People living in ACAP are not satisfied with the activities of ACAP on that matter. People want ACAP to spend the collected fund for the actual local development of the place, for upgrading the economic status of people and to provide compensation. People want help from the ACAP that they are unable to provide.

24.11.2 Global Opportunities

The high Himalayas has always been at the core of mystery. Till date no one has fully known, understood and described all the matters and history hidden inside and behind the large white layers of snow. The Hindu Kush-Himalayas can still be considered as the frontier of new discoveries. Due to various obstacles in the high altitude, most of the people failed to achieve their goals, thus far. It's a long-lasting struggle but that keeps promising opportunities! At high altitude a good diversity of animals and plant species can be found. New discoveries are likely to be find different fossil records and places; 'new' history can be done. Modernizations and renovations of the old stupas and culturally important heritages are ongoing. One of the great contributions is that findings in this 'frontier' may inform, help, and perhaps further fine-tune and revise, western science! Geology, ethnobotany, or even some Buddhist knowledge on health could be among those!

The Hindu Kush-Himalayas are actually rich in endemism and biodiversity, and so research on various unknown facts and species found in the high altitude is very much in demand now. In the present context, students can get a chance to grab the grant opportunities to complete their research in Himalayan region which may also help to discover new flora and fauna. For example, Pallas's cat and wolves are the animals that were newly re-discovered during research which helps people to know about their importance on environment and as a result many organizations as well as local people are working to save them. In the same way many NGOs and INGOs like Snow Leopard Conservancy, Global Primate Network Nepal, World Wide Fund (WWF) and many other similar organizations, institutions and local community based organizations (CBOs) are working in saving the majestic animals like "Snow leopard" and their landscapes. Till now many national and international programs have been held there in order to create the awareness to conserve snow leopard as a wider umbrella species for the region (Table 24.6).

Table 24.6 List of NGOs/INGOs/CBOs working in ACA

SN	District	Name of CBOs, NGO and INGOs	Established date	Address of the office
1	Mustang	Sanjivani Community Learning Center	27.8.2007	Jomsom-5, Mustang
2	Mustang	Farmer Unity Club	15.3.2000	Tukuchey-5, Mustang
3	Mustang	Syang Drinking Water and Hygiene Committee	14.12.1992	Marpha-8, Mustang
4	Mustang	Thasang Thakali Society	3.12.2004	Tukuchey, Mustang
5	Mustang	Janamukti Youth Club, Thini	6.5.1998	Jomsom, Mustang
6	Mustang	Jaya Bholay Care residence	7.12.2002	Marpha-8, Mustang
7	Mustang	Syang Ama Samuha	17.4.2000	Marpha-7/8, Mustang
8	Mustang	Padamsambhav Charity Foundation	12.3.2005	Tukuchey, Mustang
9	Mustang	Khinkhar Jho Womens Group	4.5.2005	Muktinath, Mustang
10	Mustang	Thakali Milan Samaj	9.7.1998	Tukuchey-8, Mustang
11	Mustang	Thak Pustakalaya	26.10.2002	Tukuchey, Mustang
12	Mustang	Gurung Sngwai Ama Samuha	20.7.2011	Kowang, Mustang
13	Mustang	Marpha Foundation	13.5.2014	Marpha, Mustang
14	Mustang	Barhaggau Sewa Samaj	15.9.2005	Kowang, Mustang
15	Mustang	Mustang Cultural and Education Centre	17.6.2012	Jomsom-8, Mustang
16	Mustang	Jharkot Paramparagat Treatment and Learning Centre	12.7.2007	Muktinath-4, Mustang
17	Mustang	Shree Mukti Chetra Development and Community Conservation Committee	10.9.1999	Muktinath, Mustang

(continued)

SN	District	Name of CBOs, NGO and INGOs	Established date	Address of the office
18	Mustang	Lo-Kunfen Upper Mustang Group	31.32003	Upper Mustang
19	Mustang	Thini Gau Ama Samuha	12.3.1996	Jomsom, Mustang
20	Mustang	Paaila Nepal	18.5.2008	Jomsom-8, Mustang
21	Mustang	Lo Gyalpo Jigmay Cultural Conservation Foundation	9.5.2002	Lo-manthang, Mustang
22	Mustang	Rural Information and Infrastructure Development Centre	1.11.2010	Jomsom, Mustang
23	Mustang	Mustang Kalyankari Sangh	3.9.2003	Jomsom-8, Mustang
24	Mustang	Lochodhun Lhowma group	31.8.2005	Lo-manthang, Mustang
25	Mustang	Mustang Forest Action Lupra	27.3.1995	Muktinath-9, Mustang
26	Mustang	Mustang Public Dental Care Centre	20.4.2015	Jomsom, Mustang
27	Mustang	Jomsom Womens' Group	21.9.1994	Jomsom, Mustang
28	Mustang	Manchayo Drugkar Thaygchayn Lingb Gumba	13.2.2008	Lo-manthang Mustang
29	Mustang	Karmachari Club	4.7.1994	Jomsom-7, Mustang
30	Mustang	Shree Sahayog Himalayan Nepal	20.9.2005	Letay, Mustang
31	Mustang	Dhe Thangchung Chaklay Re-establishment Committee	6.11.2013	Surkhang-9, Mustang
32	Mustang	Nhorjo Forbe (Kul) Sewa Samiti Bhurjungkot, Thak Saat Saya Mustang	1.10.1999	Kowang, Mustang
33	Mustang	Tukuche Public Dental Treatment Center	10.6.2015	Tukuchey-5, Mustang
34	Mustang	Larjung Khanepani and Drinking Water and Cleanliness Consumer Committee	26.6.2015	Kowang-4, Mustang
35	Mustang	Samar Women Group	11.8.2015	Chusang-9, Mustang
36	Mustang	Amarsingh Tulawan Foundation	11.8.2015	Kowang-2, Mustang
37	Mustang	Samjung Re-establishment and Management Committee	15.11.2015	Chhoser-8, Mustang
38	Mustang	Boker Thuptet Choroling Gumba	18.11.2015	Kagbeni-6, Mustang
39	Mustang	Jestha Nagarik Jilla Sangh	4.12.2015	Jomsom, Mustang
40	Mustang	Modification Jomsom	8.12.2015	Jomsom-3, Mustang
41	Mustang	Human Association	8.2.2016	Muktinath-8, Mustang
42	Mustang	Nay Chungsi Ama Samuha	20.6.2016	Ghami-3, Ghiling, Mustang
43	Mustang	Jomsom Nilgiri Hydroelectricity Production and Distribution Consumer Committee	9.9.2010	Marpha-5, Mustang

Fig. 24.11 Photo of Phoo village in Manang. (Photo credit: Tashi R. Ghale)

Many development agencies work on topics like infrastructure development and tourism development and it is tried without harming the natural habitat of living beings at least as less as possible. Booklets, articles and papers can be published for the herders and students which helps to reduce the negative impacts on wildlife and environment. Hotels and resorts can be established carefully as it is the touristic area. Franchising of those businesses has not occurred yet. The market with the trekking materials and herbal medicine should be started which could be perhaps a good source of income for the wider benefit. The notion of pervasive impacts remains to be exposed and mitigated, ideally towards forming a new, modern and sustainable culture for mankind to preserve landscapes like ACAP. Here we might have found a role model for global governance? (Fig. 24.11).

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Chapter 25
The Forgotten Data: A Rather Short but Deep Story of Museums and Libraries in HKH and Similar Information Sources in Support of the Global Biodiversity Information System (GBIF.org) and Model-Predictions for Improved Conservation Management

Falk Huettmann

The Hindu Kush-Himalaya (HKH) region has a mystic appeal to many people and nations, and thus it attracted foreign researchers and collectors over many centuries (see for instance Hooker 2012 for major expeditions 1847–1851). It remains an exotic and widely mis-understood place for westerners and it served colonialism for long time, with neocolonialism and its associated one-sided science concept still found there to this very day (Rosales 2008 for concept, Chaudhary et al. 2007; Pauli et al. 2015; Miehe et al. 2017; Thapa et al. 2018 for examples). Trying to outcompete each other, and with collector and funder vanity at stake, many nations ran long and expensive expeditions to obtain 'the best' species, specimen and experience in that vast region (see for instance Herzog and Anker 2010 for first Annapurna peak conquests by France). But those efforts pay back very little to the locals and leaving behind various devastations long-term (Baumgartner 2015 for modernity, see in GBIF.org for data details. The histories of Pakistan, Bangladesh, Vietnam and Burma reflect those details very clearly; Myint-U 2008). And to this very day many outside nations still do engage there for their foreign-paid specimen collection (e.g. Miehe et al. 2017; Thapa et al. 2018) and similar efforts (see Chaudhary et al. 2007 for examples, e.g. ethno-botany and bioexploration co-funded by international corporations).

F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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Over the last centuries of 'enlightenment' (see Diamond 1997 and Rosales 2008 for global impacts) a huge amount of samples got consequently amassed from there. It's often seen as a '*quality must-have*', an exotic, foreign and life-time achievement to have such specimen in a (western) collection, ideally from own expeditions. Repetitive collections were done across nations in the EU and across ideologies, e.g. the U.S. vs. USSR. But like with so many field data and excursions, a large amount of those precious records actually did not make it, got lost and never were published or used and analyzed for science and the wider global community (see for a recent and very destructive museum fire in Brazil https://www.theguardian.com/world/2018/sep/03/fire-engulfs-brazil-national-museum-rio; but see Lanna et al. 2019; Bakker et al. 2019 and Huettmann and Bond in press for much safer and less destructive online resource approaches). Ignoring the internet is not an option anymore (Graham et al. 2008; Huettmann 2015a; Bakker et al. 2019). There are also consistent taxonomy and trust issues in such data (e.g. Franz and Sterner 2018). An unknown but likely big amount of the costly -often unique- expedition data and information got simply lost – officially and inofficially; this includes precious cultural artefacts. And most of the data that were actually presented 'somewhere' still lack good citation standards (ESIP Data Preservation and Stewardship Committee 2019) and ISO-compliant metadata for being able to actually find and 'use' the data (*sensu* Huettmann 2005, 2009; Bluhm et al. 2010; Zuckerberg et al. 2011); often they are just presented in local languages abroad and with (digital) formats hardly usable (see for Mongolia the German webportal https://floragreif.uni-greifswald.de/ vs.GBIF.org data in Darwin Core format as the global standard for online data delivery and to be harvested via web-crawlers etc.; Costello et al. 2014). Whereas, many tools and workflows by now exist already to digitize, translate and present data for a global audience with a fast turn-around (Mordecai et al. 2010; Bluhm et al. 2010; Zuckerberg et al. 2011). The problems of the HKH specimen and data simply follow here the fate of many other expedition artefacts, such as witnessed from Amazonia, Congo or the Arctic, Antarctic and international ocean cruise explorations overall (Carlson 2011, 2013; see Table 25.1 for some bad examples worldwide). It's an inherent problem in the western science model practiced for the last centuries (see http://www.biodiversidad.gob.mx/v_ingles/ for a change example).

Usually, such collections, specimen, artefacts and data books are meant to end up in museums (e.g. Figs. 25.1 and 25.2) and libraries for public consumption. They are maintained by the public, for the public, and serving the wider public good for global benefit (see here for examples http://Darwinonline.org.uk/BeagleLibrary/Beagle_Library_Introduction.htm). Many of those carry a large public reputation, e.g. the Kaiser library in Kathmandu, Nepal (Fig. 25.3), the International Mountain Museum in Pokhara (Fig. 25.2) or the many royal and national academy institutions in Europe and North America featuring such data and specimen paid by tax payers money. It can conveniently be catered through global internet requests.

Virtually all of those larger field surveys and expeditions started out with such aims of 'serving the public' and adding national fame (see for instance Philbrick 2004 or GBIF's mission statement) but many never followed through, lost their mission and inertia, or served instead private interests (see for instance Revkin 1999 for commercially precious rubber seeds from Amazonia and the pervasive role of Kew

Table 25.1 Selected list of specimen and data that were lost in the world's explorations

Collection and origin	Location	Cause
Alexandria Library	Ancient Alexandria	Warfare, destruction
Alaska	State	Due to poor management over 50% of all data collected are not seen in the public sphere (see Carlson 2011, 2012 for higher percentages of data loss in the Arctic)
U.S. Exploring Expedition	U.S.	Disputes (personally and political), lost samples during transport and storage, mis-management, political reasons, large delays (Philbrick 2004)
Austrian plant collections from Amazonia	Austria	Fire in Vienna (Revkin 1999)
Brazilian and other collections in Rio de Janeiro	Brazil	Fire in over-aged building https://www.theguardian.com/world/2018/sep/03/fire-engulfs-brazil-national-museum-rio
Ross Sea, Antarctica	Western world	Various reasons (see Huettmann et al. 2015). Noteworthy is a generic lack of data shared by long-term institutionalized actors from the U.S., Japan, Russia and New Zealand for instance.
Papua New Guinea	German missionaries and researchers. Dutch agencies	Lack of effort & awareness, world wars, poor development aid concepts. Most of it was paid by public money, and even if it exist it is still not put online (after over 100 years).
Russian world expeditions by the Tsar	Various museums (e.g. St. Petersburg, Frankfurt, London)	Various, world wars, funding disputes, international ownerships and participants etc. Generic secretive, competitive and protective culture and behavior when dealing with the outside world while many data actually do exist and are well conserved, with selected access given to some individuals.
Primate observation and behavior data	Central America and Africa	No data sharing and poor management (details presented in Huettmann 2015a); see also vastly lacking data from Jane Goodall, Diane Fossey, Birute Galdikas or German Primatology and Max Planck Institutes.

Botanical Gardens, U.K. in this acclaimed theft of wealth and national property; Rosales 2008). In part, many of those expeditions and data sharing concepts eventually failed because a valid business model or awareness was not there to make it happen (Costello et al. 2014). Or it failed due to bad planning and management, political overrulings, or because some tragic events occurred like disasters, death, fire and warfare (see for instance details in Table 25.1 and Philbrick 2004). Nations can be inherently unstable (Whelpton 2005; Vanaik 2015) not always allowing for efficient museums or expeditions. Sustainability of data and the project overall was just not part of the initial plan and vision in times of the internet, and often it still is not done or wanted even (Miehe et al. 2017 for lack of open access promotion). Nowadays, and technically, field work projects and museums could easily present all their well-curated specimen data digital and online (Lane 1996; Graham et al. 2008; Lavoie 2013; Paton 2013; McLean et al. 2015); it could be done even in-time, and should be mandatory. NEON (http://data.neonscience.org/home) and GBIF.org are good

Fig. 25.1 Natural History Museums as a treasure-trough of information for conservation management, Kathmandu, Nepal. (Photo credit: author)

role-models for that concept and with global and central webportals serving such data of international conservation management relevance (see Kandel et al. 2015; Bakker et al. 2019; Huettmann and Ickert-Bond 2017 as examples). It makes for being compliant with the Freedom of Information Act (FOIA), the RIO convention, now followed up by the Aichi targets and the Sustainable Development Goals (SDGs; https://www.cbd.int/sp/targets/; see Huettmann 2011, 2015a for overview, and Nemitz et al. 2012; Kandel et al. 2015 and Regmi et al. 2018 for applications). Using such data for conservation really matters (Newbold 2010; Ohse et al. 2009; Peterson et al. 2015; Huettmann 2015b, c; Bakker et al. 2019). It's a measure and role-model against corruption for good global governance and well-functioning nation-states to be proud of.

However, decades later many of the poorly curated specimen rot away, disappeared or still wait for their exposure, description, test and relevant use for science and conservation (beyond pure taxonomy without wider conservation purposes) even decades after collection (see Nemitz et al. 2012 for timings). Arguably, museum specimen data and their hugely interesting records remain widely underused and underanalyzed, either way (Fig. 25.4 and its species conservation status; see Graham et al. 2008; Huettmann and Ickert-Bond 2017). They are certainly not used 'in-time' and for saving the planet; almost never have been (whatever collectors and museums state; for instance the Smithsonian - https://naturalhistory.si.edu/- in U.S. is fully excempt, certainly delayed, in joining such mind sets and the global wider community. Not suprisingly they pursued secritive military projects as

Fig. 25.2 The International Mountain Museum in Pokhara, Nepal; an information hotspot for cultures, early explorations and expeditions

well as much indusrial and oil funding)! Museum specimen collections are widely overestimated then and institutions serve neocolonialism. While the globe's wilderness and atmosphere 'go down' and decay (Mace et al. 2010) the specimen data simply sit there and remain widely under-used for a good global steward ship of the earth (Chapin et al. 2011). So how far does reason bring us, really? Are we at the end of an era of progress and modernity (Mace et al. 2010; Alexander 2013)? Science can be optimized, and likely should.

Still, online initiatives, specifically for field work, remote sensing and museums, can be rather powerful and for sharing some data and to trigger new research and better management-related approaches (Costello et al. 2014). The education parts alone can be rather large already and support a science-based conservation (e.g. Huettmann 2007a; Cook et al. 2014; Huettmann 2015b; Lacey et al. 2017; Anderson et al. 2017; Bakker et al. 2019). The HKH region has already received such data efforts using plant data (see for webportals here http://hengduan.huh.harvard.edu/fieldnotes/, and https://naturalsciences.ch/organisations/gmba/mountain_portal. See Nemitz et al. 2012 for an application; but compare for lacking online efforts and generic acknowledgements in Miehe et al. 2017).

To provide more insights for the state of the Hindu Kush Himalaya (HKH) and its publicly available national biodiversity the known data and their ownerships were compiled (Table 25.2). For empirical data and related specimen we then used GBIF.org – as the global authority on biodiversity data – and assessed all specimen data for the study area as well as for Bhutan's plants.

Fig. 25.3 Libraries as a major source for information; here the infamous Kaiser library in Kathmandu, Nepal (photo credit: author)

Like with most nations of biological relevance (see CONABIO Mexico for an example about a Megadiversity nation http://www.biodiversidad.gob.mx/v_ingles/) it becomes quickly clear that publicly-available online data from the nations of the Hindu Kush-Himalaya are not all located in their respective countries; many are located outside and often to a wide degree with the major data sets being located ‘outside’. The GBIF assessment (Tables 25.3 and 25.4) shows that the proportion of outside holdings of data for HKH nations ranges from 5% up to 45% (Mongolia; Russia with 56% is likely an outlier because of partial and marginal HKH coverage, including the Soviet Union times) but usually it is for many nations in the range of app. 20%. Notable are the ones where outside nations do not own many data; usually those are nations that do not have much data online yet or which are so powerful to not getting dominated from any outside institutions, e.g. Russia, China, India or Pakistan. Easily over 15 outside nations play a role (Tables 25.2, 25.3 and 25.4), most of them are nations more wealthy, advanced and powerful than the HKH countries. Table 25.3 shows Russia and U.S. institutions as a consistent player in the digital online data scheme; other nations like EU ones and Brazil are also quite dominant. Noteworthy is the absence of UK institutions, namely Kew Botanical Garden, or specific German, French, Danish, Swedish ones that collected specimen with expeditions for centuries. Clearly, this structure reflects already strong power inequalities, as well as policy-related science strategies (disease data are a topic of their own but are very relevant in this discussion too, just like DNA samples are). For

Fig. 25.4 A Bengal monitor, a species of conservation concern in the Hindu Kush-Himalaya region in the National History Museum in Kathmandu, Nepal. (Photo credit: author)

the HKH nations that cannot be helpful when the notion of natural resources and sustainability are to be discussed in any equal, fair and democratic manner with a local buy-in (Rosales 2008).

While a 12% 'outside ownership' of data might not look 'that' high, the relevant question is about what specimen and data that really are? Usually, this rel. small amount actually handles the very precious and commercial specimen and data, the 'crown jewels' of a nation. And thus, it really matters!

A closer look of Bhutan – a nation that hosts 250 of the world's most threatened plant species – makes that even more clear and showing that the GBIF assessment is just an underestimate with many unpublished data holdings elsewhere indicating a very serious problem instead.

A selection of major museums listed in GBIF data as rights holders for plants of Bhutan:

Missouri Botanical Garden, U.S.
The New York Botanical Garden, U.S.
The Field Museum of Natural History, U.S.
President and Fellows of Harvard College, U.S.
Natural History Museum, University of Tartu, Estonia
University of British Columbia (UBC), Canada
University de Montreal Biodiversity Centre, Canada

Table 25.2 A selected list of data schemes and outside nations that are in possession of information for the Hindu Kush-Himalaya (HKH) region

Nation with known Nepal data	Specimen and type of data	Example
UK	Bird and plant data of Nepal, Bhutan and India	Hooker (2012), many institutions including museums in London, Oxford and Cambridge
UK Kew Botanical Garden	Plant specimen of Bhutan	Some of the largest collections of Bhutan plant data are located in the UK and Japan and not globally shared in GBIF and/or with the global public; those are hardly accessible for Bhutanese and global citizens
Switzerland	Artefacts	Explorers, e.g. eighteenth century and 1940s (e.g. Baumgartner 2015)
U.S.	Various	See for instance Lipton and Ragnubs (1996) for artefacts
India	Various	Tiger, snow leopard and wildlife specimen
Germany	Plant specimen of Nepal and beyond	Miehe et al. (2017)
Germany	Plant specimen of Mongolia	https://floragreif.uni-greifswald.de/
Japan	Plant specimen	http://www.moaf.gov.bt/national-red-list-assessment-workshop-on-endemic-plants-of-bhutan/
Australia	Bird and plant specimen	e.g. Sydney museum
South Korea	Plant specimen	South Korea widly engages in the HKH region
China (including Hongkong)	Plant and lichen specimen	e.g. Kunming Herbarium and Beijing, university projects. Many are not open access.
	Birds	Many bird survey, mistnetting and geolocator data are not open access (but see Han et al. 2018)
	Charismatic species of global conservation concern (Red Panda)	See Kandel et al. (2015) and also Thapa et al. (2018); textbox on a failed Red Panda Data Management
Taiwan	Red Panda DNA samples	University projects
Norway	Plant specimen and data	e.g. Chaudhary et al. (2007)
Singapore	Plant and animal specimen	University projects
Russia	Biodiversity and wildlife specimen	National Museums in Moscow and St. Petersburg
Brazil	Plant specimen	Various herbaria

Table 25.3 Nations of the Hindu Kush-Himalaya region and their GBIF records and museum contributions (numbers are rounded)[a]. Data queries by M. K Suwal are kindly acknowledged (status fall 2018)

HKH nation	Number of records in GBIF	Proportion of GBIF records held in museums Outside	Top 3 museums (see Table 25.4 for abbreviations) for the HKH nation
Afghanistan	57,105	11	Moscow State University; few records in New York Botanical Garden, and Swedish Museum of Natural History
Bangladesh	50,766	5	New York Botanical Garden, SPWI, Missouri Botanical Garden
Bhutan	11,726	7	New York Botanical Garden, Missouri Botanical Garden (mostly)
China	2,022,710	9	Moscow State University, New York Botanical Garden, Missouri Botanical Garden
India	468,686	15	Moscow State University, New York Botanical Garden, Missouri Botanical Garden
Kyrgistan	47,486	12	Moscow State University, New York Botanical Garden, Missouri Botanical Garden
Kazakhstan	84,334	10	Moscow State University, New York Botanical Garden, Missouri Botanical Garden
Laos	57,569	33	Moscow State University, Missouri Botanical Garden, Bernice Pauahi Bishop Museum Hawaii
Myanmar (Burma)	97,184	6	New York Botanical Garden, Bernice Pauahi Bishop Museum Hawaii, North Carolina Museum of Natural Sciences
Mongolia	66,898	45	Moscow State University, New York Botanical Garden, Missouri Botanical Garden
Nepal	112,610	15	Moscow State University, New York Botanical Garden, Missouri Botanical Garden
Pakistan	138,036	12	President and Fellows of Harvard College, New York Botanical Garden, Bernice Pauahi Bishop Museum Hawaii
Russia	1,291,942	56	Moscow State University, New York Botanical Garden, Missouri Botanical Garden
Tajikistan	22,946	31	Moscow State University, New York Botanical Garden, Loskutov I. G., Russia
Turkmenistan	17,353	44	Moscow State University, New York Botanical Garden, Missouri Botanical Garden

(continued)

Table 25.3 (continued)

HKH nation	Number of records in GBIF	Proportion of GBIF records held in museums Outside	Top 3 museums (see Table 25.4 for abbreviations) for the HKH nation
Uzbekistan	20,320	18	Moscow State University, New York Botanical Garden, Missouri Botanical Garden
Vietnam	183,331	38	Missouri Botanical Garden, Moscow State University, New York Botanical Garden

[a]Nations like China, India and Russia are only partly covered in the study area and thus their metrics are not so meaningful for a comparison of HKH nations

Noteworthy in the list above for Bhutan is that Moscow State University, Russia is absent as a relevant data holder (as found otherwise very strongly; see Tables 25.3 and 25.4), and so are any Indian institutions (which are a strong dominating political force in Bhutan overall). But the nation of India does not support online data sharing in GBIF, much, as of yet. As Bhutan exemplifies, China is widely absent as a public data sharer for most nations in the Hindu Kush-Himalaya also.

There are other peculiarities for Bhutan where of its 9704 plant records in GBIF app. 3000 records have no rights holder identified. As a matter of fact, one of the biggest owners and investigators of plant specimen of Bhutan outside of Bhutan is likely the Kew Botanical Garden, U.K. as well as Japan, and those data are not really publicly available at all (see also Miehe et al. 2017). So the number presented are based on what can be seen online, whereas a vast trough of data likely exist working in favor of the argument presented here that HKH nations do not have access to, or own their data really for a 'best-possible' environmental management (Fig. 25.5).

App. 3.100 of the Bhutan records in GBIF carry no geo-referencing and cannot be mapped or used for species distribution models (*sensu* Zuckerberg et al. 2011, for an application see Nemitz et al. 2012, Kandel et al. 2015, Regmi et al. 2018). The mapped specimen locations are shown in Fig. 25.5 indicating clear road biases and opportunistic sampling. Of the 2,905 species sampled and with data in GBIF, the top 10 sampled species are shown in Table 25.5. Those top ten species have little representative landscape sampling of Bhutan, lack a research design and are often just commercially relevant species. An effective science-based conservation management is not really possible when solely based on those incomplete data; again, most typically come from outsiders collecting in the HKH region. An equal problem is found for Mongolia (Nyambayar et al. 2011), Nepal (Nemitz et al. 2012) and Turkmenistan (Rustamov and Rustamov 2007), for instance. See Ohse et al. (2009) for solutions and options though.

The data cases of Nepal, Bhutan and Mongolia are not unique, and many other examples can be found. It just reflects the science mindset to date, dominated by the western world. But this situation raises some serious issues of ownership, patriation and re-patriation of specimen data, as well as questions like 'science what for', 'science done how' and 'science by whom', globally? It fully confirms what Rosales (2008) stated as an inherent inequity among nations, made worse by the internet and

Table 25.4 List of major museums that show online specimen/data for the nations of the Hindu Kush-Himalaya region and their GBIF records[a]. (Data queries (Fall 2018) by M. K Suwal are kindly acknowledged)

Name of museum with HKH specimen/data	Number of records in GBIF (rounded)	Top 3 HKH nations covered in that respective museum collection
Bernice Pauahi Bishop Museum, Hawaii, U.S.	3,654	China, Vietnam, Nepal
Auckland War Memorial Museum, New Zealand	1,403	India, China, Russia
Estonian Museum of Natural History	13,816	Russia, Tajikistan, China
Estonian University of Life Sciences	61,190	Russia, Tajikistan, India
Finnish Museum of Natural History	2,665	Russia, India
Landcare Research NZ Ltd., New Zealand	3,786	China, Nepal
Loskutov I.G., Russia	2,539	Uzbekistan, Afghanistan, Kyrgystan
MBM – Herbario do Museu Botanico Municipal, Brazil	2,122	China, India, Russia
Missouri Botanical Garden, U.S.	84,351	China, Vietnam, India
Moscow State University, Russia	635,749	Mongolia, China, Vietnam
Natural History Museum Rotterdam, Holland	2,307	India, Russia, Kyrgistan
North Carolina Museum of Natural Sciences, U.S.	3,722	Laos, Vietnam, China
President and Fellows of Harvard College, U.S.	138,526	India, Pakistan, Russia
Royal Belgian Institute of Natural Sciences, Belgium	9,501	Russia, India, China
Royal Ontario Museum (ROM), Canada	24,213	Vietnam, China, India
Tallinn Botanic Garden	13,303	Russia, Uzbekistan, Kyrgistan
Swedish Museum of Natural History, Sweden	3,694	China, Russia, India
The New York Botanical Garden, U.S.	7669	China, India, Vietnam
The Field Museum of Natural History, Chicago, U.S.	76,394	India, China, Nepal
University of British Columbia (UBC), Canada	7425	China, Russia, Nepal
Yale Peabody Museum of Natural History, U.S.	32,011	Pakistan, Laos, Russia

[a]Nations like China, India and Russia are only partly covered in the study area and thus their metrics are not so meaningful for a comparison of HKH nations. Those rankings are therefore not so meaningful and not provided

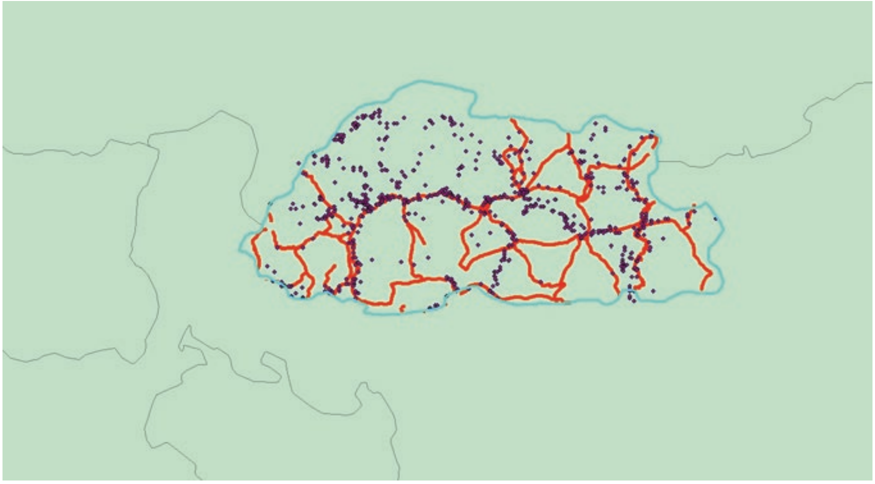

Fig. 25.5 Map of publicly available plant records for Bhutan using GBIF.org (blue dots; main roads shown in red)

Table 25.5 Top 10 species in the Bhutan dataset for plants in GBIF

Species name	Records in GBIF	Comment
Juniperus recurve	49	Many of the species shown here are of commercial and genetic interest. The dataset for instance contains 46 species of rhododendron with 167 records. However, over 2,200 records (~70%) have 2 or less specimen records per species making a meaningful scientific and conservation inquiry and inference very limited for the majority of species and their conservation. Arguably, sustainability and conservation - or protection - are not the aims here!
Cupressus cashmeriana	48	
Brassica juncea	40	
Codonopsis foetens	33	
Leontopodium jacotianum	32	
Juniperus indica	30	
Trachypodopsis serrulata	29	
Hymenophyllum blumeanun	27	
Pinus wallichiana	26	
Agrostis micrantha	24	

technology (aka '*techno-neocolonialism*')! Arguably, in the current set up, the people of the Hindu Kush-Himalaya region – and hardly the global community – can really benefit from, and experience, the wide and deep wealth of the region, as measured and collected by a large number of outside nations and their expeditions and institutions (most of those are funded on the public dime). Likely the British and Japanese efforts stand out here for owning the vast majority of relevant specimen of a HKH nation (Bhutan), but similar are many American, Norwegian, Russian, Brazilian, Korean, Indian, Chinese, Taiwanese, Australian, French etc. etc. ones. So how can that ever be ethical? How are the inherent rights of nations respected and achieved, e.g. regarding wealth or wilderness? And before those details are not resolved, how can one justify new collections even contributing to the ongoing dilemma and making things worse?

On the good side, using predictive modeling Nemitz et al. (2012) show a classic contributing example, based on those discussed plant data in the many nations of the HKH region, and how progress can be made when all components are shared and publically available, e.g. in the aforementioned GBMA webportal, and certainly via GBIF.org as a mandatory raw data repository.

And beyond 'just' plants other examples of data sharing are on the rise. A dominant example is likely found in Kandel et al. (2015) for red panda, or with Regmi et al. (2018) for Assamese Macaque. Others are discussed in subsequent chapters on GIS data for the HKH region. See also the work by Herrick et al. (2013) for shared disease data and Sriram and Huettmann (unpublished) for over 100 shared GIS layers. In addition, see the citizen science work now such as eBird.org or iNaturalist.org which has virtually doubled the existing data within just a few years and adds great new knowledge to the body that slowly accumulated over the last 100 years.

Museums can not really be disconnected from libraries (e.g. Figure 25.3); the latter often host the raw original data sources, documentations and side-aspects all needed for a proper assessment and re-analysis. Libraries play a major role as repositories and have by now massive digital options set up, e.g. ScholarWorks and dSPACE (see for Hindu Kindu-Himalaya data of the author https:// scholarworks.alaska.edu/). Libraries tend to be public, and/or linked with universities, campuses and even museums (Fig. 25.3). However, in real life, those entities rarely talk to each other, and a joined synthesis product is virtually never available (see for instance lack of library data in GBIF.org), which is to be overcome. Even libraries in the HKH region are not connected, certainly not outside (the ICIMOD library in Kathmandu Nepal remains a power house in that regard). So far, fierce competition, personal vain and 'turf guarding' drives the working environment, see Miehe et al. 2015 for a modern example in defiance of best professional practices and IPY (as promoted by Huettmann 2012, GBIF.org etc).

Libraries are well covered for mandatory global open access efforts in the Budapest Declaration, as well as the Berlin Declaration (Huettmann 2015b, c; see data sharing policies for mountains and science in general: https://www.researchgate.net/publication/232671625_Creative_use_of_mountain_biodiversity_databases_The_Kazbegi_research_agenda_of_GMBA-DIVERSITAS. Agencies in support are for instance the U.S. National Science Foundation NSF, ICSU https://council.science/cms/2017/04/open-data-in-big-data-world_short.pdf, the European Union http://data.europa.eu/euodp/en/data/ and CODATA.org). While this is well known and widely celebrated by the governments of this world, actual real-world progress is little in global conservation management; most bird banding, high-profile species and geolocator data are a good example for data not openly shared (machine readable), even if governments agreed to GBIF agreements and Rio conventions (e.g. Thapa et al. 2018). A quick inquiry of Polar Libraries, and covering the three poles (Arctic, Antarctic and Hindu Kush-Himalaya; Huettmann 2012) show that in a striking embarrassment (*sensu* Carlson 2011). Many other efforts exist to make library data available to the global audience, e.g. National Science Foundation (U.S. NSF as the biggest research funder in the world), philanthropy societies (note the low achievement of The Bill Gates Foundation here) and Google books (https://books.google.com/). But the HKH region still remains widely underrepresented, if not strikingly absent there and thus its people cannot participate in a global world and as equal participants, nor can the global community learn about HKH.

In the case of Nepal, like virtually anywhere else, museums and libraries matter a lot. For one, they are keepers of local and national written materials and specimen. But secondly, like with the specimen many books about Nepal are also not located in Nepal, hardly in the local language (of which Nepal has many; Whelpton 2005). Science-wise, most relevant books about Nepal are still in English, they are done by many outside writers and often by outside publishers (see Palin 2004; Miehe et al. 2017 for a typical example). The HKH region is historically a prime place for travel writers (Chopel 2014); and all sorts of languages occur locally and by the travelers (Palin 2004 for an international example). It's probably a good argument overall to make HKH information available to all HKH inhabitants and also to the global audience interested (for progress, or overcoming lack thereof when it comes to data; see ICIMOD.org). It's a global legacy of globalization! A specific point should be made here in regards to the deep Buddhist and Hindu writings, and the ancient scriptures with data within (see Karmay and Watt 2007; Chopel 2014). Those play a major role and easily affect 1.5 billion people directly and many more throughout the world.

In addition to the earlier and traditional forms of data, newer forms come to play now increasingly: geo-locator and telemetry data as well as stable isotopes, DNA and various predictions. But those are not much showing up in GBIF nor in

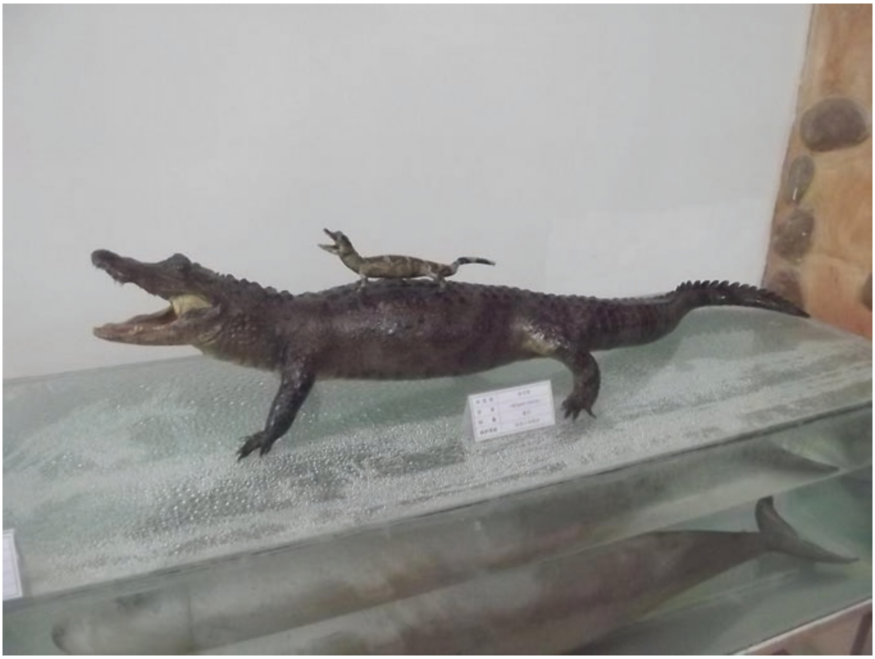

Fig. 25.6 One of the last of its kind? Endangered crocodile specimen of the Yangtse River from the Poyang Lake, fed by water from the Hindu Kush-Himalaya (HKH) region. How did this collected specimen and its data make conservation management of this world better?

museums or libraries. Those data are a class of their own but might be very relevant for applications concerning biodiversity conservation management and related well-being of humans. Arguably, none of those recent data are truly in the hands of the HKH nations and their people. It adds to the major concerns expressed here and that now come to bear (Fig. 25.6).

As it becomes easily clear from the details above, Nepal, as well as the HKH region overall, still has a huge role to play in data and information, and more is to be done to make it accessible: locally, nationally and globally for a good use of information. In an environment of such a huge ignorance of open access science, the existing work such as Kandel et al. (2015) and Regmi et al. (2018) must be perceived as milestones and role models to that effect (see Ohse et al. 2009 for a wildernes templates). It remains to be seen what the fruits will be and when -whether at all – the vision outlined by Edwards et al. (2000); Carlson (2011, 2012, 2013); Chapin et al. (2011); Huettmann (2007b, 2012); Peterson et al. (2015); Greve et al. (2016) and Wen et al. (2017) can actually ever be reached before it's too late and it all decays…

Textbox: Science-Based Red Panda Management *ad absurdum*: How not to Manage Data, Charismatic Species and Their Habitats by Range Countries, International Countries and NGOs

In the Hindu Kush-Himalaya (HKH) region there are many endangered species, and many are charismatic and endemic ones (e.g. Schaller 2000, Harris 2008). The species set-up there is unique while human pressures are vastly on the rise (Harris 2008 and Buckley 2014). To handle this problem, the western conservation management and governance model got imposed and rolled out there (Brockway 2002), namely via IUCN and national entities and funders (see Huettmann et al. 2011 for examples and performance reviews in the three poles), also widely adopted now by the major and dominating HKH nations. Its arsenal includes ministries, political parties, NGOs, international aid funds, citizen science, species working groups and protected areas for instance.

The red panda (*Ailurus fulgens*) makes for a great example of this concept to be exposed. It looks 'cute' and thus easily reaches a global celebrity status; it is endemic and endangered, living across several nations of the HKH region (*aka* "*range countries*"). Zoos worldwide are interested in obtaining specimen and they state that their captive animals would boost 'public awareness and subsequent conservation'. Further, NGOs state to work for the acclaimed protection of this species, supporting IUCN etc. So go the narratives at least, presented for fund raising reasons for decades while red panda are not in a good shape (globally endangered with decreasing populations; e.g. Kandel et al. 2018, Thapa et al. 2015).

Despite much effort and research done on this species by many actors internationally (https://nationalzoo.si.edu/animals/red-panda for zoos and WWF; http://www.panda.org.cn/english/news/news/2013-09-25/2512.html for

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China), the best data for the red panda were never compiled on this topic range-wide nor were relevant data publically available, with metadata or even searchable. Clearly, the conservation management for this species is highly fragmented with uncoordinated actors worldwide focusing on their own funding the most. Even simple data like geo-referenced sightings (as any citizen or tourist can collect) are difficult to come by; keep in mind that huge sums were spent on the red panda last decades internationally for its research and protection.

Knowing the range of a species makes for a fundamental item for a science-based management though, and such information is best-professional practice (Huettmann 2016; see Kandel et al. 2015; Xuesong et al. 2017; Regmi et al. 2018 and Suwal et al. 2018; Zhang et al. 2019 for examples and species in the region; Dornelaas et al. 2018 for global long-term examples), if not even being legally required by nations that signed the Rio Convention (with GBIF.org as the mandated global online data outlet, like it is agreed and signed by India, China, Norway, Germany, UK and the U.S. for instance), and with ICIMOD and with IUCN (the latter two being semi-NGOs and thus essentially available for purchase by any funder with a desire; Thomson 1993). Data sharing and emphasize come as a moral obligation (Huettmann et al. 2015).

Linked with local efforts, U.S. AID supported a species inventory for red panda in Nepal (e.g. Bista et al. 2017). Data were shared through several channels and eventually could be used for assessments, e.g. Kandel et al. (2015) for best-available data. Those compiled value-added data were put by the authors in the public realm for global consumption by any party interested free of charge to help red panda's science-based conservation; those data were mined and employed by the authors for predictions with latest science-based methods, the first-of-its-kind range map for this species was produced. It showed declines in the believed range, namely China. (As a side-note: respected western conservation journals and their 'professional organizations' rejected this work for 2 years straight as they are not keen, nor skilled, on machine learning methods with open access to progress conservation. Such views as shown in Kandel et al. 2015 are still too far out of their minds nor are those journals trained and skilled on the topic, just marred in parsimoninious frequency statistician mindsets or even worse, the Melbourne School of Modeling – which happens to be where their editor of the journal comes from and engaging and molding students and scholars with a like-minded culture. Needless to say that NGOs would lose money and fund raising arguments when data are shared and for everybody to see in a transparent, free fashion).

It's a common scheme these days that PhD students from countries like Nepal working abroad such as in China, Taiwan, UK, Germany, Australia or Norway, tend to take 'their' data from their home country to obtain a graduate degree abroad (typically a M.Sc. or PhD) from that 'resource' in the foreign 'host' nation. The idea is that the host nation then can claim -cheaply – that they would do research worldwide, engage in the international community, support needy students from 'poor' nations (aka "promising future

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conservation science leaders"), shape future conservation, and all looks great in public. It's meant to be a win-win situation, thus a PR trick set up on purpose, but all eventually centered just around the data that the exotic student brings abroad, and based on the species being in trouble. Instead, such projects are to serve the species and its local community and show international action, progress, on its science (usually that means these days very narrow genetic or microbiological research, as found in commercial and thus high-impact science journals. It also involves the use of R, instead of more powerful and sophisticated options; Humphries et al. 2018).

There are many flaws in such a thinking though 'using' (=exploiting) exotic graduate students, mostly imposed by western and research institutions from abroad. For one, those data they bring are often compiled with local and governmental money and taxes. Those data are meant to be for the public, and for the nation benefitting the species of concern, but not to be used for personal gain and 'cashing in' or so that the foreign nation looks good but paying next to nothing for it. Those data are also often lacking relevant research design, e.g. for an analysis in subsequent years. Those data are also frequently getting 'lost', blocked or are just shared for 'strategic' purposes; mostly for money, personal or institutional gain. Overall, it's a self-enrichment scheme for a selected few (e.g. graduate student committees) using institutions and their PR machinery (compare that with GBIF and its mission about the wider public good, or what the International Polar Year IPY promotes, or the EU data policies or the FOIAs in most english-speaking nations, U.K., Canada, Australia, New Zealand for instance. The NGO ICIMOD is actually a GBIF member and runs servers for GBIF, whereas the WWF for instance is essentially 'for profit' (Thomson 1992) and thus shares almost no data (but then is not shy to use public resources and infrastructure for its own gain and show off as their value-added achievements (http://remote-sensing-biodiversity.org/new-free-wwf-guidelines-on-satellite-remote-sensing-for-conservation-released WWF frequently uses GBIF data and remote sensing images and licenses). The latter NGO focuses more on super-charismatic species like snow leopards but left the red panda to smaller NGOs. Arguably, those decisions are purely strategic and funding-driven, but not ecologically or conservation-based at all. It's certainly not driven by science, as conservation NGOs spend perhaps over 70% of their budget on administration and PR for fund raising; tax exempt; Thomson 1992).

Typical examples of such concepts can be found across many species and students, beyond just red panda work. In such a bad deal, neocolonial as it is (Brockway 2002; Huettmann et al. 2015), data are still a central commodity while the public – the wider common good as the initial goal – gets basically left out. The poor conservation status of the species shows it all and clear, as exposed for everybody online (https://www.iucnredlist.org/species/714/110023718), while personal gain is achieved (usually a higher income and prestigious graduation level for the student and an increase in

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reputation with the institution respectively. And it's nothing unusual to see here embassies and governments involved even, further showing off those bad deals. One may expect that those politically supported efforts are used for environmental impact assessments, e.g. hydrodams or road constructions, and landscape management deals, or even territory disputes (see Buckley 2014 for red panda habitat watersheds).

To add evidence to those common schemes:

The author was personally approached by a U.S.-based NGO on red panda to serve on their 'board' (a common practice in the business community, also employed with high-level conservation NGOs). Anyways, this NGO insisted on very stringent privacy clauses and confidentiality agreements that nobody, certainly when in public office and university, is really advised to sign. Secondly, when asked about their existing field data from previous years of their campaigns, a reply went like "*our local field office recently burned down and all data were essentially lost*". Consequently, the author neither signed on with the NGO board nor is that a serious entity to deal with in the first place due to those restrictive privacy clause concepts and apparent sloppy data management.

Another one of those examples came with a big local NGO on red panda in a range nation which wanted to run a climate change model on red panda with the author. We met and communicated for over a year, signed all pre-reqs but just to find out that neither Bhutan nor China were to share their data on red panda. Thus, the model was never build…While Bhutan posted later its own data in a monopoly fashion on its server (https://biodiversity.bt/. Presumably that was the entire plan throughout and thus it blocked the red panda climate change progress. Bhutan claims to be a regional leader in green energy (hydro dams)).

Next, I then was in India, presenting to governmental research on the red panda work, namely the predicted ranges for this species (Kandel et al. 2015). Critique came from the practitioners. And they pointed out some alleged errors in the location records for India for this species. However, when asked to produce those data for evidence, and to share them for wider insight and use with all of us, e.g. model re-runs and improvements, a wide silence came. And no further progress was made on the issue. Again, India is a member nation in GBIF and in ICIMOD, where open access is to be promoted and catered. When it comes to it for many species, red panda included, we are far from any open access or open source though.

An even bigger surprise came to the author when a publication came out by Thapa et al. (2018). It was done primarily with the Chinese government, using an inferior statistical method, using all compiled public data from Kandel et al. (2015; paid, in part by the U.S. AID and the Nepal government and NGOs for wider release) but which a former co-author then used for himself not giving back any data or findings. Experts are to review such work and policies, and when their data are used and updated; editors are to check it too (specifically when those are published in the same journal even). But none has happened here, with that journal, editors and publisher. Arguably, those things

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are not professional, nor standard, certainly not respectful for those who put efforts for free towards creativity, risk-taking, a shared public value-added data source and analysis. Now what's really disturbing here is not only the PhD students conduct (with whom all of this was discussed in person several times a year prior), or the publisher, or the co-authors, but even worse, the Chinese government supported researchers, superviros and science center (Chinese Key Lab) exposing to the world how they understand conduct and treatment of researchers and the wider Red Panda community, namely in Nepal and with international authors. That's hardly in harmony with the world, certainly not friendly to the red panda research community, scientists or the global society at large. So this appears clearly the new world we live in, with China and how it moves forward in the HKH region, with species management, open access and its understanding of the global community (see Harris 2008, Buckley 2014 for similar experiences). None are to be approved, certainly not for red panda with the public license.

In the meantime, Nepal has still no good grip onto its red panda, nor is the species actively and well-managed in China, or in any of its other range nations really and with international nations and donors at all for synergy. It's mostly just management by remoteness, now using DNA-based species splits. Thus, habitats are transitioned and lost, and man-made climate change, global change, keeps getting worse while the neoliberal business model unfolds further and gets promoted to marginalize the environment further (as per textbook example; Acemoglu 2009). International development aid fuels exactly that.

In reality, nobody really cares (as stated for decades onwards by authors like Kurt 1982, Czech 2002, reviews by Huettmann 2012, Alexander 2013, Huettmann 2015); such an attitude is part of the global economy where it gets marginalized by design (e.g. Acemoglu 2009). To be here precise and clear – scientific – about this situation: the red panda, its habitat and the HKH region, mankind, the world and its atmosphere are on the way down and a science-based management is absent, certainly not effective at all while the world's governance bodies and their citizens widely enrich themselves further (Alexander 2013). We are in a global crisis state, –certainly for HKH wildlife and the red panda - and this situation is not new and likely it was started by a lack of awareness last decades with its own dynamics and culture of carelessness; and thus now the designed *laissez-faire* high-tech approach of the so-called globalization does not save it either…

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Chapter 26
A Rather Short Story of Shared GIS Data Layers in the Hindu Kush-Himalayas: State of the Art, Justifications and Urgent Suggestions for a Sustainable Global Data Governance with Open Access and Open Source Coming to the Rescue

Madan Krishna Suwal and Falk Huettmann

Without geography you are nowhere
(Source unknown)

Successful environmental management requires a good information infrastructure (Huettmann 2011; Bush et al. 2017). It's an essential foundation, and the future (e.g. Humphries and Huettmann 2018). However, this is a topic that most nations and their agencies still struggle with (Carlson 2011; Costello et al. 2014). As a matter of fact, transparency matters and is recognized as a key item for good governance. But despite a good start in 1992 with the Rio Convention, and GBIF.org, and with Google and Facebook on the rise sharing all sorts of information globally and strategically, we see no good use of tools and public efforts to move forward for a global library of things, any things, certainly data things and GIS things for serving mankind and sustainability. See ICIMOD (2018) and Peterson et al. (2018) for data growth but actual net data loss and leakage for biodiversity. See Mackie-Manson (2018) and Khalifa (2018) for an associated open access publication landscape perspective.

M. K. Suwal (✉)
Department of Geography, University of Bergen, Bergen, Norway
e-mail: madanksuwal@gmail.com

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department,
University of Alaska Fairbanks, Fairbanks, AK, USA

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In that respect, for the HKH region, Shodhganga (https://en.wikipedia.org/wiki/Shodhganga) is of major educational and cultural importance and a reservoir hosting Indian thesis works from academic institutions for instance.

Shodhganga is one of the largest open repositories of theses from India with about 2,45,000 thesis entries as of end of 2019. The digital collection has grown into about 5–6 TB of data. (India will soon be the largest nation in the world, graduate most students in the world and become the global education powerhouse setting rules and templates to follow). As of to date, this repository is working smoothly and the repository may grow exponentially to 3–4 thousand times in the future. That repository is created by using the global DSpace standard (a Digital Library Software developed jointly by HP and MIT, now maintained by DuraSpace).

So how to enforce, organize, finance and govern in times of online data, powerful software tools and with Big Data? Arguably, the current online data concept is not really sustainable, nor safe or long-term, and it has no good vision nor even a valid business model, yet (Huettmann 2011; Carlson 2011, 2013; Costello et al. 2014). It's not fit for use (https://www.ft.com/content/cb880bc2-057c-11e7-ace0-1ce02ef0def9). In times of a consistently changing digital online world it begs the question how is such 'soft material' – so essential for governments to fulfill their trusted sustainability duty – managed in the best democratic and effective form while being up-to-date all the time (Bush et al. 2017)? This has been a key concept in the RIO Convention (Huettmann 2011) as well as for the International Polar Years (IPYs; Carlson 2012; the HKH region is part of the three poles and thus, part of the International Polar Year effort, Huettmann 2011).

Missing and wrong information leads to wrong decisions and poor respect of 'the decider' in the public eye (Silvy 2012; Franz and Sterner 2017). That is nowhere so obvious than for geographic data and for legal and conservation governance applications, including landscapes and their watersheds (see for instance Magness et al. 2010). Arguably, the discipline of informatics and its international corporations and map product companies like Google, ESRI, GARMIN GPS or Facebook must not be put in charge of the natural resources; they lack the expertise, and carry no good sustainability track record, thus far. Rather, they promote fast consumption and offer not truly environmental sustainability (see for instance The Guardian 2019 for Microsoft joining a lawsuit against Climate Change damage liabilities) So now what to do? (Table 26.1).

Conceptually, it's all clear and easy though: The management of natural resources is to be science-based (Silvy 2012), and during the last 100 years science has dramatically moved forward. It intensely uses computers now and that has many implications (Huettmann 2005), most of those are hardly understood yet (Bluhm et al. 2010; Zuckerberg et al. 2011; Huettmann 2009, 2011, 2015; see in Silvy 2012 for lack of a digital discussion). But at least those references and textbooks all agree with the fact that science is to be transparent and repeatable. These concepts apply specifically to polar regions and it has been implemented there already through International Polar Years (IPY) and World Data Centers (e.g. Carlson 2011, 2012, 2013; for examples see Huettmann et al. 2015; Kandel et al. 2015; Huettmann and Ickert-Bond 2017). As per textbook (e.g. Silvy 2012 or Drew et al. 2011) and 'Best

Table 26.1 Selected list of applications in the HKH region where high-quality GIS data really matter

Application	Public data source	Examples
Conservation Management (animals)	GBIF.org, www.groms.de[a]	Kandel et al. (2015)
Conservation Management (plants)	GBIF.org	Nemitz et al. (2012)
Habitat Management	CIESIN.org	Sharma (2008)
Public Health and Disease	EMPRES-I (FAO) Influenza Research Database (IRD)	Herrick et al. (2013)
Impact studies	None available for specifically catered applications and questions	Geneletti and Dawa (2009)
Urban planning	Open Street maps	Hansen and Huettman (this publication)
Climate Change	ICIMOD, IPPC, Worldclim	IPPC assessments

[a]Movebank.org is another data source but hidden behind passwords and thus not publicly available, nor really transparent or repeatable science

Practices' (Carlson 2011; Zuckerberg et al. 2011; Huettmann 2005, 2011), modern environmental management is to be based on science, on thus empirical data and on maps; this is done these days with digital data, citations formats (ESIP Data Preservation and Stewardship Committee 2019), ISO-compliant metadata and based on Geographic Information Systems (GIS). This digital concept nowadays has the internet as the central scheme in order to make the best use of the available and steeply growing spatial-temporal data cube. This concept gets the best global traction when using an open access and open source platform that allows all members of society to engage and benefit (Huettmann 2011), not just a few experts and their funders (see for underlying concepts in Rosales 2008). However, with few exceptions sophisticated data sets and GIS expertise for the HKH are widely missing (for research with good polar standards see Nemitz et al. 2012; Kandel et al. 2015; Huettmann and Ickert-Bond 2017; Bush et al. 2017; Regmi et al. 2018; but compare with Miehe et al. 2015 still celebrating a hardcopy culture). The ones that do exist are either not much online, lack metadata, have no good or known accuracies reported (Hu and Zhigang 2010; Miehe et al. 2015), or are not in control or paid and awarded by the nations of HKH, their institutions or by the wider global community. Many studies just show digitally-produced maps but do not share them (e.g. Thapa et al. 2018; also for lack of code shared). It's nor reproducable nor transparent (Table 26.2).

But in the meantime, the HKH region is not short of relevant applications and opportunities of high quality GIS layers. Like elsewhere, the demand and need is these days virtually going through the roof ('roof of the world that is', Tables 26.1, 26.2 and 26.3; see specifically Zoeckler et al. 2016 for wider watershed and estuary-related analysis for species in the HKH region and its estuaries)! Many nations and funders are involved in creating those data layers, but efforts are usually not consistent nor well shared, hardly designed for the wider public good and for ecologically meaningful areas like watersheds.

Table 26.2 A selection of conservation modeling applications, where inference is drawn from predictions using various predictor GIS layers, for the HKH region based on Open Access information (see Zoeckler et al. 2016 for relevance of watershed data for endangered species wintering in the HKH region)

Topic	Citation	Comment
Tree conservation during climate change	Mohapatra et al. (2019)	Climate change impact models.
Tree distribution models for 52 species in China	Zhang et al. (in review)	Multi-species tree models for the current time.
Eco-distribution modeling of a socio-economic important species	Shankhwar et al. (2019)	Socio-economic data and models are rather short for the HKH region.
Open-GIS model predictions (plants)	Thapa and Rajbhandary (2019)	Open GIS applications allow many people to run models; but AUC assessments are rather low.
Frog distribution (predicted)	Zheng et al. (2018)	One of the first distributions of frogs in the HKH region. This is pretty relevant for conservation and watershed questions.
Endangered crane predictions and subsequent prioritization for the wider Tibetan plateau region	Han et al. (2018)	The black-necked crane *Grus nigricollis* is a species of major conservation concern; first-time presentations of open access and prediction data.
Macaque predictions	Regmi et al. (2018) and Suwal et al. (2018)	First quantitative range maps for this primate species and the HKH region
Charismatic endangered species predictions	Kandel et al. (2015)	First quantitative range maps for the Red Panda and the HKH region based on Open Access data sharing and using machine learning as a role model.
Disease predictions	Herrick et al. (2013)	First disease model (Avian Influenza) highlighting importance of cold regions and mountains.

The Arctic and Antarctic regions (=Two Poles) have already received such an open access data review and initial efforts since the 1950s, but still, an implication of the concept is widely missing in many projects to this very day (Dornelas et al. 2018 for overview, also Carlson 2011 and the International Polar Years. See also Huettmann 2011, and Huettmann et al. 2015 for the Ross Sea, Antarctica as one of the longest-standing wilderness research sites). Whereas, the HKH region (=Third Pole) has no good national coordination and business model for its data, and apart from ICIMOD.org and GBIF.org even on an international level and with massive funding by international aid agencies the spatial data and GIS holdings are narrow and specific, at best (see Table 26.4 for overview). Global layers can be used to help and fix gaps (see for instance in http://www.ciesin.org/, and see Herrick et al. 2013 for an application using over 20 GIS layers). A recent project using publication of 104 compiled open access 1 km GIS layers worldwide (Sriram and Huettmann unpublished) provided a change, but those are just a start. Ongoing efforts by ICIMOD with the geoportal (http://geoportal.icimod.org/), online libraries (http://

Table 26.3 Categories of data,/software, why they matter, and their status for the Hindu Kush-Himalaya region, based on research by the author and related data sources

Data and software category	What it includes	Why it matters	Digital Status and Metadata (Yes/No)	Cited examples for basic data sets
Biodiversity	Wildlife species	Conservation	Coarse and incomplete. No consistent data exist for the region (No)	Nemitz et al. (2012)
	National data holdings	Conservation	Not ISO compliant	e.g. for Bhutan www.biodiversity.bt
Socio-economic	Home economics, illiteracy	Management of human well-being	No consistent and high-quality public data exist for the region; only some aggregates (No)	http://sedac.ciesin.columbia.edu/
National information	National inventory, basic and advanced, As grid layers	National data information; often spatial	No, basic information	e.g. for Bangladesh https://gfc.ucdavis.edu/profiles/rst/bgd.html
Health	Disease and health provider access	Human health	Coarse and incomplete. No consistent and high-quality public data exist for the region; (No)	Herrick et al. (2013)
Ecological processes	Glacier thaw, water run-offs, cloud processes, predator-prey systems	Ecosystem management	Coarse data exist others are widely missing (No)	www.icimod.org
Topography	Digital Elevation Models (DEMs)	Landscape	Soil erosion maps for instance only exist in a coarse level and/or local level (No)	ETOPO1 (https://www.ngdc.noaa.gov/mgg/global/etopo1sources.html)
Climate	Temperature, wind, humidity, rainfall, evapotranspiration	Ecosystem and general well-being	Global warming predictions exist but carry various levels of accuracy (Yes)	See for instance Worldclim.org. See also Karger et al. (2017) and Sayre et al. (2018)

(continued)

Table 26.3 (continued)

Data and software category	What it includes	Why it matters	Digital Status and Metadata (Yes/No)	Cited examples for basic data sets
Future Scenarios	Development strategies	Strategic decision-making	Some local and incomplete scenarios exist, mostly for climate (Yes)	www.ippc.ch
Computational	Code in R and R projects, besides other things	Analytics	Yes, own documentation	https://github.com/r-lib
Public data and citations	Data and citations	Information and data	Yes, basic	Wikidata and WIKIcite

Noteworthy here is that virtually none of those data follow ESIP Data Preservation and Stewardship Committee (2019)

Table 26.4 Data for nations in the wider HKH region in GBIF and the proportion of data held in major museums abroad (Auckland War Memorial Museum, Bailey-Matthews National Shell Museum, Bernice Pauahi Bishop Museum, Comision Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), Dr. Alexey P. Seregin, Estonian Museum of Natural History, Estonian University of Life Sciences, Finnish Museum of Natural History, Landcare Research NZ Ltd., Loskutov I.G., MBM – Herbario do Museu Botanico Municipal, McGill University, Missouri Botanical Garden, Moscow State University, Natural History Museum Rotterdam, Natural History Museum, University of Tartu, North Carolina Museum of Natural Sciences, President and Fellows of Harvard College, Prioksko-Terrasnyi Biosphere Reserve, Rio de Janeiro Botanical Garden, Royal Belgian Institute of Natural Sciences, Royal Ontario Museum (ROM), SAIAB, Swedish Museum of Natural History, Tallinn Botanic Garden, The Field Museum of Natural History, The New York Botanical Garden, University of Alberta Museums, University of British Columbia, Yale Peabody Museum of Natural History)

Nation	# GBIF records	# of data held abroad and publicly available online (proportion; rounded in %)	GDP[a] (US$MM)	Ratio GBIF data/GDP	Comment
Afghanistan	57.105	11	21,056	0.002	A war-torn country. A nation that has received though a very high amount of international support and development aid.
Bangladesh	50,766	5	250,023	~0.203	A nation that has received a very high amount of international development aid.
Bhutan	11,726	7	2.231	5255.000	A poster child for conservation.
China[b]	2,022,710	9	11,937,562	0.169	One of the richest nations in the region.
India[b]	468,686	15	2,439,008	0.192	One of the richest nations in the region.
Kyrgyzstan	47,486	12	7062	6.724	
Kazakhstan	84,344	10	156,189	0.540	
Laos	57,569	33	17.152	3356.000	
Myanmar	97,184	6	66,966	1.451	
Mongolia	66,898	45	10.869	6154.936	
Nepal	112,610	15	24,065	4.679	
Pakistan	138,036	12	304,400	0.453	A nation that has received a very high amount of international development aid.
Russia[b]	1,291,942	56	1,469,341	0.879	A rich nation in the region
Tajikistan	22,946	31	7234	3.171	
Turkmen-istan	17,353	44	41,670	0.416	

(continued)

Table 26.4 (continued)

Nation	# GBIF records	# of data held abroad and publicly available online (proportion; rounded in %)	GDP[a] (US$MM)	Ratio GBIF data/GDP	Comment
Uzbekistan	20,320	18	67,505	0.301	
Vietnam	183,331	38	215.963	848.900	A fastly developing nation recovering from earlier warfare

[a]Source: International Monetary Fund (IMF) 2017
[b]Nations that are only partly located in the study area

www.icimod.org/himaldoc) and clearinghouses are along the same lines. But to provide a professional science aspect in regards to GIS layers, here we suggest in Table 26.5 some relevant details we encountered from our own work on GIS data compilations. From that first-hand experience we try to share and discuss added-value products available for people to use and to share (Appendix for 123 GIS data sets made available by the authors as value-added products from open access sources; for details please contact FH and see Sriram and Huettmann unpublished). Data gaps are still to be filled (see Table 26.6). This is meant to present and improve the data situation in HKH further so that a better governance of natural resources, the landscapes and the atmosphere can be achieved (Fig. 26.1).

So who should pay for such data (Costello et al. 2014), and how made available, for whom, and in what format? Is that a local, a regional or a global matter? Should there be a data police and consequences when not delivering? Arguably, a neoliberal mindset that just tries to privatize the public good for personal gain and income, instead of promoting synthesis and the wider public good will not be of help here and cannot resolve the problem. We had enough of those during the last decades already. Instead, Table 26.6 shows a decent suggestion on how to deal with the data deluge in the HKH region and the culture of 'not sharing' in Asia (Fig. 26.2).

As already shown in Table 26.4 the richest nations in the study area are also the ones that share the least amount of data via publicly available museums from abroad. Presumably the real amount of data located abroad is much higher but not publicly available. Noteworthy are the relatively poor nations that have a high percentage (e.g. 10–45%) of 'their' data shared by foreign institutions. This is usually a direct reflection for the colonial history and outside domination where specimen where taken abroad and the local citizen have 'no say'. In many cases, this now raises issues of outside dominance and data repatriation among states, even affecting international relations. Some of the ongoing repatriation topics and efforts for the HKH region are shown in Table 26.7. It becomes quickly clear that many donors and aid agencies, entire nations, have to address this topic for a fair and global approach, see Table 26.8 for an example.

By now, many national GIS and infrastructure data are freely available online (see for instance http://www.diva-gis.org/gdata or https://www.statsilk.com/maps/download-free-shapefile-maps), while major agencies and NGOs have not paid for

Table 26.5 A ranking of data groups and GIS data layers that are missing in the public sphere or where the HKH region falls short for information

Specific data layer	What to improve	What format (and units)	Why needed
Socio-economics	Add meaningful geo-referencing on an individual household-level	ESRI grid layers or ASCII grids (event and item per pixel)	Explicit in space and time for precise management at locations and regions.
Digital Elevation Model	Create a consistent DEM with high resolution across the study area with a known error structure (confidence)	ESRI grid layer or ASCII grid (meters above sea level)	An essential base layer. Needed for waterflow models and spatial planning and risk maps, e.g. for erosion prediction and flooding risks.
Endangered species	Compile a IUCN list of endangered species and their relevant data; fill data gaps	ESRI grid layers or ASCII grids (presence/absence and abundance)	Conservation management explicit in space and time.
Biodiversity	Re-patriate data, digitize and fill data gaps	ESRI grid layers or ASCII grids (presence/absence and abundance)	Conservation management explicit in space and time.
Farming and agriculture	Create a good and consistent set of GIS layers in the HKH region related to farming and agriculture, e.g. density of life stock, farms, rice paddies, poultry barns, fertilizer use, crop maps	ESRI grid layers or ASCII grids (event and item per pixel)	Essential for planning, food security and diseases
Hospital and healthcare provider locations	Address, include and extend for better decision-making	ESRI grid layers or ASCII grids (hospital location, proximity to provider, e.g. euclidean distance in meters)	Human health improvement in one of the poorest nations and regions in the world. Earthquake mitigation and risk planning.
High precision climate models and forecasts[a]	Improve accuracy and resolution in space and time	ESRI grid layers or ASCII grids for many climate metrics	Precise impact assessments and planning, including climate and water.

[a]See worldclim.org, Karger et al. (2017) and Sayre et al. (2018); also Suwal et al. (2018) for an assessment

nor, provided such data, and just cannot offer them in an easy and well-documented format or do still not support those concepts in the first place (compare with https://www.gob.mx/conabio for Mexico or http://www.opendata.go.ke/ for Kenya, for instance).

Clearly there are many questions left unresolved for data and data sharing in the HKH region and how to achieve them best. The rugged terrain and remoteness, as

Table 26.6 Some data policy steps that ought to be standard for any science and research in the year 2018 following the 4th International Polar Year (IPY; but which are widely not practiced or taught even)

Data topic	Why it matters	What to do
Data creation	Fill data gaps, new data creation	Support data creation projects
Create complete ISO compliant metadata	Describe data for better understanding and inference	Focus on data description as part of any project with an appropriate budget
Comply with data publications standards	Global standards to find and to cite and read data	Follow ESIP Data Preservation and Stewardship Committee (2019)
Data serving	Serving the public and wider good	Set up public data servers and webportals
Data check and consistent improvements	Many data are pretty old and never really reviewed for professional quality	Review data sets and apply a data quality metric
Push for data applications	Cater the need	Make use of existing data for applications
Engage in Remote Sensing	Fills data gaps in areas notorious difficult to access (e.g. Reddy and Saranya 2017)	Compile and use remote sensing data, and engage in new sensors for the region and for peaceful use
Work up historical data	The 'western world' has such worked there and data for over 400 years	Identify worthy data holdings and work them up
Work up data from abroad, repatriation of data	The 'western world' has worked there and data from there for over 400 years	Identify data sets and bring them online (see INBIO and Nemitz et al. 2012 for examples)
Constantly review and improve data, document the data legacy	Data get better when used and checked, and errors are to be updated	Enforce and call for data improvements; document all changes made
Assess and establish a sustainable data creation and maintenance	Data need a long-term vision	Consider value of data and true long-term costs and gains; support a long-term data culture

well as politics (usually centered around Tibet and national defense issues like Kashmir or Afghanistan, are true roadblocks still to be overcome. While not all of them carry answers, ignoring those issues has major (international) consequences while better solutions are readily available for over a decade already but widely left unused; hardly demanded even. This is inefficient and biased, at best, and it 'kills' people. That not acceptable in a world of reason, for a science-based management, and for a conservation driven by science in times of a global crisis when urgent changes are to be dealt with and technically possible even; it begs instead for an immediate progress with a good vision and outlook making 'best use' of all options we have at hand. So why not using them?

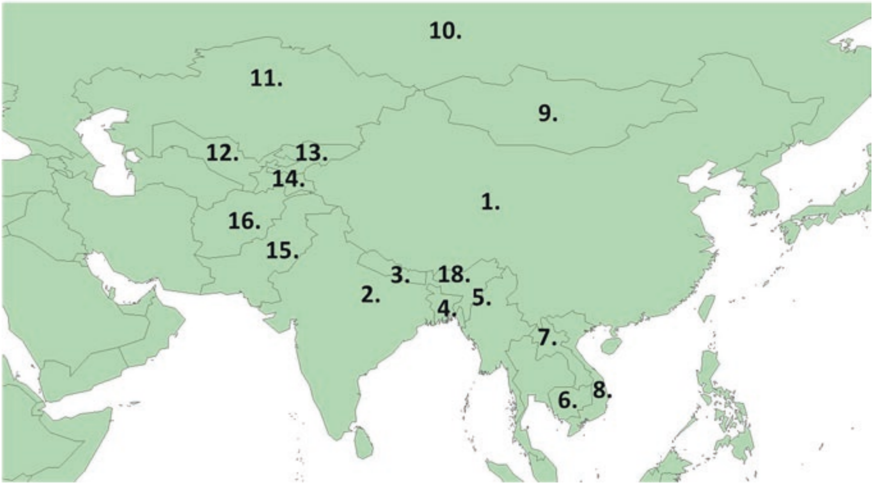

Fig. 26.1 Nations in the study area of the Hindu Kush-Himalaya. 1. China 2. India 3. Nepal 4.Bangladesh 5. Myanmar 6.Cambodia 7.Laos 8. Vietnam 9. Mongolia 10. Russia 11. Kazakhstan 12.Uzbekistan 13.Kyrgystan 14.Tajikistan 15.Pakistan 16. Afghanistan 17. Bhutan

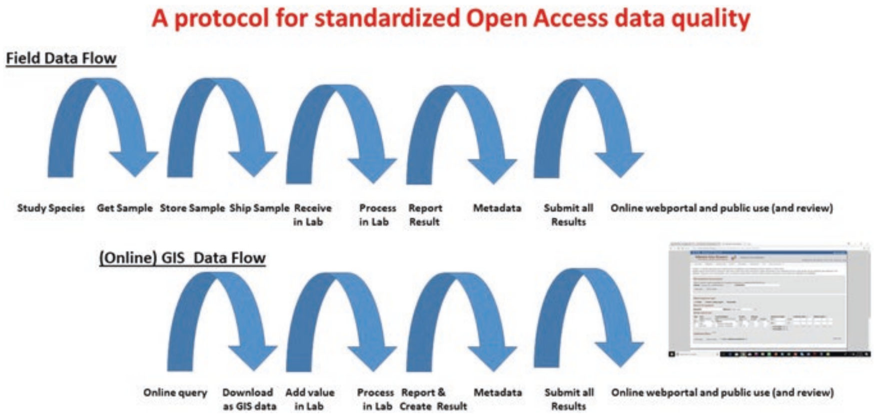

Fig. 26.2 'Best Professional Practice' for two workflows to determine funding priorities and data efforts from many stakeholders for better data and decision-making progress. (See also Bluhm et al. 2010)

Table 26.7 Data repatriation efforts for HKH region

Data repatriation topic	Justification	Result
Obtain best biodiversity data for the region held in foreign museums and collections	Use of best available science for global progress is mandatory	Better decision-making for sustainability
Obtain best-possible climate (model) data	Best-possible resolution to climate change crisis is required	Better mitigation
Obtain all expedition data carried out in HKH	Data for globally owned natural resources to be made available for the global public	More fair and equal distribution of natural resources
Obtain all research data carried out in HKH by foreign universities and research institutions	Publicly paid research projects are to be shared with the global audience	Present role-models for science, international research and gains
Obtain all development aid project data carried out in HKH by foreign nations	The World Bank, Asian Development Bank etc. invested billions of $ in such projects	Improve deliveries of development aid and its gains
Obtain all impact study data from hydro dam, road and similar projects	Many donors and NGOs are active on this topic for decades	Make better use of industrial projects and data

Table 26.8 List of selected development aid and related stakeholders active in HKH region that support projects and where data creation, collection and sharing is carried out, many more exist (a complete list of 135 NGOs registered with the Association of International Non-Governmental Organizations (NGOs) in Nepal [AIN is found at http://www.ain.org.np/). But note again almost none follow ESIP Data Preservation and Stewardship Committee (2019)

Development Aid-related stakeholder	Mission	Funding level	Data policies
FAO (UN)	Reducing global poverty[a]	App. 2.6 billion US$	No data policy officially stated. Some, no ISO compliant metadata nor detailed data qualities.
DANIDA (Denmark)	Contributes to global peace, develop human rights[a]	App. 2.34 billion US$	None known (how to find and see ?).
Norad (Norway)	Quality assurance of the Norwegian Development Cooperation	App 4.6 billion US$	None obvious.
Oxfam International (UK)	Power of people against poverty	App. 1.31 billion US$	Some, no ISO compliant metadata or conservation science focus. Virtually no support for GBIF.
GIZ (Germany)	Develop tailor-made solutions to challenging problems for GIZ clients. As a competent service provider, GIZ supports the German Government in achieving its objectives.	App. 2.4 billion US$	Little, no ISO compliant metadata. Virtually no support for GBIF.
Volkswagen Foundation/ Stiftung (Germany)	Provide impetus for the development of research and higher education.	Foundation capitol of c. 3.9 billion US$	Very little, no ISO compliant metadata. Almost no support for GBIF.

[a]A selection

[b]These are app numbers from previous business years, e.g. 2016. Often those agencies have numerous sub-organizations and contractors and the actual budgets might differ; details are found on the websites of the organizations

Appendix

List and details of 124 GIS layers available for the HKH region on a 1 km pixel size (List source page: http://rds.icimod.org/Home/Data?title=&MetadataAbstract=&Keyword=&Category=datasets&ExtentValues=&ExtentValues=&ExtentValues=&ExtentValues=&&themekey=&&page=1&&themekey=&&themekey=&&themekey=&&themekey=HKH%20Region)

S.N.	Category	Dataset name	Format	Units	Category	URL	
1	Precipitation	Annual mean precipitation for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=1629&searchlist=True	
2	Precipitation	Mean precipitation of January for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=1190&searchlist=True	
3	Precipitation	Mean precipitation of February for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=3347&searchlist=True	
4	Precipitation	Mean precipitation of March for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=1299&searchlist=True	
5	Precipitation	Mean precipitation of April for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=3477&searchlist=True	

6	Precipitation	Mean precipitation of May for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=2169&searchlist=True	
7	Precipitation	Mean precipitation of June for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=1171&searchlist=True	
8	Precipitation	Mean precipitation of July for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=2346&searchlist=True	
9	Precipitation	Mean precipitation of August for Hindu Kush Himalayan (HKH) region	GRID		Boundaries	http://rds.icimod.org/Home/DataDetail?metadataId=747&searchlist=True	
10	Precipitation	Mean precipitation of September for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=3634&searchlist=True	
11	Precipitation	Mean precipitation of October for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=2203&searchlist=True	

(continued)

S.N.	Category	Dataset name	Format	Units	Category	URL	
12	Precipitation	Mean precipitation of November for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=3564&searchlist=True	
13	Precipitation	Mean precipitation of December for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=2818&searchlist=True	
14	Temperature	Mean temperature of January for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=1181&searchlist=True	
15	Temperature	Mean temperature of February for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=3462&searchlist=True	
16	Temperature	Mean temperature of March for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=331&searchlist=True	
17	Temperature	Mean temperature of April for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=1873&searchlist=True	

18	Temperature	Mean temperature of May for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=2993&searchlist=True	
19	Temperature	Mean temperature of June for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=468&searchlist=True	
20	Temperature	Mean temperature of July for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=461&searchlist=True	
21	Temperature	Mean temperature of August for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=1699&searchlist=True	
22	Temperature	Mean temperature of September for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=844&searchlist=True	
23	Temperature	Mean temperature of October for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=3725&searchlist=True	

(continued)

S.N.	Category	Dataset name	Format	Units	Category	URL	
24	Temperature	Mean temperature of November for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=454&searchlist=True	
25	Temperature	Mean temperature of December for Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=7&searchlist=True	
26	Temperature Maximum trend	Monthly maximum temperature trend (January) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8695&searchlist=True	
27	Temperature Maximum trend	Monthly maximum temperature trend (February) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8696&searchlist=True	

28	Temperature Maximum trend	Monthly maximum temperature trend (March) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8697&searchlist=True	
29	Temperature Maximum trend	Monthly maximum temperature trend (April) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8698&searchlist=True	
30	Temperature Maximum trend	Monthly maximum temperature trend (May) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8699&searchlist=True	
31	Temperature Maximum trend	Monthly maximum temperature trend (June) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8700&searchlist=True	

(continued)

S.N.	Category	Dataset name	Format	Units	Category	URL	
32	Temperature Maximum trend	Monthly maximum temperature trend (July) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8701&searchlist=True	30 arc-second resolution grid.
33	Temperature Maximum trend	Monthly maximum temperature trend (August) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8702&searchlist=True	
34	Temperature Maximum trend	Monthly maximum temperature trend (September) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8703&searchlist=True	
35	Temperature Maximum trend	Monthly maximum temperature trend (October) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8707&searchlist=True	30 arc-second resolution grid.

36	Temperature Maximum trend	Monthly maximum temperature trend (November) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8708&searchlist=True	
37	Temperature Maximum trend	Monthly maximum temperature trend (December) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8709&searchlist=True	
38	Temperature mean trend	Monthly mean temperature trend (January) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8710&searchlist=True	
39	Temperature mean trend	Monthly mean temperature trend (February) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8711&searchlist=True	

(continued)

S.N.	Category	Dataset name	Format	Units	Category	URL	
40	Temperature mean trend	Monthly mean temperature trend (March) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8712&searchlist=True	
41	Temperature mean trend	Monthly mean temperature trend (April) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8713&searchlist=True	
42	Temperature mean trend	Monthly mean temperature trend (May) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8714&searchlist=True	
43	Temperature mean trend	Monthly mean temperature trend (June) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8715&searchlist=True	
44	Temperature mean trend	Monthly mean temperature trend (July) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8716&searchlist=True	

45	Temperature mean trend	Monthly mean temperature trend (August) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8717&searchlist=True	
46	Temperature mean trend	Monthly mean temperature trend (September) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8724&searchlist=True	
47	Temperature mean trend	Monthly mean temperature trend (October) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8725&searchlist=True	
48	Temperature mean trend	Monthly mean temperature trend (November) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8726&searchlist=True	

(continued)

S.N.	Category	Dataset name	Format	Units	Category	URL	
49	Temperature mean trend	Monthly mean temperature trend (December) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8727&searchlist=True	
50	Temperature Minimum trend	Monthly minimum temperature trend (January) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8683&searchlist=True	
51	Temperature Minimum trend	Monthly minimum temperature trend (February) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8684&searchlist=True	30 arc-second resolution grid.
52	Temperature Minimum trend	Monthly minimum temperature trend (March) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8685&searchlist=True	

53	Temperature Minimum trend	Monthly minimum temperature trend (April) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8686&searchlist=True	From worldclim
54	Temperature Minimum trend	Monthly minimum temperature trend (May) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8687&searchlist=True	
55	Temperature Minimum trend	Monthly minimum temperature trend (June) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8688&searchlist=True	
56	Temperature Minimum trend	Monthly minimum temperature trend (July) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8689&searchlist=True	
57	Temperature Minimum trend	Monthly minimum temperature trend (August) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8690&searchlist=True	From worldclim

(continued)

S.N.	Category	Dataset name	Format	Units	Category	URL	
58	Temperature Minimum trend	Monthly minimum temperature trend (September) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8691&searchlist=True	From worldclim
59	Temperature Minimum trend	Monthly minimum temperature trend (October) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8692&searchlist=True	From worldclim
60	Temperature Minimum trend	Monthly minimum temperature trend (November) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8693&searchlist=True	From worldclim
61	Temperature Minimum trend	Monthly minimum temperature trend (December) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8694&searchlist=True	From worldclim

62	Precipitation trend	Monthly precipitation trend (February) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8661&searchlist=True	From worldclim
63	Precipitation trend	Monthly precipitation trend (March) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8664&searchlist=True	From worldclim
64	Precipitation trend	Monthly precipitation trend (April) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8663&searchlist=True	From worldclim
65	Precipitation trend	Monthly precipitation trend (May) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8666&searchlist=True	From worldclim
66	Precipitation trend	Monthly precipitation trend (June) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8674&searchlist=True	From worldclim

(continued)

S.N.	Category	Dataset name	Format	Units	Category	URL	
67	Precipitation trend	Monthly precipitation trend (July) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8675&searchlist=True	From worldclim
68	Precipitation trend	Monthly precipitation trend (August) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8676&searchlist=True	From worldclim
69	Precipitation trend	Monthly precipitation trend (September) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8677&searchlist=True	From worldclim
70	Precipitation trend	Monthly precipitation trend (October) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8678&searchlist=True	From worldclim

71	Precipitation trend	Monthly precipitation trend (November) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8681&searchlist=True	From worldclim
72	Precipitation trend	Monthly precipitation trend (December) 1950–2000 of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8682&searchlist=True	From worldclim
73	NDVI	NDVI of April for Hindu Kush Himalayan (HKH) region	GRID		Environment	http://rds.icimod.org/Home/DataDetail?metadataId=1601&searchlist=True	
74	NDVI	NDVI of September for Hindu Kush Himalayan (HKH) region	GRID		Environment	http://rds.icimod.org/Home/DataDetail?metadataId=253&searchlist=True	
75	Population	Population density estimates 1995 for Hindu Kush Himalayan (HKH) region	Shape		NA	http://rds.icimod.org/Home/DataDetail?metadataId=8738&searchlist=True	

(continued)

S.N.	Category	Dataset name	Format	Units	Category	URL	
76	Population	Population density estimates 2000 for Hindu Kush Himalayan (HKH) region	Shape		MA	http://rds.icimod.org/Home/DataDetail?metadataId=8739&searchlist=True	
77	Population	Population density estimates 2005 for Hindu Kush Himalayan (HKH) region	GRID		NA	http://rds.icimod.org/Home/DataDetail?metadataId=8740&searchlist=True	
78	Population	Population density estimates 2010 for Hindu Kush Himalayan (HKH) region			NA	http://rds.icimod.org/Home/DataDetail?metadataId=8741&searchlist=True	2.5 arc-minute grid cells.
79	Population	Population density estimates 2015 for Hindu Kush Himalayan (HKH) region	Shape		Location	http://rds.icimod.org/Home/DataDetail?metadataId=8742&searchlist=True	2.5 arc-minute grid cells.
80	Watershed	Sub river basins of Hindu Kush Himalayan (HKH) region	GRID		Environment	http://rds.icimod.org/Home/DataDetail?metadataId=7952&searchlist=True	
81	Watershed	Sub-basins of Hindu Kush Himalayan (HKH) region	Shape		Boundaries	http://rds.icimod.org/Home/DataDetail?metadataId=8909&searchlist=True	

82	Geology	Division of geological time scale of Hindu Kush Himalayan (HKH) region	Shape		Environment	http://rds.icimod.org/Home/DataDetail?metadataId=3546&searchlist=True	
83	Geology	Geologic province of Hindu Kush Himalayan (HKH) region	Shape		Environment	http://rds.icimod.org/Home/DataDetail?metadataId=2722&searchlist=True	
84	Birds	Important habitat area of bird species of Hindu Kush Himalayan (HKH) region	Shape		Biota	http://rds.icimod.org/Home/DataDetail?metadataId=8655&searchlist=True	
85	Mountian regions	Mountain regions of Hindu Kush Himalayan (HKH) region	GRID		Location	http://rds.icimod.org/Home/DataDetail?metadataId=8743&searchlist=True	1 km resolution DEM
86	Snow cover	The Modis snow cover data of Hindu Kush Himalayan (HKH) region	GRID		Climatology Meteorology Atmosphere	http://rds.icimod.org/Home/DataDetail?metadataId=8852&searchlist=True	
87	Utilities	Utility infrastructures of Hindu Kush Himalayan (HKH) region	Shape		Utilities Communication	http://rds.icimod.org/Home/DataDetail?metadataId=8654&searchlist=True	

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S.N.	Category	Dataset name	Format	Units	Category	URL		
88	Night time view	Night time view of urban areas of Hindu Kush Himalayan (HKH) region	Shape		Society	http://rds.icimod.org/Home/DataDetail?metadataId=973&searchlist=True		
Additional ones from Sriram and Huettmann (unpublished)								
89	Solar radiation of each month (12)	Solar radiation of each month (12)	GRID	mm/day	SolRad1 – SolRad12	http://www.cgiar-csi.org	0.025	Zomer RJ, Trabucco A, Bossio DA, van Straaten O, Verchot LV, 2008. Climate change mitigation: A spatial analysis of global land suitability for clean development mechanism afforestation and reforestation. Agric. Ecosystems and Envir. 126: 67–80.
90	Mean cloud cover frequency of each month (12)	Mean cloud cover frequency of each month (12)	GRID	Number of days	Cloud1 – Cloud12	http://www.earthenv.org/cloud	0.008333	"Wilson AM, Jetz W (2016) remotely sensed high-resolution global cloud dynamics for predicting ecosystem and biodiversity distributions. PLoS Biol 14(3): e1002415. doi: https://doi.org/10.1371/journal.%20pbio.1002415" Data available on-line at http://www.earthenv.org/.
91	WorldClim bioclimatic variables (19)	WorldClim bioclimatic variables (19)	GRID	°C * 10	Bio1 – Bio19	http://www.worldclim.org/current	1409.718	Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965–1978.

92	Altitude	Altitude	GRID	m	Altitude	http://www.worldclim.org/current	1409.718	Hijmans, R.J., S.E. Cameron, J.L. Parra, P.G. Jones and A. Jarvis, 2005. Very high resolution interpolated climate surfaces for global land areas. International Journal of Climatology 25: 1965–1978.
93	Global land Cover 2000 (GLC2000)	Global land Cover 2000 (GLC2000)	GRID	–	GLC2000	http://forobs.jrc.ec.europa.eu/products/glc2000/products.php	0.008333	The global land cover map for the year 2000, 2003. GLC2000 database, European Commision Joint Research Centre. http://www-gem.jrc.it/glc2000.
94	Global lakes and wetlands – level 3	Global Lakes and wetlands – level 3	GRID	–	GLW3	http://www.wwfus.org/science/data.cfm	0.008333	Lehner, B. and Döll, P. (2004): Development and validation of a global database of lakes, reservoirs and wetlands. Journal of Hydrology 296/1–4: 1–22.
95	Koeppen Geiger	Koeppen Geiger	GRID	–	Koeppen Geiger	http://koeppen-geiger.vu-wien.ac.at/shifts.htm	0.5	Rubel, F., and M. Kottek, 2010: Observed and projected climate shifts 1901–2100 depicted by world maps of the Köppen-Geiger climate classification. Meteorol. Z., 19, 135–141. DOI: https://doi.org/10.1127/0941-2948/2010/0430.

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S.N.	Category	Dataset name	Format	Units	Category	URL		
96	Cyclone risk map	Cyclone risk map	GRID	1–10 risk factor	Cyclone	http://sedac.ciesin.columbia.edu/data/set/ndh-cyclone-hazard-frequency-distribution	0.0417	Center for Hazards and Risk Research – CHRR – Columbia University, Center for International Earth Science Information Network – CIESIN – Columbia University, International Bank for Reconstruction and Development – The World Bank, and United Nations environment Programme global resource information database Geneva – UNEP/GRID-Geneva. 2005. Global cyclone Hazard frequency and distribution. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4CZ353K. Accessed DAY MONTH YEAR
97	Human influence index	Human influence index	GRID	–	HII	http://sedac.ciesin.columbia.edu/wildareas/	0.008333	Wildlife Conservation Society – WCS, and Center for International Earth Science Information Network – CIESIN – Columbia University. 2005. Last of the wild project, version 2, 2005 (LWP-2): Global human influence index (HII) dataset (geographic). Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4BP00QC. Accessed DAY MONTH YEAR.

98	Human footprint	Human footprint	GRID	–	HumanFootprint	http://sedac.ciesin.columbia.edu/wildareas/	0.008333	Wildlife Conservation Society – WCS, and Center for International Earth Science Information Network – CIESIN – Columbia University. 2005. Last of the wild project, version 2, 2005 (LWP-2): Global human footprint dataset (geographic). Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4M61H5F. Accessed DAY MONTH YEAR.
99	Last of the wild	Last of the wild	GRID	–	LotW	http://www.sedac.ciesin.columbia.edu/wildareas	0.008333	Wildlife Conservation Society – WCS, and Center for International Earth Science Information Network – CIESIN – Columbia University. 2005. Last of the wild project, version 2, 2005 (LWP-2): Last of the wild dataset (geographic). Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4348H83. Accessed DAY MONTH YEAR.

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S.N.	Category	Dataset name	Format	Units	Category	URL		
100	ETOPO1	ETOPO1	GRID	m	etopo1	https://www.ngdc.noaa.gov/mgg/global/	0.01667	Amante, C. and B.W. Eakins, 2009. ETOPO1 1 Arc-Minute global relief model: Procedures, data sources and analysis. NOAA technical memorandum NESDIS NGDC-24. National Geophysical Data Center, NOAA. doi: http://dx.do.org/10.7289/V5C8276M
101	Human population count	Human population count	GRID	Number of persons	Pcount	http://sedac.ciesin.columbia.edu/data/set/gpw-v4-population-count	0.04167	Center for International Earth Science Information Network – CIESIN – Columbia University. 2016. Gridded population of the world, version 4 (GPWv4): Population count. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4X63JVC. Accessed DAY MONTH YEAR.
102	Human literacy rate	Human literacy rate	GRID		LitRate	https://nelson.wisc.edu/sage/data-and-models/atlas/data.php?incdataset=Life%20Expectancy	Polygon	Newsweek demographic data. World thematic map data description. ESRI website. 2000. http://www.esri.com/data/online/wothdata.html (23 March 2000).
103	Human life expectancy	Human life expectancy	GRID	Years	LifeExpct	https://nelson.wisc.edu/sage/data-and-models/atlas/data.php?incdataset=Life%20Expectancy	Polygon	Newsweek demographic data. world thematic map data description. ESRI website. 2000. http://www.esri.com/data/online/wothdata.html (23 March 2000).
104	GNP growth	GNP growth	GRID	%	GNP	https://nelson.wisc.edu/sage/data-and-models/atlas/data.php?incdataset=Life%20Expectancy	Polygon	Newsweek demographic data. World thematic map data description. ESRI website. 2000. http://www.esri.com/data/online/wothdata.html (23 March 2000).

105	Income per capita	Income per capita	GRID	$	Incpercap	https://nelson.wisc.edu/sage/data-and-models/atlas/data.php?incdataset=Life%20Expectancy	Polygon	Newsweek demographic data. World thematic map data description. ESRI website. 2000. http://www.esri.com/data/online/wothdata.html (23 March 2000).
106	Night light pollution	Night light pollution	GRID	0–255 indicating lights	NLP	https://www.arcgis.com/home/item.html?id=b3824432e4204db69ed48552c8c3b81f	0.043945	ESRI, NASA – visible earth
107	Livestock – pigs	Livestock – pigs	GRID	Animal density/km2	Pigs		0.05	Pigs
108	Livestock – poultry	Livestock – poultry	GRID	Animal density/km2	Poultry		0.05	Poultry
109	Species richness of amphibians	Species richness of amphibians	GRID	Number of species	Amphibians	http://www.biodiversitymapping.org/download.htm	10 km	Jenkins, CN, SL Pimm, LN Joppa (2013) Global patterns of terrestrial vertebrate diversity and conservation. PNAS 110(28): E2602–E2610. doi: 10.1073/pnas.1302251110 (PDF)
110	Species richness of birds	Species richness of birds	GRID	Number of species	Birds	http://www.biodiversitymapping.org/download.htm	10 km	Jenkins, CN, SL Pimm, LN Joppa (2013) Global patterns of terrestrial vertebrate diversity and conservation. PNAS 110(28): E2602–E2610. doi: 10.1073/pnas.1302251110 (PDF)
111	Species richness of mammals	Species richness of mammals	GRID	Number of species	Mammals	http://www.biodiversitymapping.org/download.htm	10 km	Jenkins, CN, SL Pimm, LN Joppa (2013) Global patterns of terrestrial vertebrate diversity and conservation. PNAS 110(28): E2602–E2610. doi: 10.1073/pnas.1302251110 (PDF)

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S.N.	Category	Dataset name	Format	Units	Category	URL		
112	Species richness of plants	Species richness of plants	GRID	Number of species	Plants	https://www.arcgis.com/home/item.html?id=e69b61fd6acf434bb4343d69d3eb9552	Polygon	Plant species richness by ecoregion: Kier, G., J. Mutke, E. Dinerstein, T. H. Ricketts, W. Ku, H. Kreft, and W. Barthlott. 2005. Global patterns of plant diversity and floristic knowledge. Journal of Biogeography 32: 1107–1116.
113	Proximity to coast	Proximity to coast	GRID	m	Proximity to coast	http://www.naturalearthdata.com/downloads/10m-physical-vectors/10m-coastline/	0.008333	
114	Proximity to river	Proximity to river	GRID	m	Proximity to river	http://www.naturalearthdata.com/downloads/10m-physical-vectors/10m-rivers-lake-centerlines/	0.008333	
115	Proximity to road	Proximity to road	GRID	m	Proximity to road	http://sedac.ciesin.columbia.edu/data/set/groads-global-roads-open-access-v1/data-download	0.008333	Center for International Earth Science Information Network – CIESIN – Columbia University, and information technology outreach services – ITOS – University of Georgia. 2013. Global roads open access data set, version 1 (gROADSv1). Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). https://doi.org/10.7927/H4VD6WCT.

116	Annual average potential Evapo-transpiration	Annual average potential Evapo-transpiration	GRID	mm	PET	http://www.cgiar-csi.org	0.008333	Trabucco, A., and Zomer, R.J. 2009. Global potential Evapo-transpiration (global-PET) and global aridity index (global-aridity) geo-database. CGIAR consortium for spatial information.
117	Global aridity index (multiplied by 10,000)	Global aridity index (multiplied by 10,000)	GRID	–	Aridity	http://www.cgiar-csi.org	0.008333	Trabucco, A., and Zomer, R.J. 2009. Global potential Evapo-transpiration (global-PET) and global aridity index (global-aridity) geo-database. CGIAR consortium for spatial information.
118	Infant mortality	Infant mortality	GRID	Percentage	InfMort	https://nelson.wisc.edu/sage/data-and-models/atlas/data.php?incdataset=Life%20Expectancy	Polygon	Newsweek demographic data. World thematic map data description. ESRI website. 2000. http://www.esri.com/data/online/wothdata.html (23 March 2000).
119	Sanitation	Sanitation	GRID	%	Sanitation	https://nelson.wisc.edu/sage/data-and-models/atlas/data.php?incdataset=Life%20Expectancy	Polygon	Newsweek demographic data. World thematic map data description. ESRI website. 2000. http://www.esri.com/data/online/wothdata.html (23 March 2000).
120	Cars	Cars	GRID	Thousands	Cars	https://nelson.wisc.edu/sage/data-and-models/atlas/data.php?incdataset=Life%20Expectancy	Polygon	Newsweek demographic data. World thematic map data description. ESRI website. 2000. http://www.esri.com/data/online/wothdata.html (23 March 2000).

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S.N.	Category	Dataset name	Format	Units	Category	URL		
121	Export	Export	GRID	Millions	Export	https://nelson.wisc.edu/sage/data-and-models/atlas/data.php?incdataset=Life%20Expectancy	Polygon	Newsweek demographic data. World thematic map data description. ESRI website. 2000. http://www.esri.com/data/online/wothdata.html (23 March 2000).
122	Import	Import	GRID	Millions	Import	https://nelson.wisc.edu/sage/data-and-models/atlas/data.php?incdataset=Life%20Expectancy	Polygon	Newsweek demographic data. World thematic map data description. ESRI website. 2000. http://www.esri.com/data/online/wothdata.html (23 March 2000).
123	Slope	Slope	GRID	Degree	Slope	Using ETOPO1	0.008333	
124	Aspect	Aspect	GRID		Aspect	Using ETOPO1	0.008333	

Source: http://rds.icimod.org/Home/Data?title=&MetadataAbstract=&Keyword=&Category=datasets&ExtentValues=&ExtentValues=&ExtentValues=&ExtentValues=&&themekey=&&page=1&&themekey=&&themekey=&&themekey=&&themekey=HKH%20Region

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Chapter 27
Insect Pollinators, Threats For Survival and Ecosystem Service: An Outlook From Hindu-Kush Himalaya Region

Daya Ram Bhusal

27.1 Introduction

The dynamics of mountain biodiversity and the livelihood of mountain people are influenced by the interplay of climate and other drivers of change. The Hindu Kush Himalaya (HKH) represents a wide set of ecosystem features ranging from subtropical broadleaf forests to alpine meadows. This region is rich in biodiversity but threatened by climate change and many other anthropogenic pressures. Pollination is considered as a regulating service, as it is required for the regulation of the gene flow in many natural and wild floras. Globally, it is estimated that the number of flower-visiting species around 150,000.that includes insects, birds and mammals whereas only bees account for 25,000–30,000 species and including flies, butterflies, moths, wasps, beetles (Nabhan and Buchmann 1997).

Insect pollinators are one of the key components of global biodiversity which are essential to maintain ecosystems and ecosystem services through pollination. It makes for a key ecosystem process, which is largely responsible for the reproductive success of the most native and cultivated plants (Partap and Partap 2002; Partap et al. 2012). Many agricultural crops and wild plants are effectively pollinated by insects that visit flowers for nectar or pollen. Many species of insect pollinators such as honeybees, bumblebees, flower flies, butterflies, beetles, and wasps are present in the ecosystem and play important roles in pollination of diverse flowers. Insect pollinators are clearly one of the most important components of the

D. R. Bhusal (✉)
Central Department of Zoology, Institute of Science and Technology, Tribhuvan University, Kirtipur, Kathmandu, Nepal
e-mail: drbhusal@cdztu.edu.np

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agro-biodiversity. It maintains ecosystem services leading to sustained crop production, food security, and livelihood of farmers (Ken et al. 2012). It's part of human wealth! It has been estimated that over three quarters of the world's crops and over 80% of all flowering plants depend on animal pollinators, especially one provided by bees. Worldwide, the contribution of pollinators to agricultural crops has been estimated at about USD 200 billion annually (Ken et al. 2012) where over 25,000 species of bees are reported to pollinate over 70% of the world's cultivated crops (Gallai et al. 2009). Recent evidence shows that insect pollinators declined due to being threatened by a wide range of multivariate factors including habitat loss, loss of local cultivars, pesticides, honey hunting, forest fires, monoculture, and climate change (Goulson 2003). Such decline in pollinators has seriously threatened agricultural production and pollination service in many parts of the world (Goulson 2003; Ghazoul 2005; Williams et al. 2009; Ollerton et al. 2011; Biesmeijer et al. 2006; Xie et al. 2008; Partap 2010; Potts et al. 2010). Therefore, any documentation of species profiles that are involved in the key insect pollinators and their threats for conservation in Hindu Kush Himalaya is urgent and lined to human welfare and survival.

27.2 General Threats to the Survival of Insect Pollinators in HKH

The newly described global decline of bumblebees presents a serious threat to the maintenance of biodiversity and ecosystem services in many parts of the world (Williams and Osborne 2009; Biesmeijer et al. 2006). There is ongoing global concern about the decline of key insect pollinators in recent decades. That is because of multiple causes probably including habitat loss, impacts of pesticides and insecticides, contamination, competition from non-native species, diseases, overgrazing; and climate change (Goulson et al. 2008; Xie et al. 2008; Williams and Osborne 2009; Kerr et al. 2015). There are numerous potential factors threatening the important group of insect pollinators. These may cause the disappearance and extinction of many species of pollinating insects without knowing and documenting them from this region (Fig. 27.1).

27.2.1 Habitat Loss and Fragmentation

The decline of many insect pollinators such as Bumblebees and Butterflies have been attributed to changes in landscape fragmentation and climate change (Hadley and Betts 2012). Research conducted in India Pakistan and Nepal suggests the loss of many species of solitary bees, Bumblebees and Butterflies due to rapid habitat loss. Similarly, destruction of natural habitat of high altitude pollinators by human

Fig. 27.1 *Bombus haemorrhoidalis*

encroachment while collecting of *Cordyceps sinensis* and other medicinal herbs remains an unabated stressor especially in Nepal Himalaya.

27.2.2 Use of Pesticides

Pesticides are the key factors for the loss of pollinator in modern agricultural practices, which are dominated by the excessive and indiscriminate use of pesticides and other agrochemicals. The few studies examining the impact of pesticides on pollinators such as Bumblebees, Bees and Butterflies have been reported lethal and sub lethal effects. Similarly acts the extensive use of pesticides in newly establishing agro-farms (Connolly 2013; Cresswell et al. 2012).

27.2.3 Overgrazing

Grazing by ungulates can significantly alter the landscape and can negatively impact on flowering that ultimately causes to loose many pollinators in abundance and diversity. The alpine ecosystem of this region is largely affected by different anthropogenic activities such as extension of yak pasture land (Xie et al. 2008). There are many evidences that have great impact on bumblebee's population after removing floral resources as well as reducing populations of nesting rodents (which in turn may reduce the number of nest sites available to *Bombus*). For example, on the Tibetan Plateau overgrazed areas in Tibet are associated with reductions in floral resources available to *Bombus* and a decrease in *Bombus* diversity (Xie et al. 2008).

27.2.4 Climate Change

Climate change may be affecting insect numbers, as changes in local weather conditions, such as a continuous drop in temperature and rainfall, affect the emergence of natural pollinators (Bartomeus et al. 2011; Rafferty and Ives 2011). Many researchers in alpine habitats have observed that *Bombus*' seasonal cycles have shifted in response to the changing climate (e.g. Forrest 2015). Since *Bombus* are most common in temperate regions, this genus may be especially vulnerable to the impacts of climate change there (Kerr et al. 2015).

Other factors such as the lack of focus and capacity of national institutions in a changing economic and social landscape may be impacting the decline in the populations of some common pollinators, such as indigenous honeybees, throughout the Himalayan Mountains and valleys (Joshi et al. 2002).

27.2.5 Parasites and Natural Enemies

Insect pollinators are further hampered by diseases and parasites; predators such as mice, skunks, badgers and birds, and human-created problems such as pesticides and the destruction of nesting sites. Some study noticed the presence of larvae of conopid fly or pupa in the abdomen of about 20% of queens of bumblebees (Schmid-Hempel 1990). These flies lay eggs on adult bees while foraging in the field. The larva after hatching enters into the abdomen of the queen and starts feeding on their abdominal contents. Chauhan et al. (2013) observed the incidence of pests and diseases in the colonies of some insect pollinators such as bumblebee nematodes, conopid flies, mites and moths. Similarly, while the brownish grey coloured moths that feed on the wax and pollen in colonies also caused losses up to c. 9% of developing colonies of bumblebees. In 14.7% of queens, numerous *Nosema* spores were found in the mid gut causing infection and finally leading to their death. Similarly, Streptococcacae bacteria were found in the guts of workers in c. 18% of colonies. Putatunda and Abrol (2003) recorded several species of mites associated with bumblebees in Jammu and Kashmir. Koch et al. (2013) investigated the diversity, host specificity and transmission mode of two of the most common, yet poorly known, gut bacteria of honeybees and bumblebees: *Snodgrassella alvi* (Betaproteobacteria) and *Gilliamella apicola* (Gammaproteobacteria). Furthermore, many study determined the loss of the honeybee *Apis cerana* due to the spread of the Thai sac brood virus disease that ultimately is resulting into low fruit and crop yields.

27.2.6 Traditional Honey Hunting and Wild Bee Conservation

Hunting of wild honeybees is a traditional practice in many parts of HKH and it is specifically prevalent in many remote areas of Nepal. Nowadays it is threatening though adding to the ongoing decline in the population of indigenous honeybees (Partap 2010). Ahmad et al. (2015) found already the decline of pollinators at eight sites in western part (Kaski District) of Nepal. They reported a decline in the number of wild bees (*Apis laboriosa)* nests from 182 in 1986 to 48 in 2002. *Apis laboriosa* is a high-altitude species of honeybee that plays an important role in the pollination of several crops that rapidly is decreasing the crop yield and leaves a negative impact on livelihoods of mountainous people of this region. Noteworthy is that *Apis laboriosa* honey hunting is also being encouraged in the name of ecotourism in many touristic sites of Nepal. There are trekking companies that encourages it so that tourists see honey hunting. Instead, there is a strong need of sustainable conservation action here to protect the wild bees from such forms of unconstrained honey hunting activities.

27.3 Ecosystem Service and Insect Pollinators in HKH (Tables 27.1 and 27.2)

Table 27.1 Major crops, chief insect pollinators and crop yielding status in mountain areas of the HKH

Crop	Degree of cross-poll-ination	Total flow-ering period	Peak receptivity period of the stigma to pollen	Dependence on animal pollinators	Chief pollinators	Increase in yield from insect pollination (%)
Apple			2–3 days	High	Honeybees, bumble-bees, halictid bees, *Eristalis* flies	180–6950
Apricot			4–5 days	All commercial varieties require cross-pollination	Honeybees, wild bees	5–10
Cherry	Cross-polli-nation essential	7–8 days	2 days	Cross-pollination beneficial; for some cultivars it is essential	Honeybees, wild bees	56–1000

(continued)

Table 27.1 (continued)

Crop	Degree of cross-poll-ination	Total flow-ering period	Peak receptivity period of the stigma to pollen	Dependence on animal pollinators	Chief pollinators	Increase in yield from insect pollination (%)
Citrus	Varies from self-fertile to self-sterile varieties	1 month	6–8 days	Low	Honeybees, bumble-bees, wild bees, flies	7–233
kiwi fruit	Cross-polli-nation essential	20–25 days	2–3 days	Essential	Honeybees	29–300
Grape	Generally self-fertile	20–25 days	3 days	0	Honeybees, halictid bees	23–54
Guava	Cross-polli-nation beneficial	20–25 days	1–2 days	Medium	Honeybees, bumble-bees, wild bees	–
Litchi	Cross-polli-nation beneficial	25–30 days	3 days	High	Honeybees, flies, ants	4538–10,240
Mango	Cross-polli-nation highly beneficial	2–3 weeks	Few hours to 5 days	High	Flies, honeybees, butterflies, moths, beetles	–
Papaya	Cross-polli-nation essential	1 month	–	Low	Thrips, honeybees, butterflies, hawkmoths	–
Peach	Most varieties self-fertile; few self-sterile	20–25 days	3 days	High	Honeybees	7–3788
Pear	Partially or entirely self-sterile	7–10 days	4–5 days	High	Honeybees, flies, beetles	240–6014
Persi-mmon	Mainly self-fertile	25–30 days	3–4 days	High	Honeybees, bumble-bees	21
Plum	Varies from self-fertile to self-sterile varieties	1 week	2 days	High	Honeybees, bumble-bees, blow flies	5–10
Straw-berry	Cross-polli-nation beneficial	30–35 days	3 days	High	Honeybees, wild bees	5–10

(continued)

Table 27.1 (continued)

Crop	Degree of cross-poll-ination	Total flow-ering period	Peak receptivity period of the stigma to pollen	Dependence on animal pollinators	Chief pollinators	Increase in yield from insect pollination (%)
Pome-granate	–	–	–	Medium	Honeybees, wild bees	–
Beans	Almost entirely self-polli-nated, but are benefited by cross-polli-nation	2–3 weeks	1 day	Low	Thrips	–
Peas	Almost entirely self-polli-nated, but are benefited by cross-polli-nation	2–3 weeks	1 day	Low	Thrips, bumble-bees, *Megachile* spp.	39
Butter beans (Rajmah)	Almost entirely self-polli-nated, but are bene-fited by cross-polli-nation	2–3 weeks	–	Low	Thrips	–
Pigeon peas	Almost entirely self-polli-nated, but are bene-fited by cross-polli-nation	2–3 weeks	1–2 days	Low	Honeybees, solitary bees	10–15
Mustard	Mainly cross-polli-nated	1 month	2–3 days	Medium	Honeybees, halictid bees, solitary bees, *Megachile* spp., *Eristalis* spp.	13–222

(continued)

Table 27.1 (continued)

Crop	Degree of cross-poll-ination	Total flow-ering period	Peak receptivity period of the stigma to pollen	Dependence on animal pollinators	Chief pollinators	Increase in yield from insect pollination (%)
Rape-seed	Mainly cross-polli-nated	1 month to 45 days	2–3 days	Medium	Honeybees, halictid bees, solitary bees, *Megachile* spp., *Eristalis* spp.	100–133
Sesame	5–65%	3–4 weeks	10–12 h	Medium	Honeybees, *Megachile* spp., *Eristalis* spp.	180–360
Soy-beans	Mainly self-polli-nated	1–2 weeks	1 day	Medium	Honeybees, solitary bees, flies	–
Sun-flower	20–75%	15–20 days	15–20 days	Medium	Honeybees, bumble-bees	21–3400

Source: Ken et al. (2012) Value of insect pollinators to Himalayan agricultural economies. International Centre for Integrated Mountain Development (ICIMOD)

Table 27.2 Economic value of insect pollination in different region of HKH by crop category (in million USD, with total value of crop in parentheses)

Sites	Fruit crops	Oilseed crops	Pulse crops	Spice crops	Tree nut crops	Vegetable crops	All crops
Chittagong Hill Tracts, Bangladesh	33.08 (186.56)	0.97 (5.62)	0 (0.40)	0.09 (2.26)	3.29 (13.96)	16.34 (46.37)	53.77 (255.17)
Bhutan	10.92 (52.85)	0.82 (3.28)	0.31 (6.23)	0.67 (13.46)	0.96 (20.7)	4.20 (26.7)	17.88 (123.22)
Chinese Himalayan provinces	445.82 (915.26)	187.96 (751.84)	0 (115.89)	4.03 (80.6)	0 (3134.29)	38.95 (6119.99)	676.76 (11,117.87)
Himachal Pradesh, India	354.49 (562.74)	1.06 (4.49)	1.58 (31.53)	0.02 (1.36)	0.05 (2.87)	7.84 (212.14)	365.04 (815.13)
Kashmir	408.01 (634.16)	–	–	–	9.73 (267.74)	9.10 (160.75)	426.84 (1062.65)
Uttarakhand, India	159.43 (306.02)	3.85 (39.37)	0.79 (37.08)	0.68 (11.83)	0 (51.72)	2.04 (129.05)	166.79 (575.07)
Himalayan region of Pakistan	879.74 (1627.26)	38.41 (155.89)	0 (22.13)	–	36.44 (66.93)	– (286.85)	954.59 (2159.06)
All study areas	**2291.49 (4284.85)**	**233.07 (960.49)**	**2.68 (213.26)**	**5.49 (109.51)**	**50.47 (3558.21)**	**78.47 (6981.85)**	**2661.67 (16,108.17)**

Source: Ken et al. (2012) Value of insect pollinators to Himalayan agricultural economies. International Centre for Integrated Mountain Development (ICIMOD)

27.4 Bumblebees as Potential Pollinators for the High Altitude Flora in HKH

Bumble bees are most efficient insect pollinators and potential biomarkers for the monitoring of watersheds and their landscapes (Sepp et al. 2004). Other insect pollinators such as butterflies and moths are so-called low-efficient species for pollination in high altitude regions which are generally considered as inefficient pollinators when compared to bees and bumblebees. The bumblebees of this region are interesting as this area presents a large and divergent oriental and palaearctic bumblebee fauna. Different climatic regions differ in their floral composition that creates a broad range of micro habitats for bumblebees in HKH. Bumblebees are among the most efficient pollinators of many native plant species of HKH. Is has great economic importance such as for *Brassica oleracea, B. napus, Cichorium endivia, Raphanus sativa, Solanum melongena, Lycopersicum esculentum* etc. Over 250 species of bumblebees are known throughout the world (Williams et al. 2009) and only 52 species occur in HKH. They have extensively been used for pollination in cages for several crops such as *Brassica oleracea, B. napus, Cichorium endivia, Raphanus sativus, Solanum melongena, Lycopersicum esculentum* etc. They have been reported to increase the seed yield from 110 kg/ha to 210 kg/ha in red clover at differing bumblebee densities (Barron Mandy 1998). Bumblebees can operate at low temperatures (−3.6 °C) at which no other insect pollinator can fly; it's their special niche! Further then can exploit flowers with deep corollas and they have higher foraging rates. But the distribution of the bumblebee fauna in the Hindu Kush-Himalayan region is still poorly known and it is in great need of much more study. The currently documented information is rather fragmentary, scanty and far from complete; hardly digital or available online. Initially 24 species of bumblebees from higher elevations including Kashmir, Himachal through Sikkim as well as Assam. Mani (1962) reported four species of bumblebees at elevations of over 4000 m at the Himalayas. Currently, Streinzer et al. (2019) recorded 21 species of Bombus from eastern himalaya. In other studies, the genus *Bombus* is represented by 48 species covering ten subgenera from India, of which 30 have been reported from the Kashmir Himalaya (Edwards and Williams 2004; Williams 2007; Saini et al. 2011). *Bombus miniatus* Bingham is an oriental species and it is widely distributed in Kashmir, Himachal Pradesh, Uttarakhand and Sikkim. Saini and Ghattor (2007) provided the list of seven species of bumblebee in Lahaul-Spiti valley of Himachal Pradesh and also illustrated their taxonomic description, synonymy, food plants and distribution pattern. Bumblebees are important pollinators for many wild flowers and for economically important food crops (Grixti et al. 2009; Sihag 1986). They are especially efficient pollinators for Leguminosae and Solanaceae, which benefit from their particular ability in buzz pollination across HKH. Recently, some 43 species of Bumblebees have been published from few sites of Nepal (Williams et al. 2010) but the systematic survey, ecological study and people's attitude about the conservation of this important pollinator and climate change indicator is not known from this country. Some notable species such as *Bombus abnormis, B. branickii, B.grahami, B. personatus, B. pressus* are reported but a nation-wide species survey and endemic species inventory needs much more work. The mid-hill and high-altitude region of HKH – including the one in Nepal – is facing rapid habitat alternation, fragmentation, overgrazing, use of pesticides (Giri et al. 2009) and infrastructure development, whereas the effect of these factors on bumblebees is currently not explored. Therefore, a sound species inventory, ecology study and assessment of people perception for this important pollinator is highly needed for sustainable conservation of this fauna from HKH. The baseline information to formulate the effective conservation action plan of this important pollinator across the countries of HKH including Nepal is extremely urgent.

27.5 Research Gaps on Pollinators Including Bumblebees in HKH

The HKH region has a high potential to harbor the many species of insect pollinators due to immense climatic and topographic variations. They may cause the disappearance and extinction of many species of pollinating insects without us knowing and documenting them from this region even. Therefore, a complete inventory of many insect pollinators including bumblebees becomes crucial across the high altitude region of Himalaya (Williams et al. 2010). The detailed taxonomic, ecological study and conservation issues of bumblebees in this area were highlighted due to rapidly changing agricultural landscape and increasing trends of pesticide use in many rural agrofarms.. The bumblebees of this region are of particular interest since they represent both i.e. oriental and Palaearctic group. There are c. 250 species of the bumblebee known throughout the world only 52 species documented from Hindu Kush himalayan (HKH) region, and 48 species recorded from India (Williams 2007) and 34 species from Nepal (Williams et al. 2010). Nation-wide detail species survey and relevant conservation threats assessment is urgent to carried from HKH. It is highly needed to prepare species listing, distribution mapping and initiation of conservation program for Bumblebees in this region. There is a high risk of local extinction of many species of Bumblebees without documenting. There need to bring together scientists, conservationists and policy makers from HKH countries that world to catalyze conservation action and influence policy in HKH. Important pollinators including Bumblebees have extensively been utilized for pollination purposes in several countries of the world like France, Japan, Korea, Germany, Canada, Sweden, Brazil, U.K., U.S.A and many other countries. In these countries they have been reared /domesticated in artificially to increase their population for effective crop pollination in commercialized agro-farms. No such attempt has been made from the countries of HKH.

27.6 In summary

This global disappearing of many insect pollinators has highlighted the need for a comprehensive study from HKH and from highly dynamic agricultural landscape. High topographic and immense microclimatic variation within the HKH region has the great possibility to have high species diversity of many insect pollinators such as Hoverflies, Butterlfies, Bees and Bumblebees. Therefore, in future studies focusing on taxonomy, ecology, distribution mapping and assessment of conservation status of this important pollinator from the HKH region is very important. This allows to obtain crucial baseline information for the formulation of the first conservation action plan of pollinators in Nepal.

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Chapter 28
A First High-Resolution Open Access Data and Open Source GIS Model-Prediction for the Globally Threatened Sarus Crane (*Antigone antigone*) in Nepal: Data Mining of 81 Predictors Support Evidence for Ongoing Declines in Distribution and Abundance

Dikpal Krishna Karmacharya, Falk Huettmann, Chunrong Mi, Xuesong Han, Rabita Duwal, Santosh Kumar Yadav, and Yumin Guo

"In Buddhism, we have a concept called interdependency. It is very relevant today. Simply put it says that my future is linked to that of society, that of human beings to the environment."
(IVX Dalai Lama in Hellstrom 2016)

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D. K. Karmacharya (✉)
Bhaktapur Multiple Campus,Tribhuvan University, Doodhpati-1, Bhaktapur, Nepal

Third Pole Conservancy, Kathmandu, Nepal
e-mail: dikpal.karmacharya@gmail.com

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA

C. Mi · X. Han · Y. Guo
College of Nature Conservation, Beijing Forestry University, Beijing, China

R. Duwal
Third Pole Conservancy, Kathmandu, Nepal

S. K. Yadav
Green Youth of Lumbini, Bhagwanpur-4, Rupandehi, Nepal

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28.1 Introduction

The Sarus crane (*Antigone antigone)* is one of the tallest flying birds of the world. It is unique in appearance, having a red skin-covered head, throat and upper neck, being 180 cm tall, with a 240 cm wing span and weighing 6.8–12.24 kg. Its elegance, size and appearance result into admiration by humans, including a spiritual one (Matthiessen 2001; Adesh and Amita 2017 for associations with Buddhism). This species is of global concern and has been listed as Vulnerable in the National Red List of Nepal and also in the Red List of IUCN (Archibald et al. 2016a; ICF 2016; Birdlife International 2016 and Inskipp et al. 2016).

Among the six genera of cranes, 15 species exist, resulting into 25 taxa of cranes. According to Archibald et al. (2016a, b) there are three extant subspecies of *Antigone antigone.* They are *A. a. antigone* distributed in Southern Pakistan, Northern India, Nepal and Bangladesh; whereas *A. a. sharpie* is distributed in Myanmar, Cambodia, S. Laos and S. Vietnam; the third one, *A. a. gillae* is located in Northern Australia (Table 28.1. for taxonomic details). But like commonly found for subspecies (Winker and Haig 2010), these crane subspecies are easily described morphometrically and biogeographically, but lack genetic and biological details and are not really mutually accepted. Already from an ecological niche perspective, those are all rather similar.

Historically, *A. antigone* were distributed through the northern parts of the Indian subcontinent, south of the Himalayas (including our study area of Terai Lowlands of southwestern Nepal) stretching from Sind and Punjab in Pakistan reaching eastward through Uttar Pradesh, Bihar, and northern Bengal to western Assam in India (Ali and Ripley 1969; Matthiessen 2001). They were residents of northern India, ranging east to Burma, on the Malay Peninsula, in Indo-Chinese countries, and northern Australia. However, in recent times they were extirpated from the Philippine Islands, Thailand, and Malaysia (Johnsgard 1983). The current range includes the plains of northern, northwestern, and western India as well as the western half of Nepal's Terai Lowlands and small numbers in Pakistan (ICF 2016) with the contraction of its range found towards north and west of the Subcontinent (Sundar et al. 2000). Arguably, the global population is to be in decline (Archibald et al. 2003). In Nepal their population has been estimated from 450 to 700+ (Inskipp et al. 2016) without a sampled, transparent science-based number or confidence estimates though.

The species is non-migratory in most parts of India and northern Australia, but it shows seasonal movement during drought with a limited migration from isolated breeding areas of the upper basin of Mekong to its delta in Vietnam (Archibald et al. 2016a, b). Clearly, birds move across national boundaries.

This species's population is reported to have widely decreased (Birdlife International 2016; Inskipp et al. 2016). Like similar species of this size and lifestyle, it is due to the loss and degradation of wetlands by drainage and conversion to agriculture land, conversion of farmland to village settlements, housing, road construction, industrialization, disturbance, power lines, vandalising of nests, water pollution, agrochemical ingestion of pesticides, hunting of adults, collection of eggs

Table 28.1 Taxonomic name and classification according to different authoritive sources

Sarus crane and sub species list	Avibase	Avibase ID	IT IS	TSN	IUCN
Grus antigone (Linnaeus, 1758)	NA	NA	Yes	176181	NA
Grus antigone antigone (Linnaeus, 1758)	NA	NA	Yes	708142	NA
Grus antigone gillae (Schodde, Blackman, & Haffenden, 1989)	NA	NA	Yes	708143	NA
Grus antigone sharpie (Blanford, 1895)	NA	NA	Yes	708144	NA
Antigone antigone (Linnaeus, 1758)	Yes	8D891DB7520688E0	NA	176181	Yes
Antigone antigone antigone (Linnaeus, 1758)	Yes	F695F32AF5A31D1D	NA	708142	NA
Antigone antigone sharpii (sharpii) (= Antigone antigone sharpii) Blanford, 1895	Yes	617EFEEA53790E70	NA	708144	NA
Antigone antigone sharpii (Blanford, 1895)	Yes	B12D6B555FC146AE	NA	708144	NA
Antigone antigone sharpii (luzonica) (= Antigone antigone luzonica) (Hachisuka, 1941)	Yes	4D55C96920483BEF	NA	NA	NA
Antigone antigone gillae (gillae) (= *Antigone antigone gillae*) (Schodde, Blackman & Haffenden, 1989)	Yes	33C72D1311C92EC7	NA	708143	NA
Antigone antigone gillae (Schodde, Blackman & Haffenden, 1989)	Yes	8498583D26E25174	NA	708143	NA
Antigone antigone gillae (fordi) (= Antigone antigone fordi) (Bruce & McAllan, 1989)	Yes	3F3DB1C4C286D17E	NA	NA	NA

and chicks for trade, food, medicinal purposes and to help limit damage to crops (Birdlife International 2016; Inskipp et al. 2016). It comes as a multivariate package of stressors and true synergistic impacts are not fully described yet. Arguably, the Anthropocene has not been beneficial or this species (*sensu* Czech and Krausman 2003).

In Nepal, this species was first officially recorded by western sources in 1877 in central Terai (Scully 1879) with a distributional range stretching from the Sukla Phanta Wildlife Reserve to Chitwan National Park (Suwal and Shrestha 1992) and along the entire belt of lowland Nepal from east to west. However, it is known for Nepal that their range was significantly reduced mainly due to hunting and habitat loss (Meine and Archibald 1996). More than 90% of the country's population is located outside protected areas (Baral 2009) and they have been extirpated from large portions of their historic range in the eastern half of the Terai lowland regions (Suwal 1995). The declines continue from existing areas (Aryal et al. 2009). It should be noted that the Lumbini area – the birthplace of Buddha – is one of the best-known areas for Sarus crane in Nepal and Asia, and the species is widely honored and nurtured there (for World Heritage Site see https://whc.unesco.org/en/list/666).

In Asia, the Sarus crane is a mythical species and carries high spiritual value affecting land management (Adesh and Amita 2017). It is highly regarded by the Buddhist community and celebrated at the birthplace of Buddha in Lumbini (Matthiessen 2001, DKK, FH and YG pers. com) (Fig. 28.1).

So far, most of the crane studies are descriptive, based on population dynamics, behavior and limited habitat work, but with the exact quantitative ecological ranges and abundance estimates still missing. Reference to irrigation and watershed management, governance, impacts of the economic regime, the use of modern research design, open source, open access data sharing or software and optimization methods are widely missing in crane research (but see Cai et al. 2014, 2019; Jiao et al. 2014; Han et al. 2018; Mi et al. 2017; Huettmann et al. 2018 for good progress obtained when using those methods). Here we present for the first time for Nepal and the Sarus crane the use of latest modern machine learning technology and open source GIS try to provide science-based evidence for the species distribution and abundance in Nepal as a study template for global progress. For inference we focus on model-predicting the potential niche and to assess the validity of the approach we confront the model predictions with latest ground-truther data and evidence for an assessment from several years, including abundance estimates. In order to make the concept and tools more accessible and used, we employ OpenGIS and Open Access data sharing platforms for this work and make it freely accessible to a global audience as a template (Ohse et al. 2009; Zoeckler et al. 2016) and for further improvement.

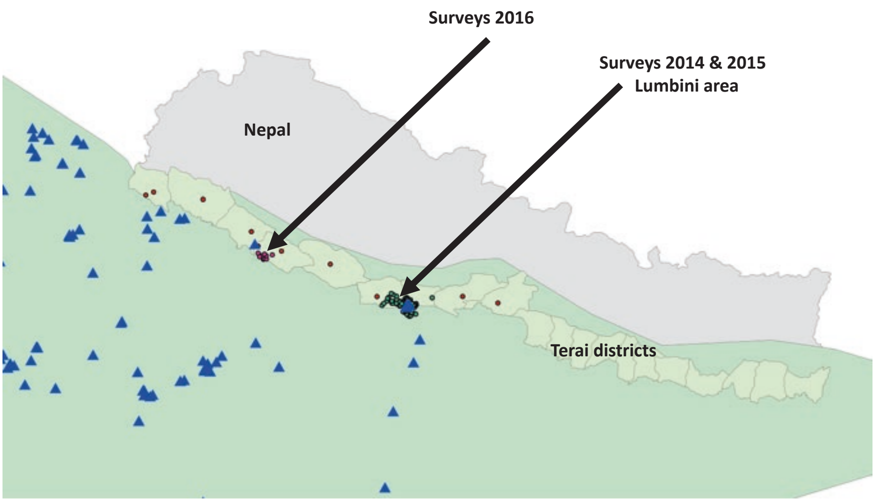

Fig. 28.1 Map of study area and survey locations for Sarus Cranes in Nepal in Terai, Nepal. (Data details are shown in Table 28.2)

28.2 Methods

28.2.1 Study Area, Data Collection and Metadata

This study includes the entire Terai belt, c. 840 km long and 50 km wide, located in southern Nepal. For training data, we followed all the accessible trails and potential sites in the Kapilvastu and Rupandehi districts, including farmlands of Lumbini Important Bird and Biodiversity Area (IBA). Surveys were done employing a van from the highway, and a motorbike on minor trails; bicycles and walking were employed through the farmlands to detect the presence and nesting sites in the 2014 and 2015 field seasons. We followed all the sites in the Kapilvastu and Rupandehi districts where previously Sarus crane were recorded. We visited all the potential presence sites as advised by local people and recorded the GPS readings, numbers and habitat parameters of Sarus cranes. Further we compiled literature data from published and unpublished reports, thesis, books and journals as well as from freely available online resources like GBIF and Birdlife International/IUCN.

The surveys were carried out regularly for many years and include number of birds seen (males and females, usually in nesting areas). Data details are described in Table 28.2. These data trained a distribution model of Sarus crane surveys based on the extensive field survey data in Rupandehi and Kapilbastu districts, Nepal from

Table 28.2 Best available and compiled datasets on presence and occurrence for Sarus crane in Nepal

Dataset Name and sample size (n = sighting location)	Survey Year	Start and End Date	Used for model stage	Type	Source
Field Kapilvastu and Rupandehi districts (n = 73)	2014	25 Sept – 5 Oct	Training	Field data, nests, presences and abundance	DKK and team, Gyawali (2014)
Field Kapilvastu and Rupandehi districts (n = 89)	2015	13 Sept – 14 Oct	Model assessment	Field data, nests, presences and abundance	DKK, FH and team
Field Banke District (n = 11)	2015–2016	1 Nov 2015 – 30 Jan 2016	Model assessment	Compiled literature	Tiwari (2016)
Birdlife international (n = 10)	1950–1999	NA	Model assessment	Extracted ‘presence only’	BirdLife International (2001)
GBIF (n = 11)	2008–2014	Year-round	Model assessment	Observations (‘presence only’)	GBIF.org
Birdlife international/ IUCN (shape file)	Till 2016	Year-round	Model assessment	Distribution map	http://datazone.birdlife.org/species/requestdis

2014 (Fig. 28.1) (see the data repository as well as METADATA published online at the data repository with the library of the University of Alaska Fairbanks (https://scholarworks.alaska.edu/handle/11122/5732).

28.2.2 GIS Work and Environmental Predictor Layers

To link Sarus crane with their habitats we used 81 compiled GIS layers from (Sriram and Huettmann, unpublished). Details on those data are found in Appendix 1. This set represents to our knowledge the best publicly available environmental data set for Nepal, all made freely available to be used in an easy-to-use GIS format for the global community for their own use and assessment.

For the GIS work we used ESRI grid and shapefile formats, but operated all those data in ArcGIS as well as QGIS, an open source GIS freely available from the internet (http://www.qgis.org/en/site/). We overlaid the presence/pseudo-absence data with the predictors. We did the same with the abundance data. In addition, we overlaid all predictors with a point lattice, spaced c. 1.25 km apart. This was done to create a smoothed-out prediction surface for the entire study area without gaps. We used IDW on a 1 km^2 pixel size for the subsequent density and population estimates (Species Abundance Model SAM).

28.2.3 Modeling

We followed a machine learning approach where we used many training data, leave the actual data use to the algorithm, and then infer from the best possible predictions and confront the model with alternative ground-truthing data (see for example in Mi et al. 2017). We tried to extrapolate the 73 unique sighting locations from 2014 around the farmlands of Lumbini IBA and adjacent districts to obtain the ecological niche for all of Nepal. Based on Salford Predictive Modeling Suite (SPM8; Salford Systems Ltd. https://www.salford-systems.com/products/spm) we used latest machine learning ensemble methods for presence/pseudo-absence as well as for abundance data. In our models 1000 trees were created both for species distribution model (SDM) and for the subsequent species abundance model (SAM); the balance weight was set for SDM, all others were run in the default setting as those settings are designed, and known, to provide high-performance results.

We ran Random Forest (RF) and TreeNet (TN) models as ensembles and then obtained the best model prediction for inference. The software and machine learning tools we used create robust models even when using a small and/or poor quality number of ‘presence only’ data (Herrick 2013; Hernandez et al. 2006). These tools are well-established in niche modeling, and as far as the potential niche is concerned, incomplete and somewhat biased sampling (presence and random habitat) is usually not a problem for the inference and results (Kadmon et al. 2004; Drew and Perera 2011; Tessarolo et al. 2014; Mi et al. 2017). This method is also known to employ very well in the 81 Open Access Environmental GIS layers we used. Based on the model algorithm chosen, this resulted into two map predictions for Nepal, and here we presented the one that matches the assessment data best.

28.2.4 Model Assessment (Range Map)

For the SDMs we used the Area Under the Curve (AUC) to assess the model performance on the (internal) training data. The field survey data from 2014, 2015 and 2016 used the same protocols. The field data 2014, 2015 and 2016 all come from the Terai region. In 2016, we supported financially and technically for a Master's degree student to study Sarus crane in the Banke District, Nepal. That study followed the same protocol from 2014 we used and it allows for a spatial comparison, helping to confront model predictions with field data from 2016. In addition, we queried GBIF.org data and found 11 records for Nepal. Further, we extracted 10 records for Nepal from distribution map of Sarus crane, from the publication Threatened Birds of Asia (BirdlIfe International 2001) and geo-referenced the known sightings with ArcGIS into a resulting map. Further, we requested the distribution range shape file of Sarus crane with Birdlife International (datazone.birdlife.org) and overlaid them with our prediction modeling maps or an assessment (Details in Figs. 28.1 and 28.2).

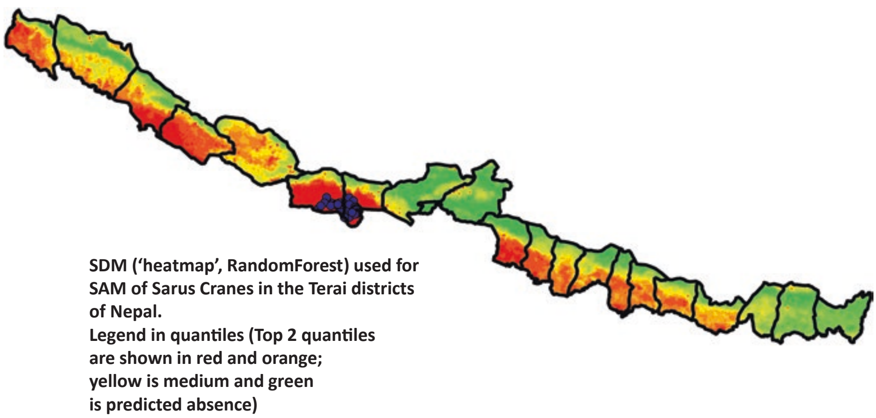

Fig. 28.2 Prediction map of Sarus Crane occurrence with RandomForest (RF) model in Terai, Nepal

28.2.5 Species Abundance Models (SAMs)

The surveys from 2014 and 2015 from Lumbini area include birds counted, males and females, nests, eggs and chicks. We overlaid those abundance estimates with the predictive surfaces and extrapolated bird densities (animals/km^2) for the predicted areas to obtain first population estimates of the Sarus crane in Nepal.

28.3 Results

28.3.1 Sarus Crane Occurrence Predictions

Our model prediction for the presence of Sarus crane resulted into the first quantitative distribution map for the Sarus crane (Fig. 28.2). This model has a high internal testing accuracy (ROC of 95 for TreeNet and 97 Random Forest respectively; details not shown, but the partial dependence plots of the top5 predictors are presented in Appendix 2). We further assessed this model with other, best-available public data across years and locations, and we found that it predicts them to almost 100%. Our map shows a high RIO for the Lumbini area, but some other areas also have suggested presences. Those occur usually at individual and clumped pixels throughout the study area. Most of these points are located in the western side of southern Nepal. The eastern region of southern Nepal lacks survey data, but our model still predicts the existence of suitable potential niche for Sarus crane in that region. However, we think these sites are accurate and they do not present an overestimation because other maps, like BirdLife International as well as IUCN also show that region as relevant for the species. We acknowledge some potential model uncertainty for that region but state that this area seems to matter for this species, e.g. as a potential niche. If the species is not found there anymore, likely, this shows that this species is on the decline or extinct in that part of Nepal as well, even within the potential niche. While this model helps to guide detailed surveys there to clarify that question, we are not aware of nesting birds in eastern Nepal and believe that it reflects a true decline (Fig. 28.2).

28.3.2 Sarus Crane Abundance Predictions

Our model presented the first predicted abundance map of Sarus crane, density of birds per km^2, with three levels of predicted densities. (i) predicted areas around Lumbini (top quantile: 736 km^2). (ii) areas in Nepal predicted with lower abundances (top 2 quantiles" 8344 km^2), and (iii) areas where we predict general absence (Fig. 28.3).

Our 2014 survey data (n = 74 sighting locations) shows that most survey sightings consist of app. 2 birds (pair) per km^2 in average; there are a few other cluster

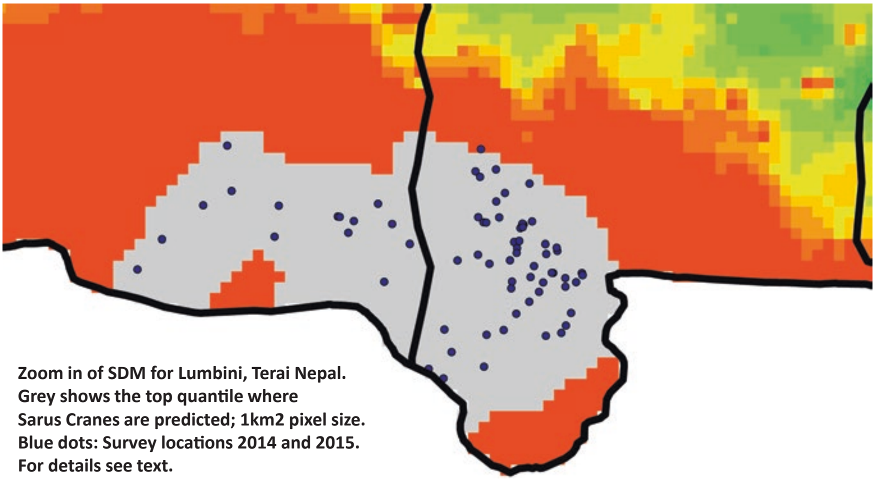

Fig. 28.3 Prediction map of Sarus Crane abundance with RandomForest (RF) in the Lumbini Area

sightings with larger numbers, usually flocks of 3–5 and very few foraging aggregations of up to 27 cranes. However, here we want to provide minimum estimates for the breeding population and we acknowledge higher numbers overall due to floating populations (non-breeders, failed breeders, dispersing individuals etc), which can make up to 60% for many species.

That way, and just looking at the Lumbini area alone, centered around the World Heritage Site, the predicted breeding population would consist of 1472 individuals (= two times the upper estimates by Inskipp et al. 2016).

If we consider the wider area of Sarus crane abundance in the Terai of Nepal, it consists of an predicted area of 8344 km^2. If just 50% of that area would be occupied (1 pair per km^2) it would still result into a breeding population of 4172 breeding individuals. Considering a high proportion of non-breeding birds in addition, the overall estimate for Nepal would even be higher.

28.4 Discussion

We are able to present the first predicted Open Source Open Access prediction maps for Sarus crane in Nepal using our multiyear field data and publicly available 'presence only' data. We focused specifically on the Terai region of Nepal having large farmlands and wetlands which are the best habitat of Sarus crane (Gosai et al. 2016; Inskipp et al. 2016; Katuwal 2016; Panthi 2016).

We presented 81 GIS predictor layers for the first time made publicly available for the country (compare with ICIMOD http://geoportal.icimod.org/ and with

Kandel et al. 2015 and Regmi et al. 2018). Our predictions are based on ensemble model algorithms. And include occurrence (presence/absence, SDMs) as well as abundance (SAMs) and they show good accuracies.

These models and underlying data are freely available (see Appendix 3 onwards) for further use and model improvement, which we encourage. Our work follows earlier examples set by Kandel et al. (2015) and Regmi et al. (2018) for the Hindu Kush Himalaya region (see also Zuckerberg et al. 2011; Huettmann et al. 2015; and Huettmann 2015; for data sharing standards in even one of the remotest areas in the world see Huettman et al. 2018). We suggest more research is to be done with those concepts to advance conservation.

Further, we used a small but well-surveyed area from 2014 to train our model, and we found a realistic and good prediction for subsequent years for most of the study area in Nepal.

Our model predicts presence in the western Terai, including Lumbini. Whereas the wide absence of Sarus crane is predicted in the center of the study area, as well as in eastern Nepal near India and Sikkim (see also Aryal et al. 2009; Grimmett et al. 2000; Inskipp et al. 2016; Katuwal 2016; Suwal 1995). We are not aware of any modern sightings in that area but the Birdlife International/IUCN range map shows them as present (Birdlife International 2016). Likely, this is a wide overestimate of its current range. We interpret the specific finding on the limited Sarus crane range in Nepal as part of ongoing wider declines and range retractions for this species (see Katuwal 2016 for agreements with global declines and for Nepal-wide increases, namely around the Lumbini region). With further intensification of land use and development in the Terai, as well as elsewhere in the species range, and while glaciers retreat causing arid areas, we see no good outlook for Sarus cranes on the landscape scale beyond the spiritual protection perhaps.

Our Species Abundance Model (SAM) is the first of its kind and shows numbers for Nepal in excess of 4172 breeding birds; already the wider Lumbini area would carry app. 1472 individuals (For both estimates non-breeders and first year cohorts are still to be added also). While the current official estimate is app. 700 birds (Inskipp et al. 2016), we believe the latter figure is still an underestimate, that based on limited surveys and opportunistic sightings and how the numbers were obtained is not so clear. We recorded already 237 Sarus cranes in 2014 while 299 were detected in 2015 including five juveniles and four chicks in 13 nests with 19 eggs from two districts Rupandehi and Kapilvastu only. We also observed a flock of 27 non-breeder cranes in Bhagwanpur, Rupandehi. Ramond and Giri (2009) recorded already the largest concentration of 104 Sarus cranes, seen on the banks of Dano River of Rupandehi. Gosai et al. (2016) estimated population density of Sarus crane as 4.2 induviduals per km^2 in Rupandehi. The true number of Sarus cranes in Nepal remains unknown. But our SAM is based on conservative estimates, science, a repeatable workflow and it matches assessment survey data across years. So far, the field survey numbers are not corrected for detection bias, thus report underestimates. Our modeling work suggests that helping to explain the low numbers presented with Inskipp et al. (2016). For a better conclusion and consolidation, there can be five action items from this work: (i) improve survey area coverage with abundance, absence and detection estimates for a Sarus crane database, (ii) run SAM updates, (iii) focus on the abundance and role of non-breeders, (iv) identify areas of high Sarus crane aggregations, (v) consider Asia-wide population work across borders, including nesting success and dispersal studies.

For now, we predict the potential niche and thus our estimates of the SDM and SAM appear high. However, our models are built on real, best-available data and assess well. Our findings could mean that many birds exist on the landscape but die over the year, which is a realistic scenario (Inskipp et al. 2016). Predation and mortality rates remain widely unknown, thus far. It might be that our high estimates are explained by high mortality rates and thus it explains eventually the lower population estimates as reported by Inskipp et al. (2016).

The Sarus crane is an elegant, appreciated, spiritual and mythical species in Asia (Adesh and Amita 2017), and its high abundance around Lumbini, the birthplace of Buddha, reflects that well. Like found with other cranes, they are not well protected in real life and are often found widely outside of protected areas such as national parks (Huettmann et al. 2018; Cai et al. 2019). This intimate area, covered with observations as well as predicted, has no direct legal protection beyond nomination as an IBA and an adjacent RAMSAR site, but the spiritual component seems to contribute to a high level of inofficial and indirect protection instead. In the absence of effective protection measures in Nepal and many parts of Asia, the 'holy' perception of this bird might be a powerful approach to its conservation.

It should still be noted though that this IBA area is heavily modified due to watershed irrigation, and the resulting reservoir is classified as a RAMSAR site but lacks a budget and enforcement to achieve. So is the real-world status of crane and bird conservation in the 'Anthropocene'. The area has also received in recent times major record heat waves, beyond 45 °C resulting into human death and droughts; bird stress is not described yet but can be expected to occur. Impacts on cranes can only be speculated on, thus far, but are unlikely to be positive, creating further stress on the populations and that are to increase with climate change. Further detailed study of mortality rates, movement ecology using telemetry and potential translocation of the species in the suitable eastern regions are highly recommended. Production of Sarus crane conservation action plan is mandatory for the long term protection of this holy bird.

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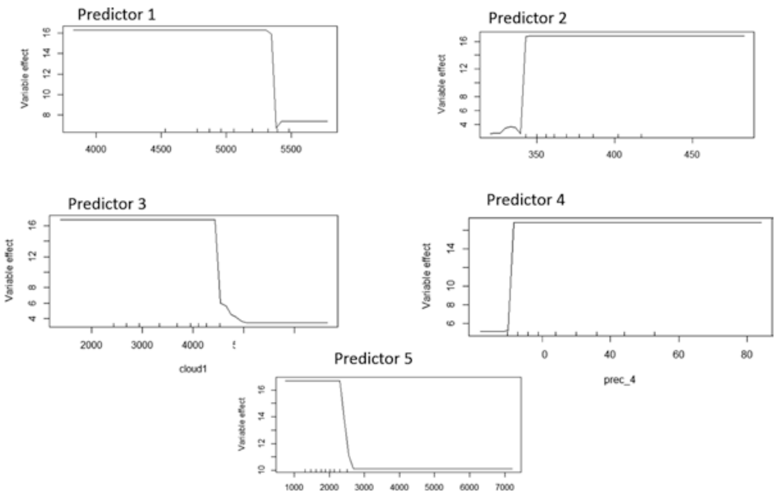
Appendices

Appendix 1

Overview and description of 81 predictors used and made available for Nepal by the authors. These datasets comes primarily from Sriram and Huettmann (unpublished; https://www.earth-syst-sci-data-discuss.net/essd-2016-65/) and DIVA-GIS national GIS layers (https://www.diva-gis.org/Data); for details and specific data sets please contact authors for data transfer.

Appendix 2



Partial Dependence plots for the top5 predictors

Appendix 3 (See Supplementary Electronic Material)

Model data for the RandomForest predictions
Surveys 2014 (points; ArcGIS ESRI shapefile)
Surveys 2015 (points; ArcGIS ESRI shapefile)
Surveys 2016 (points; ArcGIS ESRI shapefile)
BirdLife range (points; ArcGIS ESRI shapefile)
Model table (data cube from GIS overlays; CSV)
RandomForest prediction (lattice points, ArcGIS ESRI shapefile)
RandomForest prediction (1 km^2 pixel size, geotiff)

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Part IV
Very Serious Problems in the HKH Nations

Chapter 29
A 'Global Change' Eulogy, Sermons and Obituaries: 'Everest', its Models, the Reality, the Governmental Misbehavior, Associated Institutional Terror and the Global Abuse of the Hindu Kush-Himalaya Region

Falk Huettmann

An institution is not only a building, instead it comes with a method, its mindset and its champions linked in higher decision-making circles
Source unknown

Climate change – the man-made aspects and implications of it – represent the topic of our time to resolve. It speaks to virtually all aspects of our life-style and the globe, as we know it (Table 29.1; see Singh et al. 2011; Mukherji et al. 2019 for the Hindu Kush-Himalaya HKH region). But climate change also easily presents a fear-monger for policy, industry and the public, and rightly so due its severity and lack of progress by 'deciders' for decades (e.g. half of the glaciers in the HKH melted just since 2000: https://www.theguardian.com/environment/2019/jun/19/himalayan-glacier-melting-doubled-since-2000-scientists-reveal). It's specifically clear here that policy, industry, institutions and the established public fail on it; simply judged by carbon footprints due to consumption (Huettmann 2015; see Schmid et al. 2015 for biological distribution). When looked in good detail, the real-world implications of climate change are massive either way, even in the best of all current predictions and they are currently underpredicted, thus far (http://nymag.com/daily/

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F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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Table 29.1 Selection of topics known to be wider climate change impacts

Topic	Impact	Evidence already	Further citations
Temperature rise	Warming and heat waves	Glaciers melt in HKH region and worldwide	Huettmann (2012) and Bajracharya et al. (2014)
Desertification	Deserts grow bigger and become even dry'er	Desertification ongoing in HKH region and worldwide	e.g. Groisman et al. (2017) for Central Asia
Global change	Change of the entire environmental and social fabric	Dramatic cultural changes, indigenous cultures break down	Alexander (2013), Bisman (2013)
Change of weather patterns	Farming systems change	Change in El Nino, monsoon, ITC etc	Pendergrass and Hartmann (2014)
Increased flooding events	Flooding and devastation	GLOFs	ICIMOD (2017), Viet Hoa Le et al. (2007)
Earthquake increases	Destruction	Recent large earthquakes	https://nuscimag.com/does-climate-change-really-trigger-earthquakes-41a91477e7fc
Glacier retreat	Water decline and temperature increase	Volume and extent of glaciers	Gao et al. (2019) for HKH region; see Mukherji et al. (2019) for review and wider impacts
Sea level rise and people migration	Decrease in land-mass, coastal destruction and uprooting of people	Alaska, Solomon Islands, Bangladesh and India	Albert et al. (2018) and Harms (2019)
Niche decay	Species that live in the ecological niche will get stressed and lost	Fate of many alpine and polar species, e.g. at the southern/warmer species range	Huettmann (2011, 2017), Brambilla et al. (2018) and Bhattacharyya et al. (2019)
Risk assessment focus of public institutions, nations and funds	Public funds not available for other purposes	China, HKH	Tang and Ge (2017) and ICIMOD (2015, 2017)

intelligencer/2017/07/climate-change-earth-too-hot-for-humans-annotated.html). Considering political inaction and increase of CO_2 and Methane the real-world forecast is not that it will just get a few degrees warmer, globally, but instead that we actually could well be flooded and burned (Evers 2019 and citations within). From all we know, climate change comes without borders and without any consideration of man-kind or of life; it works continental (Lawler et al. 2009) and global (e.g. Huettmann 2017). If life moves out of its ecological climate niche it simply will die, and human societies -the biotic parts of the earth-are facing their end (Mukherji et al. 2019; see Miehe et al. 2017 and Wester et al. 2019 for a wider underestimate of reality impacts in the HKH region).

Table 29.2 Selected evidence of climate change across spatial scales

Scale	Citation	Impacts
Global	Pendergrass and Hartmann (2014) and Huettmann (2017)	Less rainy days, increased dryness, niche decays
HKH	Shrestha et al. (2012) and Lamsal et al. (2018a)	Invasive species
	Gao et al. (2019) ICIMOD 2019 (in The Guardian 2019)	Glacier retreat
Tibetan Plateau	Han et al. (2018) and Dehua et al. (2018)	Development, lake drying
	Han et al. (2018)	Black-necked crane range changes
	Wang et al. (2016)	Long-term snowfall/rain ratio changes
	Liu et al. (2019)	Grassland changes due to grazing etc.
Qinghai Plateau	Li (2019)	Plant species endangerment
Western Himalaya	Thapa et al. (2018)	Invasive species
Tajikistan	Salas et al. (2018)	Habitat changes and shifts for wild sheep species
Nepal	Shrestha et al. (1999), Shrestha and Aryal (2011), Chhetri and Cairns (2018), Harnid et al. (2018) and Robson et al. (2018)	Local glacier melt, (stable) tree line dynamics

Clearly, the change of climate is a major topic of our time, and when considering that human actions are the prime reason that caused it worldwide. Humans changed the only known place with life in the entire universe; they changed it to the worse and brought it out of balance judged by a life-system that was stable, more or less, for millennia and provided a space for humanity and well-being (Tables 29.1 and 29.2). In hindsight, we clearly used the atmosphere and its weather-making processes as a ‘marginal’ resource and helping us to reduce our costs of industrial production. How cheap was that ... Or when expressed more directly: our industrial life style parasites ‘Mother Earth’ and directly results into the man-made climate change discussed; it’s the industrialization -a form of environmental free-riding- that results here in the world’s people suffering and many humans to die (According to The Guardian 2017a, b for instance, c. 250 people have died in just 5 days as a result of flooding and landslides devastating northern India, Nepal and Bangladesh, while millions of people have been displaced. In Nepal alone, 110 people recently died due to incessant rain, with a third of Bangladesh being flooded after monsoon rains swept over; see Viet Hoa Le et al. 2007 for Vietnam). For now, the GDP is a good index to express climate change causing those processes, and they indicate the top-guilty nations. How can that ever be ethical? How many people die, environmentally speaking, when using a mobile phone, or sending one email, or a text message? There is little doubt that areas downriver, and the estuaries will carry the brunt of impacts (e.g. https://www.nytimes.com/interactive/2018/06/28/climate/india-pakistan-warming-hotspots.html; Wang et al. 2010).

And even worse, the bigger the GDP the bigger the actual real-world inaction and winding around the core problems. Starting with the Kyoto Agreement, the Paris Accord, Katowicse, Paris, Madrid and so on shows it no other (soon we will run out of cities to name all those U.N. attempts and Communique's). Apart of endless but well-documented negotiations, re-negotiations, lip-service, and blunt denial, man-made Climate Change is not really addressed by our current leadership and major players, and the future generation will face the synergy impacts. It's not only some little warming, and drying perhaps. Instead, it involves very high temperatures and dire aspects for man-kind, society; and life as we know it simply can burn away, or can die in related ways. That's not a good outlook to have, to create, or to be proud of! What's the modern vision?

The IPPC is the globally elected and assigned entity that has taken on climate change as its main tasks for well over three decades. Has it achieved much? Perhaps, but any action on climate change by the western world remains widely insufficient and thus it acts deeply unethical (see Evers 2019 for an example of 'hell'). While it's not easy to bring people on board regarding the weather, or consumptive waste, a subsequent new culture did not emerge, certainly not globally yet. While Rome is burning, the fiddle is still played by all stakeholders, and business goes on 'as usual' (Czech 2012).

We are apparently not able, or willing, to delineate temperatures -cold or warm-as 'endangered' and to protect/maintain it; our political leaders, often driven by industry, deny abiotic and biotic features any rights, or relevant laws.

And so we still lack a 'ministry of climate change', or a minister of such a topic (New Zealand is currently to take that on by the way). Tragic-funny enough, we have public action for health issues, e.g. the chief surgeon general (for instance suggesting you not to smoke tobacco), but the connection between climate, CO_2, methane and health is not made yet by our governments; hardly accepted even by many nations (see U.S., parts of Canada, China and India). Most governments and related entities simply fail on that issue to this very day, repeatedly, despite science (see Elvin 2004 for China's environmental history as a world-dominating nation). The lack of governance adjustment remains mind-boggling (Power and Chapin 2009). And the 'parties' are still going on; but why? That is the question of our time: where is good governance and global leadership?! Many textbooks were written on the subject, but which achieved?

Although data are still improved (see IPCC updates over time, the required inclusion of solar effects in IPCC models, or Poggio et al. 2018 for GIS data), the impacts of climate change are clearly 'humongous' (see for Jetstream for instance https://weather.com/de-DE/wissen/klima/news/2018-08-20-nicht-nur-naturliche-ursachen-verlangsamter-jetstream-befeuert/?cm_ven=focus_web_main). Several reports tried to assess the financial impacts, and they all agreed early on that we run a massive global bankruptcy. Beyond IPCC, that is expressed in the Stern (2006) report, and then just recently the report by National Academies of Sciences, Engineering, and Medicine (2017). They all agree in one fact, that is, the costs will be outstanding and not payable. With that, notions of inflation, value, monetary units and equity, or wealth distribution become a new value. Climate change demands either way a change in doing business, as well as a new culture how we deal with the earth. Perhaps that is a good thing, finally, but nature still pays the bill regardless.

Climate change is known to be observed stronger in more extreme places such as…the Hindu-Kush Himalaya of course, but also at other high altitudes (Moore et al. 2017), plateaus (The Guardian 2017a, b, c, 2019; Xinping et al. 2018) and the basins, coastlines and estuaries (due to sea level rise, e.g. Lutz et al. 2019). Lakes and wetlands in high altitudes are clear victims, e.g. the disappearing Poopo lake in Bolivia where indigenous lifestyles are lost. Other places hit by increasing temperatures are the glaciers (e.g. Rai et al. 2017; Mukherji et al. 2019), all snow and ice-covered regions as well as marginal zones where CO_2 concentration matters, e.g. leaf stomata, alveolus in lungs of animals and humans, and many similar membranes. Climate change is a matter that affects the metabolism, even blood molecules. With CO_2 also the changing PH values, ocean acidification, and any contact zones with such liquids will become global hotspots (Pterapods as a classic example; Bednaršek et al. 2016). One may just think of eyes and skin, e.g. for fish and marine mammals. The impact on molecules and organisms is hardly well-known and described yet. Evolution is certainly changing and leaving a mark for millennia to detect afterwards. Some of those changes we find already, others affect for instance things like nutrient content in food items (Wheeler and von Braun 2013) adding to a global food security problem.

To add to the many uncountable microviews of climate change the changing water properties should receive a specific consideration (see also Lutz et al. 2019). A change of temperature can turn water either into vapor, liquid or ice. Water remains fluid up to −4 °C when resolved in salt. Man-made climate change, still left unconstrained on a global level, will affect water availability, e.g. palm trees have vessels where frozen water destroys the plant. With warming, not only will palm tree range limits be moved, but with strong fluctuations many of the existing palms will simply die when exposed to a once-a-lifetime freeze! The entire concept of photosynthesis will be affected.

Climate change links it all, from the mountains to the land and rivers, watersheds, as well as the oceans and the atmosphere, of course. Impacts are felt wholesale across scales (Tables 29.1, 29.2, 29.3 and 29.4) That's what climate change is

Table 29.3 Some interactions that are affected and to change with man-made climate change

Topic to come	Impact	Evidence already	Further citations
Metabolism	Change of the underlying chemistry	Photosynthesis, mammals	Wheeler and von Braun (2013), Huettmann (2017), Barton et al. (2018) and Lamsal et al.(2018b)
Water dynamics	Water, as a chemical element, is used and impacts differently; change of some chemical base reactions. This affects the biology as well as snow, ice and the flow of water	Ocean acidification, different types of snow and ice, floodings	Bednaršek et al. (2016)
Monsoon	Rainfall, temperature and wind (weather; jetstreams)	Drier and shifted monsoon patterns	Turner and Annamalai (2012)

Table 29.4 Climate change and global change impacts directly observed by field work along the Great Himalaya Trail, as stated by Hinze (2019) as well as studied by the author

Topic	Impact and comment
Agrobusiness moves up and is now in the range of 3600 m.	Apple orchards with international funding in Annapurna; Kiwi plantations are planned.
Mosquito plagues now occur in mountain villages	A widely found modern scheme all over the HKH region.
Specific yak breed numbers go down because those are not used to the heat.	Change in lifestyles, landscape maintenance and business models.
Amchi healers are in decline, their plants are reduced due to lack of rainfall to grow	A change of medication practice and faith.
Formerly very remote villages close to China are now connected by road and get access to ocean, tourists and resources overall.	Remoteness vanishes and truck traffic dominates.
Remote monastries shut down due to lack of young people and lifestyle	Change in culture.
Wool coloration not natural anymore. It has to be done now chemically because plants are not available and not growing anymore locally.	Change in business and culture. Chemicals require financing and create polluting waste.
Borders get tighter controlled, e.g. China, and thus, are more difficult to pass	Local exchanges get affected, bothai culture gets further fragmented.

and does: it comes in those locations as well as in all its processes and then combined as a synergistic change and with impacts, bigger than we had anticipated. Climate change has no boundaries.

Many examples about complexity and unwanted outcomes can be told for the HKH region. Some of the story in Bangladesh, located downriver, is told by Rahman (2017) and Lutz et al. (2019). And in Afghanistan for instance most human settlements end at the highlands c. 3000 m high. Temperatures increased there and waters declined, thus, according to the farmers it becomes a desert now (The Guardian 2017a, b, 2019). Following this source the wider implication is that this area received for 15 years one of the highest development aid supports, but it is now starving! This aid support was actually meant for fast impact, good turn-around and to win the war; but climate change is not making it possible. As a matter of fact, c. 80% of conflicts in Afghanistan are about water and land. Garbage piles up at rivers there and it spills into the food chain. Afghanistan is among one of the most biodiverse nations in the world and four National Parks can help for better water tables. USAID has provided pesticides and fertilizer to get rid of poppy seed (to address the heroin market in the western world), but which hits biodiversity. Women often pay the bill, and when crop species change e.g. barley turning to wheat or broccoli even (Chaudhary et al. 2007); that means the locals have to work harder and their life is changed (Baumgartner 2015) (Figs. 29.1, 29.2 and 29.3) (Table 29.5).

Clearly, most citizens of the HKH have not really caused climate change. And if they do, then just in a small contribution when compared to the industrial players and their designed society. One may argue here about 'black carbon' and some

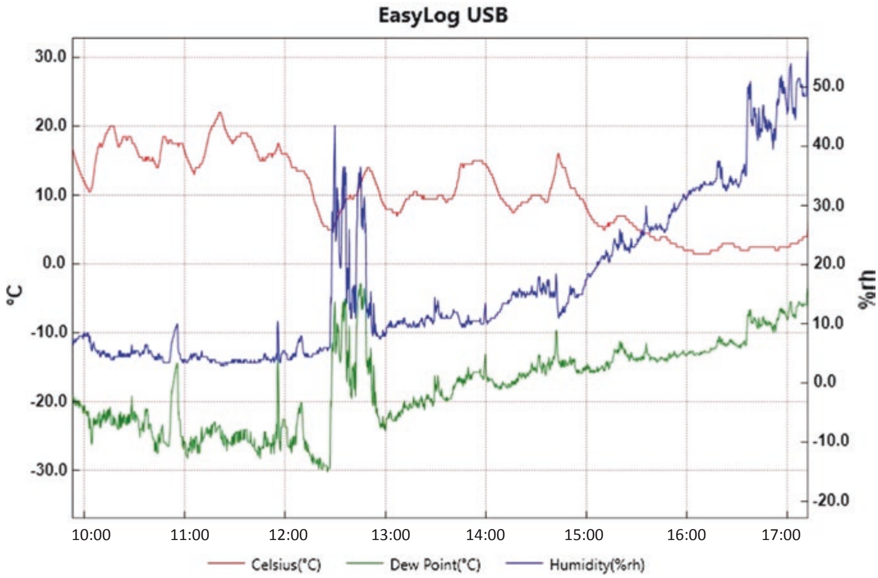

Fig. 29.1 Data logger data (Temperature, Humidity and Dew Point) from a 7 h walking profile in Annapurna (from Manang 3000 m up to 4400 m and back, in mid-winter January 1st 2015; from 24h data collection, original in Alaska time). One can see generic temperatures (red line) widely above freezing, crossing of a river valley around noon-time and increasing fog during the day; humidity as a blue line). As shown in Fig. 29.2, snow was widely absent. (Data Source: Author)

Fig. 29.2 Annapurna in winter: Lack of snow in the Manang region, c. 4000 m above sea level showing mountains in the background up to c. 7300 m. (Photo: Author)

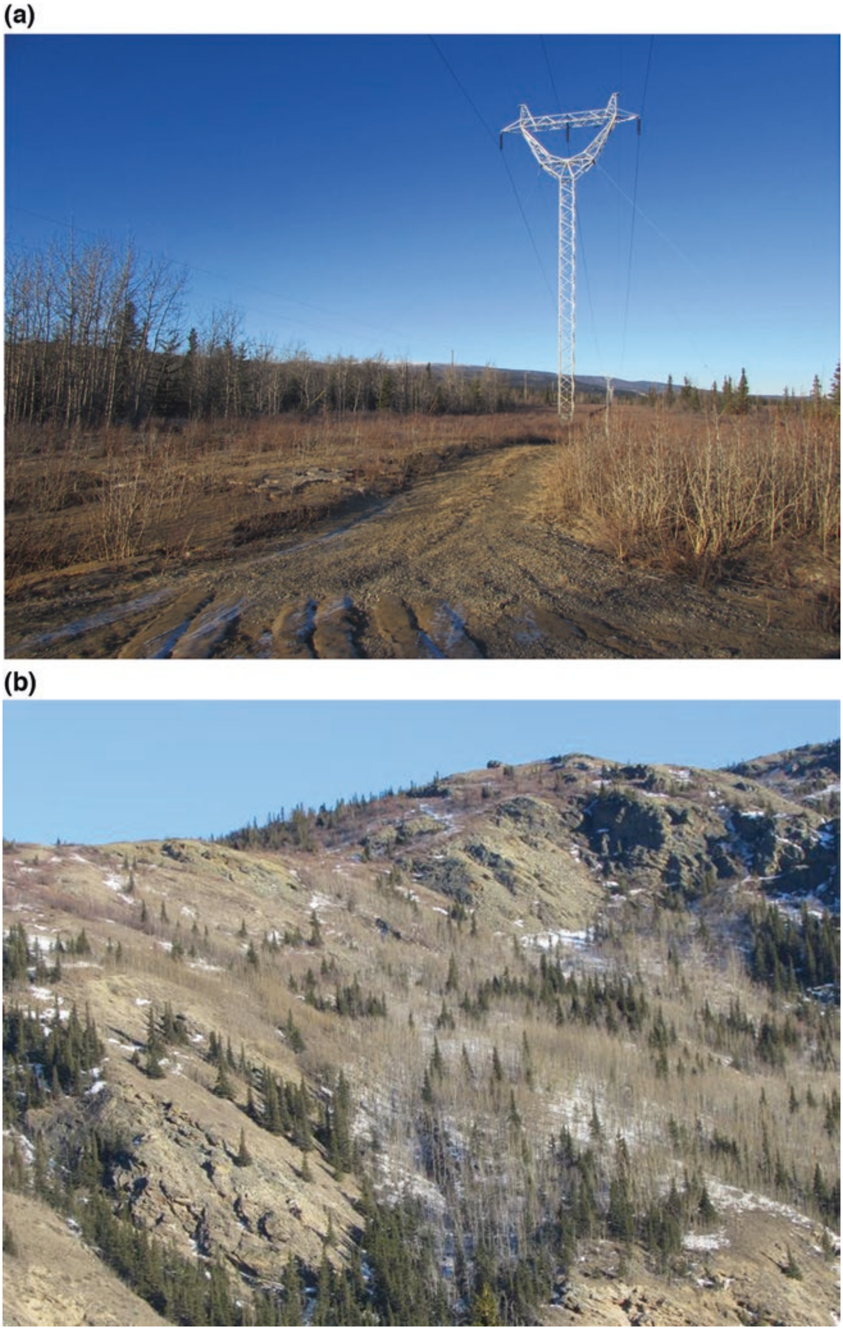

Fig. 29.3 Denali, Alaska in winter: Lack of snow, too (in regions of alpine latitude. (**a**) This photo is taken app at 500 m above sea level at a subartic latitude in Healy, the village where a coal plant is located, providing most of the energy in interior subarctic Alaska). (**b**) This photo is taken in the nearby mountains showing app 1000 m above sea level. (Photo: Author)

Table 29.5 Topics expected to come up due to climate change impacts

Topic to come	Impact	Evidence already	Further citations
Drying	Desertification	Many deserts increase	Groisman et al. (2017)
Wide melting of glaciers	Terminal lakes, lack of water overall, warm temperatures, albedo changes	Glacier retreat ad volume decrease	Bhattacharyya et al. (2019) and Mukherji et al. (2019)
Lack of snow	Lack of water, warm temperatures and albedo changes	Snow layers decrease strongly (see Fig. 29.2)	Figure 29.2
Tropical species invading alpine areas	Treeline change and invasive species	Invasive species in mountain slopes	Ismail et al. (2018), Lamsal et al. (2018a), Pauli et al. (1996, 2003), Rehnus et al. (2018) and Thapa et al. (2018)
Human foot print extends	Destruction of wilderness, urbanization and roads	Railway on Tibetan Plateau, transportation plans across Everest	Huettmann (2012) and Buckley (2014)
Consumption of resources increases	Deep landscape modifications	Erosion, mining and hydrodam in HKH region	Han et al. (2018) and Buckley (2014)
Conflicts about resources	Warfare and domestic violence	Increased tensions between Nepal and India, China and India, India and Pakistan	Huettmann (2012) and Marsden (2017)

Table 29.6 Selection of institutions and entities with a global mission of global sustainability, justice and peace and their insufficient track record on problem and climate change improvements

Global institution	Impact	Track record to improve climate change problems	Further citations
The World Bank	Money lending and stimulus	Very low	Rich (2013)
FAO	Global food supply and security	Low	Pauly (2010)
UNEP	Global sustainability	Low	Huettmann et al. (2011)
IUCN	Endangered species	Very low	https://www.iucn.org
IPCC	Updated reportings	Low	IPCC.ch

being caused by cooking and fuel wood; but this primarily relates to the governance failures of eradicating poverty for centuries, not obtaining female equity gains and also to no progress on eradicating lower 'casts' in India (all of those items can easily be perceived these days as 'barbaric'). Like seen with the Tibetans after the second world war (Buckley 2014), the HKH got abused again, and by the global community doing 'nothing' (or at least, not enough). And nobody in the international community really cared. The U.N. did not really act effectively and 1000 s of people

Table 29.7 Climate change impacts known to occur for estuaries with rivers that originate from the HKH

Estuary impact	Citation	Comment
Sea level rise	Wang et al. (2010) and Harms (2019)	A truly global problem (if the Antarctic land ice melts it will easily result into over 50m global sea level rise)
Brackish water	Rahman (2017)	Most relevant estuaries in Asia are already affected
Unsettling of coastal people	Rahman (2017)	Ongoing for many years already and on a massive scale, e.g. from Bangladesh to India
Destruction of property, e.g. due to floods	ICIMOD (2017), Viet Hoa Le et al. (2017) and Harms (2019)	Ongoing already for many years
Fortification of coastal areas (dams and dykes)	e.g. Ma et al. (2014) and Tang and Ge (2017) for Chinas sea wall and coastal areas	Done, and proposed, for many estuary areas in the world

suffered and many died. That's a typical characteristic when the U.N. and the global 'community' and their institutions (Table 29.6) get involved. Such tragic situations must automatically come with the current set up of global governance and the institution of the U.N. (see Ostrom 1990 and subsequent publications for concept and failures of such a *laissez-faire* global governance; see Huettmann 2012 and Mukherji et al. 2019 instead for a needed global '*cryosphere protection*'). And thus many languages and cultures got lost to this very day, genocides have been described, and here it just seems to repeat itself with climate change issues all over again. And this is not just the climate that changes, but a global change affecting ~all and everything. This change goes on, globally, and it is enforced, hard-wired and imposed by the global community and their makers, designers, deciders, and particularly the by-standers. "*It's the economy, stupid*" (Czech 2002; Rosales 2008; Daly and Farlye 2010; Galaz et al. 2018; Welzer 2018). The western world is in the driver seat for this, creating great coffee table books and DVD series for their own financial gain (Ohmori 1994; Palin 2009; Miehe et al. 2017, but see The Guardian 2017c re. Attenborough's Blue Planet by the BBC). It does virtually nothing for a fair, sustainable and meaningful governance (Rosales 2008). More is still destroyed and no actions taken; the climate change forecast does look pretty bleak too (Tables 29.5 and 29.7). Considering we are a science-based and well-informed society, why is that not a mis-behavior of global governance, and its institutions and experts, or citizens, for that matter? Do they not see it? All relevant metrics show it. Everybody else can see it who is informed. And so why do they persist then? In the western world, those 'experts' can safely await their pensions and retire for their own rescue; harm done with current and future generations.

We are now in the Anthropocene. The atmosphere and virtually all relevant aspects of the global processes are now driven by human actions (Smith and Zeder 2013); man-made climate change will not go away any time soon. And with that, the HKH region will change (see Table 29.3), and as part of the three poles (Huettmann 2012)

Table 29.8 Short selection of laws and legislations related to climate change

Law	Parties involved	Gain	Comment
Kyoto agreement	Started with 55 parties, now a global but incomplete coverage	Agree on a basic climate change metrics and mitigations	A wide global failure, based on a science fundament from 1990
Paris agreement	Like above	Advancing for climate measures	Another, recent failure among many that essentially brings climate change policy to a global stall
100s of non-governmental, regional and sectorial agreements	Worldwide, many entities and actors	Less-constrained solutions	More or less a voluntary concept but without relevant global buy-in and progress, yet.

it will be one of the first that will be affected for everybody to see outside of the typical polar regions, e.g. in surrounding tropical watershed. Those are the facts. What leadership, and their policies (Table 29.8), will deal with it effectively remains to be seen over time. But China, India, Russia, the U.S., the EU, Africa and many other nations need to be on board to achieve something (e.g. http://www.planetexperts.com/chinas-cooperation-necessary-fight-global-climate-change/)! So far, the track record of the most sophisticated civilization in the universe is… that they are inactive and not leading well (Alexander 2013) but do so already for over 40 years of pure climate change failure; nothing was that really helped. Neoliberalism was promoted instead (Rich 2018, Springer 2018). A free world will not survive if people understand they got fooled, again. What will survive though is the need to remain humble and to be connected with Mother Earth and to listen to her, for what she has to say. One cannot live without her (Czech 2002; Huettmann 2011, 2012). That culture of caring for Mother Eart still somewhat exists in the HKH region and one can only hope it teaches the western world a good lesson.

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Chapter 30
"The Gods Are Angry": A First-Hand Environmental Account and an Experience of the 2015 Nepal Earthquake in Hindsight towards a New Culture on How to Approach and Live Well with Mother Earth

Falk Huettmann

The Earth is crying and I cry with her
Polly Higgins, lawyer who fought for recognition of 'ecocide'

Who would have guessed? Remote sensing imagery taken from space shows that the earth is breathing (https://www.space.com/38806-nasa-satellites-watch-earth-breathe-video.html; https://www.facebook.com/GOODHQ/videos/10153562146633059/). One can easily see there how the CO_2 fluxes change throughout the year. And when using NDVI (Normalized Difference Vegetation Index) satellite imagery the associated phenology patterns can also be detected across seasons; similar can further be found for wind patterns, monsoon weather systems or ocean currents: Yes, earth breathes and does have a pulse, and this pulse changes over the year and across years! And, it affects wildlife, recruitment, predator-prey and spatial distributions (see Hegel et al. 2009, 2010 for an example in polar and mountain regions).

These facts should change for many people their view about the earth being just an abiotic ball flying through the universe. Instead, consider already the spin of the earth, and that those movements are pretty wobbly (see for a suggested human interference of those patterns and BBC story and scientific references within: http://www.bbc.com/earth/story/20161205-the-earth-does-not-just-spin-it-also-shakes-and-wobbles).

F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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There are theories and entire textbooks about a living and responding earth (Hallmann 2005; Miller and Spoolman 2011; Lovelock 2016). And once it is accepted that earth is a living and organized organism, it follows that it can regulate itself and do everything to stay alive and with a certain structure (as expressed in the GAIA theory, Lovelock 2016; see also Wilson 2000 for Sociobiology). For those who do not believe it, please see Wohleben and Billinghurst (2016, 2017, 2019) for plants and animals, or even more 'crazy', learn about microbes and parasites and how they manipulate their hosts to transition and to achieve reproduction into the next stage (it resembles some sort of a transitional life stage passing through bodies and it seems to equal re-incararation). And just to move it even further, many microbiologist would argue that their study species are the major drivers for macroecology and patterns on earth (just think of a global pandemic, or the earth's distribution of bacteria, microbes, and plankton) and it follows a certain pattern. And this pattern has a structure! It's self-organization of micro-species being in the 'driver seat' (bottom up), and/or driven by global processes (top down); details to be understood more by science. But it does not even end there, because neither microorganisms nor molecules or chemical elements are the smallest particles, instead it sits in the neutrinos, or even smaller! And those neutrinos have antineutrinos apparently split by black holes in the universe. Similar as recently found with DNA, those neutrinos might even transition through your body in high concentrations, just as we speak! So, this raises the question: what is now really the unit to manage conservation for and what is the driver overall? Clearly, our so-western species and building block concepts are to be revised and fine-tuned… with Mother Earth processes fully in mind.

Let's face it, we do not really know the answers or associated mechanisms, yet! Science does not know, nor anybody else really! We entered the world of the unknown and of the uncertain (compare with Miehe et al. 2017 for sticking with the opposite narrow parsimonious and deductive science concept). Indeed, HKH with a successful human civilization for over 40,000 years can teach us a lot, and it should.

Many more examples of such dynamics and of 'life' within earth – its responses and reactions – often in a self-sustaining fashion – can be detected when just looked at closer. Even on broader scales one easily sees it. For instance, a forest fire will create its own weather, e.g. through the smoke and severe (hot) winds caused by steep temperature gradients (e.g. Wohlleben and Billinghurst 2016, 2017, 2019). And clouds are created by forests and their leaves; as affected by healthy mycorrhiza in the soil. It's all connected, and eventually a massive water pump system that puts earth water into the atmosphere and thus it subsequently creates various global dynamics in the wider atmosphere across scales. Clearly, the topography plays a role (consider the HKH region -formerly a marine sediment layer (Miehe et al. 2017) – being established relatively recent in the earth's history). Another classic -but widely debated – example is actually found in the world's ocean, where clouds are created by phytoplankton, and specifically, through the release of dimethylsulfid (DMS) when eaten/broken-up by zooplankton (=the infamous CLAW hypothesis to regulate the earth's temperature as part of the GAIA concept; Lovelock 2016). It's often described to act as a feedback loop to stop global warming, because sunlight (which triggered plankton action and thus clouds) get blocked! DMS also has other effects and seems to relate with marine mammals and seabirds on a global scale (e.g. see Humphries 2010, also for the Arctic). Other widely described examples of agents (= species and their societies) heavily modifying earth and its wider processes are for instance beavers and how they manage their habitat, dams, watersheds and entire forests and landscapes at their will and for their own benefit (now a massive problem at the second pole, Patagonia with introduced beavers from Canada). Muskrats can achieve similar effects in wetlands. And elephants are also described to manage and modify their living space, and so do most moose and ungulate species through browsing. Wild boars are frequently in the news for ploughing through the forest floor and agricultural fields (arguably it has a major effect on soil succession and related processes landscape-wide; see Wohlleben and Billinghurst 2017 for rainworms and their large role in ecosystems!). Predators, including tigers, wolves or snow leopards, will affect landscape set-ups too (Li et al. 2014; Hegel et al. 2012 for cycles). People who study ants have pointed for decades on how this species is a major driver for soil health, e.g. Wilson (2000 and references within). There is a wider debate how the steppes and grasslands of this world maintain themselves and how animals and humans correspond and co-evolve (e.g. Bone et al. 2015; see Schaller 1998; Buckley 2014 and Han et al. 2018 for the wider Tibetan Plateau and its species). Arguably, there are feedback loops at work here. And dynamics, fire

Textbox 1: Zoroastrian's (Zarathushtis) Believes in the Harmony with the Protection of the Mother Earth

by Khoda Zabihi

The "*Theory of the Four Sacred Elements*" (air, water, earth, and fire) has been originated from a Persian Empire, Zoroastrian, living in ancient Iran or Persia (Habashi 2000) reaching far into Asia and the HKH region. The founder of the Zoroastrian Empire, Zarathustra (named as "Zoroaster" in the Greek literature, living approximately 3700 years ago (Sarosh 2013)), believed the essence of these four elements for the survival of all organisms (Habashi 2000). To appreciate the spirituality and vital importance of air, water, earth, and fire, Zarathustra, the Persian philosopher indeed, believed that people should venerate these elements and avoid to contaminate them (Habashi 2000). Zarathustra's philosophical view towards the four elements has been providing humans a fundamental and conceptual perception about the environments even in today's modern world and view (Habashi 2000). Zarathustra believed there is only one God on the Earth called "Ahura Mazda" or the "Wise Spirit", and the element of fire has the "Wise Spirit" that fights with an Evil called "Ahriman". According to the Zoroastrian's believes, all creatures, even plants, belong to either the camp of "Ahura Mazada", or the camp of "Ahriman" (Habashi 2000). For example, all dangerous, toxic, and poisonous animals and plants are allied to the camp of Ahriman or "Evil Spirit". Zarathustra also believed the fight or contest between God (Ahura Mazada) and Evil (Ahriman) will continue to the point where the Good triumphs and defeats the Evil (Habashi 2000). The prospect of Zoroastrian system is achieving a perfection world in which every creature will adopt to the right path (Habashi 2000; Skjærvø 2006). These philosophical views about our Mother Earth's property and behavior are resembling two concepts of an ecological system, called "Resilience" and "Stability" (see, Holling 1973). That would off course happen if humans avoid or minimize their destructive influence on the Mother Earth by doing unsustainable exploitation and contamination of natural resources. The idea of not contaminating natural resources such as air, soil, and water has been evident in the Zoroastrian practice of disposing humans' dead bodies. Zoroastrian believed that dead bodies could not be burned or buried on the land, or thrown into the water (Habashi 2000). Instead, the corpses need to be placed in the center of a raised circular stone platform called "Dakhma" or "Tower of Silence" located on hilltops and exposed to the sky, known as open or sky burial (Habashi 2000; Sarosh 2013; Zykov 2016). The exposed corpse to the sky provides a food source for scavenger species mostly vultures, the birds of prey (Habashi 2000; Sarosh 2013; Zykov 2016). This type of funeral ceremony, which comes from a perception about the spirituality considering a soul-free human's dead body, is following the concept of a "Food Chain" in an ecological system. In addition, it protects the Mother Earth from more human disturbances of making a cemetery with a lot of cementation for graves that may indeed ruin the beauty of a nature. Most Zoroastrian followers escaped to India after the Arab invasion to their origin, Persia (Iran, the current name), and only a few of them are still living in Iran, mostly in the ancient city of Yazd (Habashi 2000). But Zoroastrians are also found dispersed in Central Asia, including the Hindu Kush Himalaya region.

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and atmospheric temperature and humidity all play a role affecting earth processes (see for instance Bush et al. 2007 for Amazonia grasslands over time and being replaced by tropical rainforests; Pluvial Theory. The Amazonia basin is known to have a large effect on the earth’s climate, and so have the three polar regions: Arctic, Antarctic and HKH as the world’s climate cooling chambers; Huettmann 2012). It all relates to the intriguing question whether and how self-correcting GAIA mechanisms are known to occur and what they do, and what the human role really is in the Anthropocene? Nobody really knows for certain.

On a larger scale, the sun and the universe are driving a lot for what happens on earth; just think of radiation and photosynthesis. It’s difficult to deny that cosmology – the science about the cosmos – plays a role for the earth system and many of its various processes. And that is not even really new but instead still not really appreciated, much or included in the (western) sciences (Cartwright 1999). Beyond our current narrow science, the wider and holistic views do matter after all! And that has been stated for millennia; it’s as relevant as science is these days (e.g. Carlson 2012; Lovelock 2016 for the wider questions in GAIA)! Here then some core questions:

What really steers life, on earth and in HKH?
What gives live?
Does earth, or live, have a memory?
Does earth, or live, act on that memory, and how does it look like?
How does the wider cosmos interact with the earth, and can both revenge on harm done?
Is there paradise or hell, or are we re-incarnated

The HKH area is unique on those questions and it carries some explanations for us to ponder (e.g. Lama 2005). Considering that no good answers and proof exist for questions above either way, the HKH region offers us other views, shared easily by its c.3 billion inhabitants. That’s because it carries shamanism, bon, hinduism, buddhis, jainism, Daoism, zarathustrians etc. and which are among the oldest and most powerful religions in the world. Some of those views can also be found in other places for away, e.g. Mexico and its *‘dias mortes’* (a certain cult of the death, and an alleged afterlife, which survived in modern Catholic Mexico without a problem).

As will be elaborated, shamans are used to communicate with Mother Earth, and those messages play a rather big role (Lama 2012). As a good leader or manager, you better want to know those voices and understand how people and natural resources act! It’s hardly different than what the ancient Greece (=the so-called foundation of the western civilization) learned from their Delphi oracle, the voice from earth (inspired by a sulphur vent coming out of Mount Panassos; Spiller et al. 2002).

So much can be learned in the HKH by ‘the west’ still. Many of those religions of HKH give the abiotic material a reason for their own existence and behavior (Lama 2012). They assign meaning for what the western world tends to fully dismiss and what it just calls 'stochastic (random[1]) events' e.g., earthquakes, floods, vulcanoe events or outbreaks of fire (these 'problems' tend to be events that are usually far away from Central Europe). Instead one can easily conclude that stochastic events are not so stochastic but instead often come with a pattern and a cause, e.g. driven by Mother Earth either way.

According to that spiritual view though – widely found deeply entrenched in the HKH region – those features have their own balance, relationship and harmony with the earth and with people and other beings. Things then get explained accordingly, beyond a limited but dominating western, industrial and science world view. Shamanism, bon, hinduism, buddhism, zanathustrians, jain'ism and daoism are more holistic and authentic here than for what the western world can offer (think of an American Christianity where Jesus has never been). They are also deeper in, and closer to, earth and its processes; having a good relationship with those features actually matters for human survival. Those religions are more complete and inclusive to deal with life on earth (compare that with the imposed reductionism and ignorance of the western sciences and its institutions promoting unlimited economy, development and the 'free market' (*laissez-faire*) instead; e.g. Norgaard 1985; Burnham and Anderson 2002; Zar 2010)! Those views look naïve by now for a global governance (see also Bandura 2007)! They cannot achieve.

To no wonder, the HKH region remains mysterious to most (western) people. But it's a living landscape and heavily shaped by the human culture and its mindset. Beyond Kailash (Lama 2012) and Rolwaling (Baumgartner 2015), many other examples can be found, for instance the Bagan temple landscape adjacent to the Irrawaddy river plain, or the many shaman sites in Mongolia or Quinghai lake.

The HKH region is located in the wider Pacific Ring of Fire. The HKH region is one of the most active regions for floods, earth quakes and seismic activities and which are not predictable, hardly understood even. They remain mysterious to most people creating fear and death. But by now, the HKH region also experiences a big boost for (modern) development, namely digging tunnels, building roads, constructing endless river barrages, electrification, industrialization, urbanization and growing cash crops. The large and deep spirituality in the society of HKH has been discussed in a previous chapter already. But when blending it all together, a view emerges where sensitive – and spiritual – local observers of the recent development easily come to the conclusion that Mother Earth actually is hurt. Drilling deep holes into the earth surface for oil and mining exploration and which promotes air pollution later, re-routing water for industrial energy, blocking entire river flows (otherwise flowing for millennia) through hydro dams, cabling up the landscape, cutting down ancient forests, drilling tunnels in mountains, polluting the earth, decaying the lifestyle and society leaves little doubt that Mother Earth would be happy. It's not

[1] It should be expressed here that 'random' is a rather odd concept to use. It's meant to mean 'no pattern' and thus unbiased occurrence. Instead, 'random' is virtually not repeatable and thus hard to prove either way, statistically. And earth events are virtually never random, but instead poorly understand. Further, earth events are not probalistic neither and cannot get well expressed that way. It's not really possible. A second, deeper look will show it.

Fig. 30.1 Ghosts, deities and spirits or Mother Earth can indeed be rather evil (Photo credit: author)

part of what the ancient religions and their gods know or would approve of (see Baumgartner 2015 for an example). In response, the deeper ghosts, spirits and deities can be rather evil (Fig. 30.1).

So how tolerant is Mother Earth? Can it forgive us, e.g. through sacrifices (Fig. 30.2)? Is there a threshold that was reached? And what about if Mother Earth takes revenge, and targets an action to stop those impacts? What about if this ‘revenge strike’ is a counterbalance – the ying and yang – to ongoing onslaughts and of the sin created by mankind, e.g. due to globally melting glaciers, plate tectonic moves, and associated dynamics (for seismic sound waves see for instance Flatté et al. 1979, Munk and MacDonald 1975, Munk and Baggeroer 1994, Munk et al. 1995)? And what about if this revenge action is strategic and effective, hitting where most harm is made? And what about if those actions manifest themselves in plate tectonics, a tsunami, or an asteroid hitting us from outer space, or on a microbiology level where a global pandemic hits mankind? Who knows for sure? While the western science view will quickly dismiss it, other world views exist, and none has the ultimate proof, yet. Ancient human beliefs in the HKH region have been around longer than Christianity (c. 2000 years old), or western industrialization (c. 180 years old).

Fig. 30.2 Appeasing the bad spirits through animal sacrifices. This practice is common in tribal deep-rooted practices of some Hindu sekts, like shown here for Nepal app 50 km near the Tibetan border (Photo credit: author)

Arguably, we live in the Anthropocene, or Capitalocene, and that means, humans have affected all aspects of global processes (Fig. 30.3 for a subsurface example; for another example see Tauler-Ametller et al. 2017 on the wider relevance of trash landfills to vultures in Spain and North Africa; same can be expected for Asia and where vultures are considered spiritual but now have crashed dramatically towards extinction, e.g. due to contamination). If trashed and widely mistreated, Mother Earth and its species might take revenge indeed, and why not? This is somewhat described for the GAIA theory (Lovelock 2007) and it can sit inherently underneath much of 'western environmental research' like IPCC (https://www.ipcc.ch/) but is just not described that way. Seen with a deeper look, the profiles and connections can be pretty clear though (see also in Ausubel 2002; Carlson 2012). Consider also Liu et al. (2018) for 'telecoupling' as another means to express scientifically such wider, more global connections and spill-over effects beyond the usual linear additive hypothesis.

Revenge is known as a concept in the living world and that animals can retaliate. Such is well known with most zoo animals and from captivity (often in a very strategic and gruesome manner, e.g. Halloran 2012 for chimpanzees). Also, wild animals can respond to intrusion and bad experiences – including stinging insects; and thus some take revenge. This is known to occur in bears, elephants, wolves, tigers and so on (see for such type of responses in Russell and Enns 2003; Neupane et al. 2017). People who look at animal capture data, e.g. capture-mark-re-capture analysis (Amstrup et al. 2007), know this first hand through individuals that are either

Fig. 30.3 A tunnel might make mountain gods pretty angry. (Photo credit: author)

'trap happy', or 'trap shy'. Reasons for this behavior are not well described, but arguably it relates to previous (bad) experience with humans. Other violations on the good respect of nature are found throughout. For instance, the world-wide anesthesia and subsequent tagging of animals not done for the wider good (https://timesofoman.com/article/128064) and when data are not shared for efficient applications (Huettmann 2011, 2015). Animals do suffer and die in such activities! Instead, many indigenous people only harvest/kill animals when they actually offer themselves to humans. Greed is known to be a sin for millennia.

But if 'life' -the being- strikes back, that might well be part of Mother Earth's revenge and to keep a certain balance overall. Such views become even more clear when those affected animals are perceived in Asia as deities (see for instance Athreya et al. 2018 for cats, Liu et al. 2018 for Snow Leopard and Matthiesen 2001 for cranes)! This does affect then landscapes and their sustainability.

Of course, those perspectives are foreign to most of the western world and get easily dismissed as: '*there is no scientific evidence*' (that argument is often done with frequency statistics, whereas it falls apart when looking at the same data with AI and Machine Learning). However, in reality though a closer look can show us a different perspective. While much of those aspects have not been fully understood (the usual argument that scared scientists can offer is: "*We do not know… with good certainty*", or "*This is not significant*…"), those concepts should be assessed more and tested. For instance, there is a clear association between climate change -man-made-, the amount of frozen water from snow and glaciers holding down tectonic plates through its weight, and subsequent plate dynamic actions, perhaps even vulcanoe-ism and subsequent atmospheric processes affected by vulcanic vents. At least little doubt is left that it can unhook plates and results into earthquakes. The HKH has seen a recent burst of those.

Along the same lines, watershed erosion is now steeply on the rise. The amount of mud slides, and some sediment, that comes down the rivers from the mountains and into the ocean (and thus changes tectonic plates, their characteristics and dynamics) has dramatically increased (see Chen et al. 2001 for Yangtse river example). While this might even be perceived as something good, for nutrients, the real-world balance and implications are not well understood, e.g. when it comes to contaminants and filter systems of the earth, plate weights or earth movements. The notion of flows and weight changes, namely horizontal ones, and what it means to the earth spin -on a micro-scale but with a vast impact- remain unknown. But some people say that the earth spin is affected by huge dam construction and concrete buildings set up in Eastern China (e.g. https://www.nytimes.com/1996/03/03/news/dams-for-water-supply-are-altering-earth-s-orbit-expert-says.html). We also know now that humans can detect magnetic fields (The Guardian 2019) and that the earth's magnetic system has changed several times in the earth's history, just as many river flows have (see Bush et al. 2007 for wholesale changes of the Amazon river flow throughout earth's history). But what triggered it, and why did it happen? Was that a reply by Mother Earth? We do not know. But clearly, many reasons can be found for what would make Mother Earth angry (see textbox below for a real-world example involving western science).

Textbox 2: Making the Gods Angry Through Western Science?! An Example of the Saiga and Its Habitat Management

In the Kumbu region, Mt. Everest, a western scientist working on glaciers was blamed by the local community for making gods angry taking revenge and creating a huge destructive flood on them (Byers 2017, p. 53). Only with the help of the Rinpoche Lama, paradoxically, the scientist was saved.

Many more of such stories can be found.

We commonly experience that people see science as a wizardry; a specific ritual (Guthery 2008) done by 'the west' and colonial powers, now in a neo-colonial sense (Alexander 2013). It's a practice and value system that gives the western world 'the edge' and to convince. This view is not surprising when knowing what 'The Period of Enlightenment' is based on. Science, so-called reason, including Darwinism and DNA, are the power tools that make and justify the western civilization and all what comes with it: global abuse, destruction of the living world, loss of environmental taboos, social decay, warfare for oil and generic global bankruptcy (Alexander 2013; Cockburn 2014). Alternatives exist though and they have been applied for millennia in a more sustainable world (Leopold 2012; see for instance in Lama 2012 for the HKH study area mentioned below). Clearly, people tend to live longer now, they have a certain pension plan, and they are pushed into a cash economy

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using mobile phones and the internet, besides other things. But many other serious problems remain, and many things get worse than ever before, e.g. over-consumption, industrialization, urbanization, environmental decay, wilderness loss and a world-record high but still increasing human world population. There is a certain science folly too, as well as the steadfast believe that we still can manage nature and all problems according to the western style and globalization.

A typical example of this conservation science folly in the HKH region can be found and tracked in the wider Mongolia, Tibet and adjacent regions (Kazhakstan) when it comes to angulate management. The failures are easily seen in shahtoosh wool management of the Tibetan antelope conservation (chiru, *Pantolops hodgsonii*; Schaller 1998; Penman 2007) or in the saiga (*Saiga tatarica*) conservation: massive declines and repeated crashes occurred unabated. There is no relevant science-based management for those species, hardly for the landscape; it mostly exist just on paper, if even that (Buckley 2014 for Tibet).

The saiga population for instance during the last 100 years in Kazakhstan was affected by major political and global regimes and paradigm shifts, e.g. pasturism, communism, white guards, glasnost, chaotic split from the soviet block, development aid, and now capitalism and globalization. It all links to the governmental state and economic crisis as well as other things in the modern world we live in. Classic evidence can be seen over time by the management-related science and its underlying publications done on this species, as promoted by 'leading researchers' on the topic, coming primarily from the UK and former Russia being promoted heavily through the British Ecology Society, the Royal Society and similar conservation research journals. A wider link with UK Aid and Kazakh-Russian petroleum and mining deals between involved nations could be speculated and might be quite realistic because of impact studies needed for land management and banking systems funding it for their 'clean' western investments. Such a reseach is well paid and often quite prestigious; it attracts 'the high priests' of such a science and ideology, but most not even living in the study area; far from it. The over-time -and essentially arbitrary – changes of believes, attitudes, and the so-called science tools employed can easily be tracked over time from the literature. Examples of changes exist in the use and self-confidence of foreign experts, underlying business models, application of the latest-cry monitoring Leslie-Matrix population models, promotion of a 10% (!) harvest in the 1990s, and then moving into more complex questions (aka "*Oopsi, this is more difficult as we had thought…*") and so on. The research and citations by Milner-Gulland (1994, 1997), Bekenov et al. (1998), Coulson et al. (2000), Robinson and Milner-Gulland (2003), Milner-Gulland et al. (2001), Morgan et al. (2004, 2006), Kuehl et al. (2009) and Singh et al. (2010) (all boldly presented and essentially driven by one common British researcher) reflect those details and the transitions very well.

(continued)

All of that high impact science work – published in best British tongue – as virtually never really used in Kazakhstan by its entities or landscape actors, nor anywhere else where those ungulates occur. It's part of a classic self-serving and self-done model and science published in commercial high-impact science journals with a blessing of the wider western community and professional societies, but ignoring local realities in full. The sheer helplessness is then expressed in more bigger words and terms (CMS 2010 for 'MOU', Singh et al. 2011 for a new 'Moving Target'). Well, the monitoring keeps going on (Singh and Gulland 2011 a, b). Just like counting and re-arranging the deck chairs on the Titanic while the mother ship sinks… This western-industrial template can be found applied all over the world while resources decline further (also published then again in the same outlets with same entities involved, e.g. Mace et al. 2010).

As an outside observer and working in the field, one easily wonders what is going on here? The western science model rolled out globally during globalization is full of such examples (see Kessler et al. 2015 for another very narrow and parsimonious science model in the region), while the core problem of finite resources, western bias, poverty ignorance, global capitalism (Daly and Farley 2010) and associated landscape destruction is virtually never addressed in real life with real and effective actions (Ostrom 1990). Consequently the ungulates, specifically the saiga – in case this matters – and its required habitats will be worse off than ever. So one has to ask: Does anybody really care, and in the western world, or in royal and professional societies?

The overwhelmingly sad global story of climate change, or of a science-based poverty mitigation and sustainable landscape management hardly go any other way (Alexander 2013; Cockburn 2014; Czech 2002).

So why would the gods not be angry, and why would they not revenge then on the actors and their experts and advisors? The question why that many saigas have to die remains widely unanswered and the slaughter, loss of live, seems just to go on. What a science that would be?

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However, for the frequency of earthquakes, tsunamis, vulcanoe outbreaks, and even fire outbreaks, these things really should matter. Clearly, science is not up-to-date on those things yet, and those wider linkages are not well documented and studied. The lack of evidence does not mean though it's not real or not happening, every science textbook says just that about experiments (e.g. type II errors; Zar 2010). For those questions, science is a rather poor 'bed companion', as it has been shown throughout the earth's history and in the history of mankind and science itself (Conner 2005). And if we learn one thing from Astronomy, Quantum Physics, Macroecology, Climate Change and Human Civilization then that the western science and its eduction and funding scheme has a very hard time to grasp those concepts and tackle them correctly and efficiently (compare with 'recent' science findings like Spiesberger and Metzger 1991). Ancient views by indigenous people can be more insightful here (e.g. Karmay and Watt 2007 for Bon; Flannery 2002 for Australian aborigines living in 'Dream Time'). Further, Buddhism has already shown many leading and new ways into medicine, physics and cosmology as well as land and species conservation that just now scientists are grasping and are trying to understand and to apply (Lama 2005, 2009; Li et al. 2014 for snow leopards; see also Carlson 2012).

Table 30.1 A short list and selection of classic Mother Earth right violations in HKH, many more can be named

Mother earth right violation	Impact	Example
Habitat transition	Loss of pristine and endemic habitats	Unsustainable clear cutting forests and changes of forest structure
Extensive tunnel digging	Change in geological set up	Many hydro dam projects
Melting of the major glaciers due to human activities	Less weight and pressure on the plates, plate movements	All of the Himalaya
Commercial drinking water extraction	Loss of water table	Bottled water plant in Lantang region for export markets
River pollution	Lack of drinking water	Most rivers in HKH
Air pollution	Air bowls off Kathmandu, New Delhi, Chengdu,Lhasa etc.	Asian Brown Cloud (ABC)
Excessive industrialization	Consumption of the natural world, pollution, contamination	Mining and electricity needs
Militarization	Conflict, damage and loss of human life	Afghanistan, Pakistan, Indian border, civil-war in Nepal, China's rise of aggression
Electrification	Creates pollution and impacts to mother earth	Coal power plants, Hydrodam barrages, industrial hydropower plants

The conflicts of the western human enterprise with nature, and the earth, are well known (e.g. Pauly et al. 1998; Pauly and Zeller 2016; Czech et al. 2000; Rockström et al. 2009). It can easily be understood from Table 30.1 then that a view can emerge where Mother Earth seeks revenge (compare with classic views expressed in the mainstream pop-culture triggered events by a wasted coca-cola bottle https://en.wikipedia.org/wiki/The_Gods_Must_Be_Crazy)! If GAIA is correct, Mother Earth tries to correct for those mistakes made by its human citizens and to steer things back to normal, or at least, to lessen impacts and towards a benign and balanced lifestyle for sustaining itself. It tries to help to re-establish good taboos that human society lost last 150 years or so, specifically last 40 years during times of neoliberlism; this includes capitalism (Heikkurinen and Ruuska 2014a, b, 2015; Heikkurinen 2017) and likely as well a so-called atheist marxist-leninist governance by China (Xudong 1999). The 'modern' mankind has overdone it, lived beyond taboos and carrying capacity (Daly and Farley 2010), and now finally Mother Earth hits back in its own way! So in case the ghosts and spirits get annoyed, they can revenge! Such cases got described by Byers (2017) when westerners worked on glaciers and climbed in high altitudes of Kumbu, Everest region (more details in the textbox). It's widely known by the public for the HKH region to occur, e.g. Lama (2012) (Fig. 30.4).

I have heard such views first-hand and a lot in the HKH region, local people will tell you those ones once you get closer to them. It became very clear when in Nepal in times of the recent earth quakes! Also, herders, who live on the land in tents and who tend their cattle day and night see those connections a lot (Fig. 30.4). They know

Fig. 30.4 Yak herders will know the environment well and have deep traditional ecological knowledge across many generations about Mother Earth and the cosmos. (Photo credit: author)

and feel it; it affects their income and wealth. It's part of a spiritual worldview and where respect of nature rules! Mother Earth sets your limits for survival. You see it surfacing when there is a slope slide erosion, and with many other catastrophies. Glacier lake outburst floods (GLOFs) are among such perceived indications where the gods are angry and try to teach us a lesson (Byers 2017). In the western science view, we call it man-made climate change effects, global change. But what's the difference, really? Beyond climate change, the biggest of those events remain probably earthquakes. The HKH region is a global earthquake hotspot, and recent earthquakes in Nepal sparked the view that the gods are angry indeed; very angry (Fig. 30.5). And they would have all reasons to be angry (Tables 30.1 and 30.2; Fig. 30.3).

Arguably, such concepts and mindsets for the need of humans to be mindful of Mother Earth and to address what it needs stand in direct conflict with Globalization and the 'modern' paradigm (Czech et al. 2000) and sustainable development promoted by The World Bank (Rich 1994; Daly and Farley 2010), global aid, and most governments and its institutions in this world, regardless of the political spectrum. The notion of Mother Earth is hardly scientific, yet, because it has not really been measured directly. How to quantify it? It is not studied in detail and has not reached mainstream thought yet and simply is not so well investigated so far. 1 + 1 is not well put together yet. Time-scales and data do not really match yet, nor are they really liked, assessed and valued (but see Humphries 2018; Huettmann 2015; Jiao et al. 2016). It might well be in conflict with the current form and interpretation of Christianity (whereas the bible is actually pretty clear on appreciating and protecting

Fig. 30.5 A first-hand earthquake experience in Nepal. Mother Earth is angry and strikes back? (Photo credit: author)

the creation regardless. And see for instance Francis of Assisi, a holy christian saint!). And even more so, most traditional statistical methods do not even allow such wider views and their analysis (but see Huettmann 2018a, b for machine learning contrasted with parsimony, Burnham and Anderson 2002). And it also begs the question whether nature has a memory and how is this really applied? The answer from Wohlleben and Billinghurst (2016, 2017, 2019) is YES: Nature does have a memory. It can count and feel, even if the exact mechanism is not really known yet. And just think of genetics (which essentially is an assemblage of skills and expertise codified in DNA and waiting to be unleashed for survival. Is the DNA actually a chemical brain that can transition across bodies? Horizontal gene transfer is just now being recognized as a major process). The world of viruses shows us similar and better examples even (an achieved resistance can be used again at a much later stage). So if earth then has a morale, what type of morale would it be? Is there mercy and forgiveness, and should there be, and at what scales? Likely, Mother Earth would take some revenge of the pain it all endured to teach us a lesson and for betterment?

So what really is the evidence for all of that? Can and does Mother Earth hit back, and does it happen in a certain structure and strategy? Can we appeal and appeas? Is there a revenge, and over what time-scales does it act? One might naively say, again, that there is no evidence. But because this is a core question, let's wait a minute, reflect and look very hard at the case to make sure. So let's simply have a second look (Table 30.3) and see what modern human society has created and then see how it matches with HKH views presented here.

Table 30.2 Concepts promoted by the western world that are in direct conflict with Mother Earth

Western world concept	Conflict with Mother Earth and justification	Example
Economic growth	Development on a Finite Earth	The World Bank policy to globalization
Capitalism	Privatize a public good	Underlying western world concept
Neoliberalism	One-sided economic views	Promoted by many corporations and governments, e.g. India
Pretend a decoupling of wealth from the ecological processes	Trying to justify that things are not connected but 'independent' entities	Poverty policy
Unlimited individual freedom	Use of global resources, living on the wider cost of others	Canada, U.S., Germany and other rich nations
Extract resources from the subsurface	Destroy earth surface and interior	Oil drilling in the polar regions, or in Tibetan plateau (part of the Third Pole)
Open pit surface mining	Destroy earth surface and interior	Tibet, Nepal
Seafloor mining	Destroy sea floor, ocean bottom	Widely promoted and starting to be carried out, almost globally
Excessive use of pesticides and insecticides	Kills insects and so-called pest species	Virtually unconstrained use of DDT and derivatives in China, Nepal and other areas

Table 30.3 shows some examples where Mother Earth took revenge and struck back

Revenge item by mother earth	Cause[a]	Comment
GLOFs in HKH region	Melting glaciers	See Byers (2017) and others
Earth Quake in Nepal	Lighter tectonic plates, besides other factors	Widely heard in the local public, also now studied due to melting glacier weights/pressures, e.g. in Iceland
Landscape fires	Global warming plays a bigger role	Scientifically that is pretty clear, as per IPCC
Man-made global warming	Burning fossil fuels	Scientifically that is pretty clear, as per IPCC
Sixth species extinction	Human factors, namely economic growth related one	Scientifically that is pretty clear, as per IUCN and other entities. See also marine mammals in rivers and estuaries
Decline of Asian birds	Unconstrained globalization	Outlined by Dalai Lama (see in Prins and Namgail 2017) as well in the scientific literature (Kamp et al. 2015, Jiao et al. 2016)

[a]All of those can be linked directly to human factors of modern times, primarily just the last 50 years

The concept of Mother Earth and the need to take it seriously, to live in peace with, is still a somewhat new concept for the western science (but see Naess 1989; Ausubel 2002). However, it's an ancient system that people followed for millennia all over the world (Diamond 1997). It might well be the guiding principle of mankind, a good and so-called noble (knight) style, and it's time we find such guidance in an otherwise lost global public, governance and leadership. Why not?

Can this concept be rolled out globally? Well, it's basically already there. The wider HKH region easily connects with the 'Old World' (Mongolia, Russia, Middle East, EU, Mediterranean) through the Silk Road and Mongolian invasions. Further, North American and subsequent Central and South American indigenous people are linked through ancient tribal connections and movements (e.g. Diamond 1997). Other ancient places such as the Pacific Islands, Australia, or Africa have their own and known Mother Earth connections, and which are very close to what is described here. And even in the western world there is a foundation and demand to get closer to Mother Earth and its spirituality (Davies 2011). Virtually all big HITECH companies support such causes, e.g. Google or Microsoft, and certainly the Dalai Lama is closely linked with the associated finance worlds in San Francisco, London, Frankfurt, Tokyo and Paris, let's say. So what holds us back, really?

While the western science here is always behind and needs to catch up still (aka '*needs more science*'), the ancient spirituality might guide the way and show us insights that we – in our own culture and recent upbringing – had simply ignored, thus far. So it should be used more and could become a good role model.

It's overdue we take Mother Earth serious for what it can tell us, about ourselves and how we treat and consider others!

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Chapter 31
Hydrodams in the Hindu Kush-Himalayas: Death by over 100 Cuts and 100 Blockages Built During a 'Development Hype' but Without a Relevant Impact Assessment or Synthesis

Falk Huettmann

Promoted by engineers, politicians and their PR machinery – locally and internationally – hydrodams have been coined 'green energy' (see World Commission of Dams https://www.internationalrivers.org/sites/default/files/attached-files/world_commission_on_dams_final_report.pdf as approved by Nelson Mandela. But compare with that with some professional authorities (https://www.internationalrivers.org/campaigns/the-world-commission-on-dams). And why would you not use running water to drive a large turbine gaining electricity to fuel industrial action? Entire commissions and huge governments are in place to make it happen, e.g. United Nations Environmental Program (UNEP), while the local citizenry is not so well organized and often it tries to reject those projects that spoil their wealth (water supply, food production, democracy and freedom of nations and minorities).

Seen at the last 70 years or so, hydroprojects are usually designed large for their kick-backs, and they present megaprojects, instead of more locally adjusted minigrids of lower impact. One reason for those megaprojects to exist can simply be (national/industrial) 'grandstanding'. Another reason for them to be built is effectivity, but the biggest reason clearly is that they serve wider financial and related industrial interests, e.g. mining industries and banks (instead of local citizens, as widely claimed; see Buckley 2014 for examples). Likely, all of those motivations are at play here (Zarfl et al. 2015)! Hydrodams are big business, always have been and are scheduled to remain so. That is true globally (Zarfl et al. 2015), and specifically true for the wider HKH region (Buckley 2014; Barlow 2016; Raesaenen 2017) (Table 31.1).

F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department,
University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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Table 31.1 A selected list of well-known and documented hydrodam projects in the world and HKH with a massive local resistance and impact

Hydrodam project	River	Impact	Resistance detail	Operator and purpose
Belo Monte	Xingiu falls, Brazil	Deforestation of rainforest and many other effects	Indigenous tribes and industrial lobbies	Energy provision
Columbia	Columbia river U.S.	Electricity prices, salmon runs, bird populations	Several government, tribal and environmental citizen groups	Provision of energy
Hoover Dam	Black Canyon, Colorado river, U.S.	Water regulation, fish endangerment, salinity, estuary drying, tourism site. One of the first and many other examples to follow	A very early dam from the 1930s	Electricity
Tatshenshini (A project on hold)	Tatshenshini river B.C. Canada	Pristine river destruction (one of the last rivers left undammed in North America)	Several government, tribal and environmental citizen groups	Provision of energy
Farakka Barrage	Ganges river, India	Siltation	Nations of India vs. Bangladesh	Provision of energy and drinking water
Three Gorges Dam	Yangtze river, China	Affects Poyang Lake, subsequent rivers, estuaries and a large area of China	Biggest dam in the world, supported by the Chinese government but global outcries exist	Provision of energy
Xayaburi dam	Mekong, Vietnam	Affects many nations downstream	National and international interest groups	Provision of energy and water regulation

But hydrodams are never stand-alone projects, and their water damage spoils areas downstream, namely lower river watersheds and estuaries that are already ‘at the edge’ of survival (Valett and Ely 2019). Based on the history, in the world and the HKH region, the hydrodam legacy and its reality remain dubious, if not even devastating (Siegmund-Schultze et al. 2018). Same can be said for the specific plans for the HKH region. Those all remain very destructive. They are primarily geared towards undemocratic procedures and mining activities (e.g. Buckley 2014). This is nowhere so obvious than in the Yarlung-Tsangp and the Mekong (see Raesaenen 2017 and studies cited within for impacts across China, Myanmar, Laos, Vietnam, Thailand and Cambodia). Also, there is a wider and fluent discussion on failed dams worldwide (e.g., https://en.wikipedia.org/wiki/List_of_hydroelectric_power_station_failures) (Fig. 31.1).

Fig. 31.1 Photo of a typical barrage section of a river in Nepal. (Photo credit author)

The impacts on the many HKH rivers and subsequent watersheds are already very large, however, more can be expected (Table 31.2 for overview).

Either way it becomes obvious that the reality and the major plan really is to dam the landscapes and watersheds of HKH with hydroenergy projects as much as possible; cashing in on the steep terrain to run turbines by water. Considering the many other environmental problems ongoing in the region already (Buckley 2014), this then is no small feat. The international water supply remains of global relevance, affecting warfare and political intimidations, besides many other details! (Table 31.3)

Over 110 major dams exist in the closer HKH region alone (Appendix I) and many more are proposed and commissioned (see Table 31.2 above). Figure 31.2 shows not only dam locations but also their reservoirs nearby. Reservoirs are usually not really part of the public discussion of hydro dams but beyond the actual footprint they easily show the wider issues that come with hydro dams (e.g. Shivers et al. 2017; Strictar Pereira et al. 2018). Hydo dams of global size are usually directly related with development schemes of the same scale (=global), featuring such a type of industrial globalization! Apart from the water and energy resources needed for such an operation, one has to ask here where do the human resources come from, and how much can they handle, and whom do they serve? And as in the case of China, who really produces there at those sites, to what social, environmental substandards, and for who gains? Good examples on those questions can be found with the American company 'Apple' producing in Kaifeng (a trillion$ company relying on China), and the German-international conglomerate 'Volkswagen'

Table 31.2 Rivers of HKH and their planned hydro dams

Name of river	Projected and under construction	Comment
Mekong	Don Sahong	Massive development plans are on the way. A lot of international critique and involvement.
Ganges	Bhillangana	A river that has already received a huge amount of dams.
	Birahi Ganga	
	Kali Ganga	
	Kali Ganga I	
	Kali Ganga II	
	Kodeshwar	
	Madhmaheshwar	
	Phata Byung	
	Rishi Ganga	
	Singoli Bhatwari	
	Srinagar	
	Tapowan Vishnugad	
	Vishnugad Pipalkoti	
	as well as 54 proposed projects	
Irrawaddy river (Ayeyarwady)	Myitsone	
Yellow River	18 scheduled to be built by 2030	An area with a long history of dams.
Heilongyang/ Amur	JSC RusHydro company (Russian) and government has proposed more hydroelectric projects on the Amur. Hoping that China Three Gorges invest in it too.	There are also islands in the waterway that are of international claim and dispute. Changes in their water levels can either wash them away or extend the areas gained.
Yangtze river	Zhuyangxi Dam Shipeng Dam	The Three Georges Dam and its impact and mitigations remain a big driver in this discussion.
Indus	Chutak	
Onon River	NA	While not of major relevance for energy yet it's widely assessed for energy development.
Tarim River	NA	While not of major relevance for energy it's widely assessed for energy development.
Gandaki river	NA	Big energy potential.
Koshi river	NA	One of the rivers from Makalu and Everest.
Yarlung-Tsangpo river	The latest "world's biggest hydro dam project" is proposed to happen here.	A major project of world relevance, done on the 'Roof of the World'
	Langzhen	
	Zhongla	
	Lengda	

(continued)

Table 31.2 (continued)

Name of river	Projected and under construction	Comment
	Jiacha	
	Zangmu	
	Jiexu	
	Dagu	
	Bayu	
	Daguaiwan	
	Daduqia	
Yamuna river (Jumna)	Lakhwar Dam Dark Pathar Barrage Hathini Kund Barrage	
Padma river	NA	See above Ganges barrage
Brahmaputra river	NA	
Jhelum river	NA	
Amu Darya river (Amo or Oxus)	NA	While not of major relevance for energy it's widely assessed for energy development.

Table 31.3 A selection of species that are affected, endangered or lost due to hydrodam projects in the HKH region

Species	River Location and associated dam	Status	Comment
Baiji (River Dolphin)	Yangtze and Three Gorges Dam	Functionally extinct	Dramatic loss of genes and unrealistic to return
Finless Porpoise	Yangtze and Three Gorges Dam	Predicted to be extinct in 20 years or less	13% population loss per year.
Gharial	Dams at Ganges river and tributaries	Endangered	Large population stress linked with other factors
Fish species	Mekong river	Reduced, stress	Many species, estimated to be large impacts
Ganges shark	Dams at Ganges river and tributaries	Critically endangered	A unique species of freshwater shark

(VW; known for 'Dieselgate' and a dictator history exploiting forced jewish labor) in Shanghai all benefitting from 'free' HKH water. Without the mountains, the water flows and the associated industry, such a global economy and its people would not be there! It's clearly a people issue, all driven by the consumption and demands elsewhere, which is part of the global governance scheme (Ostrom and Hess 2007) that was set up last decades (Rich 2013 for The World Bank).

With hydro damns, it is not always possible to point to, and to discuss, one single factor of impact, which is to be independent and then when fixed, all can be addressed and development can continue fine. Instead, and as it is common in ecology and with landscapes, human society and international projects, these are very complex and long processes driven by cultural attitudes. They come like waves and stay like a flood. It carries an arbitrary component too. Usually, it involves different

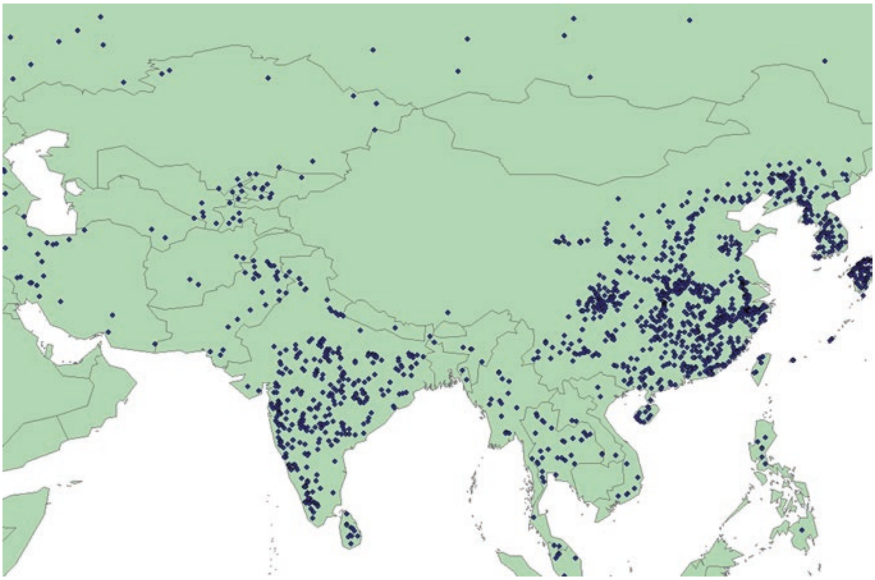

Fig. 31.2 Map of documented large hydro dams in the study region. Data SEDAC (http://sedac.ciesin.columbia.edu/) mapped by author in QGIS. It must be noted that this publically available data set still widely underestimates the reality of hydro dams in the HKH region (compare with data sources, tables and appendices mentioned in text)

phases, different owners and promoters and it consists of a settling process for society and a culture and its administration and tenure with a pension plan to develop around. Approaching it from a reductionist narrow science perspective (Burnham and Anderson 2002) will present a bias and subsequently fails not only on ethical grounds (Bandura 2007; Rohlfs et al. 2018). It provides for an incomplete view point and is harmful. Many examples have shown this problem (aka, "*this is more complicated than we had initially thought*"; e.g. Yi 2018) and then the public is left with the clean up and all costs (Huettmann 2012). In such cases, the 'public approval/licence' is just not there. Legally, those ecology issues are just now to be tackled and proved to be outermost 'complex' for the western governance style (Marsden 2017; Rohlfs et al. 2018).

Already the bird populations that connect the HKH region with their migration patterns are staggering (see Rogacheva 1992 for Siberia and declines reported 1970s onwards; Wang et al. 2018 for Chinese waterbirds, and Jiao et al. 2016 for wider flyway declines). This has not only impacts then on the bird populations but also on the entire ecosystem they connect, including disease spread, e.g. Avian Influenza (Winker et al. 2007; Herrick et al. 2013). The endangered species - many are requiring wetlands (Wang et al. 2018) – even become a side aspect in this discussion (see for instance Han et al. 2018 for Black-necked Crane, *Grus nigricollis,* Wu et al. (2009) for Siberian crane *Leucogeranus leucogeranus*, or Sun et al. 2016 for Asian crested ibis *Nipponia nippon*). Unless habitat is dealt with, not much can be done for them as they do not live in a vacuum.

Beyond birds, there are of course many other species that are affected by dams, for instance fish (Li et al. 2018; Newton et al. 2018), sharks, river otters or marine mammals. I use here the '*Water Elve*' (Yangtze Finless Porpoise *Neophocaena asiaeorientalis ssp. asiaeorientalis*) as an example (Fumei 2018) because it is the only surviving mammal in the Yangtze River, genetically separate from the porpoise – and heavily affected by the reported 24,700 (!) hydro dams in the river system! It's only place of occurrence in the world is in the middle and lower reach of the Yangtze river, between Nanjing and Shanghia in the deep river sections at the Dongting and Poyang lakes where it is found to associate with ships and swims alongside them. It has a 20 years long lifespan, and slow reproduction and thus is vulnerable. If there are accidents with this species, e.g. with the 'baby', the mother swims nearby and stays (and thus often both get killed). Consequently large species groups (pods) are now a rare sight (87 as the biggest cluster observed in recent times). Significant declines started in the 1980s, and then Bajii in those waters became already extinct. This species is also noise sensitive. The remaining thousand animals probably remain with an annual decrease of 13%; such a situation will make this species extinct in 10 years. For its protection there were eight reserves set up, as well as a declared seasonal fishing ban on the Yangtze river in 2013. Artificial breeding is also tried. The sewage treatment on the Yangtse river watershed has last 2 years increased by 8% and the treated rubbish by 11% (Yi 2018), at least according to an official audit by the Chinese government. Aside from the huge number of hydrodams there is arguably also too much construction done and often without a relevant environmental impact study. Five major lakes on the Yangtze, including Poyang lake, do not really meet standards for drinking water! And during last year alone there were 346,000 cases of illegal electrical fishing reported (30 people got electrocuted)! That is reality for the watershed in the HKH region! So what is electricity really used for (Fig. 31.3)?

As can be easily understood from such examples, the list of impacts for hydrodams is very long and very big. Therefore, to say a hydrodam has no impact, or little impact, is sustainabale, or even, the hydram would be worth the impacts, remains a very dubious statement, often a lie. Appendix II shows a list of 100 (!) impacts that are known to occur. Those are the facts, and difficult to argue away. Classic examples on watershed depletions exist in the entire world (Reisner 1993) and are widely discussed, e.g. the infamous U.S. Ogala watershed (https://www.nationalgeographic.com/magazine/2016/08/vanishing-midwest-ogallala-aquifer-drought/), and the author -Laura Parker -presents a list of Asian aquifers that are getting depleted (http://www.nationalgeographic.com/magazine/2016/08/vanishing-aquifer-interactive-map/). Many members of the global community ask to get a break from the hydro-dam actions (see The Guardian 2018a, b for an example; Tanzeem 2018 for the HKH region).

Hydro dams leave us with many questions, here some basic ones:

"*Does hydro dam development shape human society*"? I think the answer is certainly '*yes'*, either way.

"*Do we need services provided by hydro dams"*? The answer is '*not really*', because alternatives exist, considering the huge impacts.

Fig. 31.3 What is electricity used for and on what costs? (Photo credit author)

"*Can we have a modern live and civilization without hydro dams*"? The answer is '*very likely*', because alternatives exist and more should be investigated, considering the funds used and made available for hydro dams.

One hears in the discussion about hydo dams a lot about 'TINA' ("*There is No Alternative*"), as if all is already written in stone, a *fait complit* and unescapable path leading us to hydro dams, river destruction and wider impacts! But those details are widely untrue and should be rejected. Instead the hydro dam problem is really a problem of vision, public awareness, democracy, honest reflection, governance, leadership, open-mindedness and of a good, sustainable life style. So far, it looks like leading nations and cultures -their chief engineers, politicians and bankers – have simply forgotten to be in harmony with nature (Naess 1989; Rich 2013), or to respect natural processes, or the gods that are said live there (Sing and de Hugo 1994). The over 100 impacts and over 100 barrages speak for themselves and how the new life and landscape will look like in this post-industrial time! One must be scared then (as so many people suffer these days from anxiety for a reason!).

Appendices

Appendix I: List of Hydro Dams Known and Projected to Occur in the Wider HKH Region

Name of river	Name of existing hydrodam	Projected and under construction	Comment
Mekong	Dachaoshan	NA	One of the most build-up river systems
	Gongguoqiao		
	Nuozhadu		
	Jinghong		
	Manwan		
	Xiaowan		
	Miaowei		
Ganges	Agunda Thatl	Bhillangana	A large legacy of dams exist already
	Badrinath II	Birahi Ganga	
	Bhillangana	Kali Ganga	
	Chilla	Kali Ganga I	
	Debal	Kali Ganga II	
	Jummagad	Kodeshwar	
	Maneri Bhall I	Madhmaheshwar	
	Maneri Bhall II	Phata Byung	
	Pilangad	Rishi Ganga	
	Rajwakti	Singoli Bhatwari	
	Tehri Stage	Srinagar	
	Tapowan	Tapowan Vishnugad	
	Tharall	Vishnugad Pipalkoti	
	Tilwara	as well as 54 proposed projects	
	Urgam		
	Vanala		
	Farakka Barrage		
Irrawaddy river (Ayeyarwady)	None at the moment	Myitsone	
Yellow River	Sanmenxia DamSanshenggong Dam	18 scheduled to be built by 2030	A massive destruction of a national river.
	Qingtong Gorge hydroelectric power station		

(continued)

Name of river	Name of existing hydrodam	Projected and under construction	Comment
	Liujiaxia Dam		
	Lijiaxia Dam		
	Yanguoxia Dam		
	Tianqiao Dam		
	Bapanxia Dam Longyangxia Dam		
	Da Gorge hydroelectric power station		
	Li Gorge hydroelectric power station		
	Wanjiazhai Dam		
	Xiaolangdi Dam		
	Laxiwa Dam		
	Yangqu Dam		
	Maerdang Dam		
Heilongyang/ Amur	No dams directly on the river. However, tributaries of Zeya and Bureya feature large hydroelectric dams and affect the main river	JSC RusHydro company (Russian) and government has proposed more hydroelectric projects on the Amur. It is hoped that China's Three Gorges invest in it too.	A border river, heavily by China.
Yangtze river	Gezhouba Dam	Zhuyangxi Dam	Three Gorges Dam stands out
	Three Gorges Dam	Shipeng Dam	
	Xiangjiaba Dam		
	Xiluodu Dam		
	Xionanhai Dam		
Indus	Tarbela Dam	Chutak	A river systems with a large legacy
	Bunji Dam		
	Chashma Barrage		
	Dasu Dam		
	Diamer-Bhasha Dam		
	Dumkhar Dam		
	Ghazi-Barotha Hydropower Project		
	Ghazi Barotha Dam		
	Warsak Dam		
	Kalabagh Dam		
	Kotri Barrage		
	Sukkur Barrage		
	Guddu Barrage		
	Taunsa Barrage		

(continued)

Name of river	Name of existing hydrodam	Projected and under construction	Comment
	Chashma Barrage		
	Jinnah Barrage		
	Panjnad Barrage		
	Trimmu Barrage		
	Rasul Barrage		
	Qadirabad Barrage		
	Khanki Barrage		
	Marala Barrage		
	Sidhnai Barrage		
	Balloki Barrage		
	Madhopur Barrage		
	Islam Barrage		
	Suleimanki Barrage		
	Hussainiwala Barrage		
	Harike Barrage		
	Shah Nehar Barrage		
	Ropar Barrage		
	Khurram Garhi Barrage		
	Nimoo Bazgo Hydroelectric Plant		
Onon River	None recorded		A major river in Mongolia
Tarim River	Daxihaizi Dam [dried up]		
Gandaki river	Kaligandaki A Hydroelectric Power Station (the dam is located in the Gandaki river) [Nepal Electricity Authority]		
	Gandak Barrage		
Koshi river	Sapta Kosi High Dam Multipurpose Project		
	Koshi Barrage		
Yarlung-Tsangpo river	Zangmu	The world's biggest hydro dam project as proposed.	A very controversial set of projects, primarily serving industrial purposes
		Langzhen	
		Zhongla	
		Lengda	
		Jiacha	
		Zangmu	
		Jiexu	
		Dagu	

(continued)

Name of river	Name of existing hydrodam	Projected and under construction	Comment
		Bayu	
		Daguaiwan	
		Daduqia	
Yamuna river (Jumna)	Ichari Dam	Lakhwar Dam	
	Lakhwar Dam	Dark Pathar Barrage	
	Dakpathar Barrage	Hathini Kund Barrage	
	Asan Barrage		
	Hathni Kund Barrage		
	Tajewala Barrage		
Padma river	No dams recorded directly on Padma river	NA	See above Ganges barrage
Brahmaputra river	Zangmu dam	NA	Also a holy river
Jhelum river	Mohra Hydroelectric project	NA	
	Lower Jhelum Hydroelectric project		
Amu Darya river (Amo or Oxus)	Rogun dam	NA	Important water system for Central Asia
	Nurek Dam		
	Tuyamuyun dam		
	(known as THC) complex.		

Appendix II: List of Over 100 Impacts Known to Occur with Hydro Dams (This is Based on Personal Experience and also Taken from Wills 1991, Reisner 1993, Henton and Flower 2007, Buckley 2014 and Czech et al. 2000; See also https://www.internationalrivers.org/campaigns/the-world-commission-on-dams)

– economic growth is assumed
– change of the waterflow (direction)
– change of the waterflow (speed)
– change in electricity creation and provision
– more electricity than before
– increased use of electricity available
– more industry
– more neoliberal values are pushed in the society

- lack of options eventually
- more banking and credit in the community
- local interest rates change
- effects and changes on a very local scale
- effects and changes on a large scale, far away
- local workforce changes
- immigration can increase for required workforce
- subsistence declines
- increased flow of money
- higher volume of money
- artificial stimulus of buying power at local markets
- local cultures (music and arts) get promoted
- change in products consumed
- new shops and markets establish
- new products flood the market
- hospitals get bigger
- change on education system and curriculum
- environmental discussion intensifies
- media are affected through public discussion and funders
- wildlife impacts
- plant impacts
- disease impacts
- micro-climate impact
- endangered species impacts
- sedimentation rates change in river
- estuaries are affected
- river fisheries are affected
- ocean fisheries are affected
- downriver systems are affected in many ways (seasonality, flooding, water quality)
- farming changes
- cars increase
- electro products increase
- more mobile phones
- more telephones
- more internet
- more gambling
- more alcohol
- more (hard) drugs
- more sugar
- more consumption of oil
- more consumption of gas
- changes in politics
- changes in governance and ministries
- set up of a professional system, standard and society

- change in the local museum (usually its profile and collections rise)
- contamination increases
- the ‘biofilm’ changes on the river and on land
- change of the water table
- nutrients increase on land and in the water
- invasive species are rising
- diseases are increasing
- more contractors
- unions form
- NGOs become present
- more waste
- sewage treatment plants get extended
- basic understanding of ‘time’ changes and becomes more hectic/western
- so-called ‘professionalism’ increases on the cost of the old system
- coastal waters change
- focus on materialism
- quality of housing increases
- discrepancy between rich and poor rises
- education level grows for some (elites)
- now ghettos get formed and promoted
- prostitution is on the rise
- violence increases
- better police is needed
- indigenous people get de-rooted
- water ways change their temperature, and often, the PH
- specific flood areas are created, often they increase mercury levels due to biomass leakage
- specific ministries get created or assigned to handle the new problems
- legal changes are introduced to address the new issues
- travel infrastructure is enhanced greatly
- almost everybody will agree that ‘*this got more complicated than we had thought*’
- existing irrigation patterns are heavily modified
- outside influence grows
- local autonomy declines
- upstream problems have a serious impact on ‘the dam’ and downriver
- more plastics in the systems
- an unknown amount of new contaminants enters the system (can be in the 1000s)
- air pollution increase, e.g. dust or fumes
- vegetation changes in the riparian zones and in the landscapes overall
- having to deal with problems brought from the outside
- current form of religion and belief system changes
- migratory fish species are stressed more
- the river becomes part of the industrial process and production scheme
- high-quality water gets very precious and expensive
- initially wild riparian buffer zones disappear

- cancer rates are affected
- river refugia are affected
- use of credit cards increases
- more ATMs are placed
- land-tenure changes
- health care details change

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Chapter 32
Hydrodams Again: A Closer Look at Expensive Gharials, Lost Dolphins, Dissected Fish Migration, and Destructive Energy for Non-sustainable Mining and Societies Abroad Fueling a Non-democratic Governance for the Designed ‘*homo electricus*’

Falk Huettmann, Mina Shrestha, Ganesh Puri, and Ganga Ram Regmi

Justice delayed is justice denied
A legal maxim

It is well established by now that breaking the flow of an ancient river destroys an entire ecosystem that otherwise evolved for centuries, often through thousands of years or even longer (Dudgeon 1992; Guo et al. 2012). It’s a biotic lifeline that gets cut and thus destroyed, modifications then try to evolve around it. This ‘cut’ is not only serious for the river itself that is affected, but also for the overall ecosystems upstream as well as downstream, including the micro-climate of the region and the wider water table and water shed (see for instance The Guardian 2019 and references within for extinction of giant river animals world-wide)! The foot print of a dam is

F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

M. Shrestha · G. R. Regmi
Third Pole Conservancy, Kathmandu, Nepal

G. Puri
Department of Forests, Ministry of Forests and Environment, Government of Nepal, Kathmandu, Nepal
e-mail: gpuri.forestry@gmail.com

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beyond local, it's certainly regional, often national and in most cases, international; global repercussions have been observed including national tensions, if not even civil and international warfare (see for here for some more details: https://www.internationalrivers.org/campaigns/the-world-commission-on-dams). Human suffering and migration is one consequence of many impacts.

And dams do exactly produce that; they certainly cut was 'one' for millennia. In most cases of the HKH region, those are hydro-dams used for industrial energy production (Buckley 2014). Despite the arguments provided to the public (Barlow 2016), only very little energy tends to go to the local community, 20% or less. Resulting jobs are not all covered by local supply either. The public pays for it either way: most of the wider impacts, development and clean-up costs (https://www.internationalrivers.org/campaigns/the-world-commission-on-dams). This scheme comes like a global template and argument set provided by the hydrodam industry and the paying governments. It is ongoing already for many decades (Reisner 1993). Whereas, on a global scale such industrial hydrodams probably are not really used longer than the last 70 years and thus present a new and industrial topic without a good historical track-record, sustainable culture and legacy at all. Irrigation projects are not new in human history though (e.g. Elvin 2004 for China). During English colonial rule Pakistan and India show those massive impacts clearly, e.g. the infamous Punjab Canals. In earnest, virtually all such projects show clear top-down profiles for the people that have to live and make an income in those watersheds. Still, industrial dams, and modern hydrodams – specifically the global megaprojects as a trend – are a modern recent man-made artefact and not god-sent but instead they leave a vast and long-term legacy of modern human fallacy, ignorance and impact. Even worse, it's called 'green energy' (see UNEP World Commission of Dams https://www.internationalrivers.org/sites/default/files/attached-files/world_commission_on_dams_final_report.pdf)! There is not much green in such industrial hydrodams at all.

Like any deep cut with a sharp knife, the destruction of a dam cannot be denied; it's clearly there, has an impact and exists. It's difficult to justify though. People tried all sorts of mitigations but still the earth shows the impacts all over. Those 'great innovations' to mitigate impacts can consist of side-channels, temporary openings, or even trucking migratory fish back by a hauling truck beyond the barrage. 'Mitigation through design' is an entire discipline in engineering by now to make the impacts of a construction more appealing and to obtain the 'local license', public buy-in. Often this includes the extensive use of PR, politics and other demagogic means including re-designed school curricular, but all of which deny reality and people (e.g. Buckley 2014).

But however tried, and however cushioned, the actual impact does not go away. No nice words make it better and no PR action ever does. Considering the huge amounts of dams built world-wide, humans have modified the earth and all what comes with it. Dams are another part of what is called 'brutalism' (https://en.wikipedia.org/wiki/List_of_brutalist_structures).

Beyond the generic views known to many experts and as described above, here we show six details of such impact cases from different view points in support of the devastating impacts caused by dams:

32.1 Gharials (*Gavialis gangeticus*)

The gharial is a unique species of 'fish eating' crocodile- not a mammal; it is seen on river banks and in the water (Fig. 32.1). Its population has specifically crashed last 70 years! App 270 individuals are left, out of over 7,000 individuals initially (Choudhury et al. 2007). Now it only lives in some very limited river pockets of India and Nepal (Fig. 32.2). It already became extinct from Myanmar and most possibly also extinct from Bangladesh, Bhutan and Pakistan (all are areas in the HKH region where rivers are fed from the mountains and where hydrodams now play a big and widely celebrated role). Since 1982 this species has been assessed as 'Endangered 'and now is listed as a 'Critically Endangered' species by the IUCN Red List of Threatened Species (Choudhury et al. 2007). Some aspects of the species and its population dynamics still remain a mystery, e.g. Whitaker et al. (2008) for mass mortality events in protected areas. Breeding programs were set in place in support of this species, but as long as habitat in the wild is not really available, those programs have no good long-term outlook. Only wild rivers are places for those animals to strive. Like with most fish hatcheries as well, those operations tend to be financial sustainability failures. Most of those projects essentially failed (Ballouard et al. 2010) and natural breeding success is very low and non-viable (Shrestha 2019). One of the major challenge in natural breeding is the damaging of eggs of Gharials which lay eggs in the sand bank of Glacier-fed flood rivers like the Narayani, Rapti, Karnali and Babai of Nepal (Shrestha 2019; Fig. 32.3 for examples).

Fig. 32.1 A gharial sighting in Chitwan National Park, Nepal. (Photo credit: Mina Shrestha)

Fig. 32.2 Map of gharial sightings in Nepal; protected areas are the hotspots left for this species. (Map credit: Shrestha 2019)

Fig. 32.3 Gharial eggs collected for captive breeding. (Photo credit: Mina Shrestha)

Those egg laying river sand banks are not safe for many reasons e.g. locations are collected by school kids and locals for food and medicine, damaged by livestock and elephants; also they get damaged by the flood as gharials lay eggs in the spring and hatchlings are released in the onset of summer (Shrestha 2019). Even if eggs survive those disturbances and calamities, most of them become infertile (climate change is known to affect eggs and their sex-ratios for crocodilians also then affecting populations). It easily becomes clear that the hydrodams in the upper section of such rivers and their consequences have tremendous effects for the survival of such challenging and 'Critically Endangered' species like the gharial whose captive breeding programs are very challenging in itself.

Keeping gharials alive is a very expensive undertaking by now, and it involves big budgets and PR work by industries. Arguably, the hydro dams play a direct link in the well-being of this species and the budgets and public campaigns. Notable populations are still found in the protected areas of Nepal for instance: Chitwan National park in the Narayani-Rapti river, as well as in Bardia National park and the Karnali-Babai river (see Fig. 32.1). However, these watersheds are affected by many other stressors outside of the parks, and even inside the park! Other areas with gharials left are located in India, and they are also usually found there just around protected river areas. Arguably, hydro dams play a role in the crash of the gharial last decades, as well as in affecting their prey (fish) and in river fragmentations affecting gharial movements (Bustard 1983). Hydro dams simply do not serve and benefit gharials.

32.2 River Dolphins

The story of river dolphins – freshwater mammals- does not differ too much from the gharials, except that the species of the Baiji (*Lipotes vexillifer*) is virtually extinct already in China and another one, the Finless Porpoise (*Neophocaena asiaeorientalis ssp. asiaeorientalis*) is to become extinct there in the next 10 years or so. Details on that species have been mentioned in another chapter in this book (see also Yi 2018). The issue here simply is that major hydro-dam construction did not help to re-populate the reservoirs set up for this species in China and the Baijii is the only river dolphin in the world that is gone extinct while dam constructions were ongoing! Arguably, the narrow guilt-assignment of 'reserves' funded by some hydro-dams did not help. Instead, political gigantomania and industrial grandstanding coupled with blunt ecological ignorance are to blame. The question here may be posed such as: what is a good human life-style that keeps river dolphins alive and serves mankind and their happiness alike, long-term? And specifically for China: is the communist dream and modern rise just built on species losses like the river dolphins, and is a massive annual economic growth rate of over 6% really worth it, long-term?

There are also river dolphins in India, namely the South Asian river dolphin (*Platanista gangetica*), with two subspecies. These species are primarily found in the Ganges and Brahmaputra Rivers but then as well as in their tributaries in Bangladesh and Nepal. The irrigation diversions have aggravated fishing impacts on dolphins in many rivers in Nepal including the Karnali basin suggesting that their new habitat has become an 'ecological trap'. In low river depths and due to upper-stream hydrodams, fishing intensity has negative impact on dolphin abundance. However there is no reported effect of fishing in higher depths of the river (Khanal et al. 2016). This suggests that there is a tremendous effect of upper hydrodams and unplanned irrigation on endangered fresh water dolphin populations and distributions. Since the dolphin distribution has actually been shifting downstream, an effective protection of this river dolphin population from extinction will require the governments of habitat countries to prioritize ecologically adequate river flow regimes. This to be done by managing and regulating hydrodams and for implementing efficient irrigation schemes also adaptive fisheries regulations in the fresh water rivers (Khanal et al. 2016). A more holistic view is required, free'd from the narrow industrial perspective as imposed by western governance models.

The other Indus river dolphin is now only found in the main channel of the Indus river in Pakistan and in active channels connected with it between the Jinnah and Kotri barrages. There are genetic exchange problems caused by hydro dams. Overall, their conservation status is hardly much better than in China and Nepal and similar problems and questions remain (Rajeevan 2018 for lack of science-based managements). It comes back to the fact that hydrodams are not good for river dolphins regardless.

32.3 Fish Migration

A very high number of fish species are found in tropical watersheds; the diversity in such 'ancient rivers' fueled by mountains is exceeding this average (Fig. 32.4) but poorly researched worldwide. Because of these waterways existing for millennia in their natural ways, any man-made changes are of great impact for fish and conservation; movements get fragmented (Newton et al. 2018 for an example). Asian rivers carry a vast endemic biodiversity, much is not understood or even known. Many fish species require a migration for their reproduction, and allowing for a subsequent sustainable harvest. Interrupting such migration patterns, as hydrodams are known to do, can result into population stress and even extinctions. Fish species are the main prey species and they maintain various ecological services, including for human society. (Coastal) fish remains a major food security item for parts of central Asia and it has been part of a sustainable life-style for centuries, if not millennia. In the higher HKH regions many religions treat fish as 'holy', e.g. in lakes of Tibet, and do not really harvest or eat them (Buckley 2014). Hydro dams threaten such a society and such life-systems. Rivers are not to be touched for harmony with nature.

Fig. 32.4 A river flow with a natural set up of species in Asia, e.g. gharial and many fish occur here. (Photo credit: Mina Shrestha)

32.4 Energy Used for What?

The argument for putting in a hydro dam for energy production sounds convincing to most. But the wider question is: energy for what, to what cost and for whom? In most cases, beyond the industrial use, the energy supplied results into more consumption, such as karaoke shows, bars and TV, video games or mobile phones. Energy – electricity in most cases – results into a classic set of western values, products and consumption patterns, and its destructive impacts, pathetic symptoms and the legacy (Siegmund-Schultze et al. 2018; see also Alexander 2013 and Cockburn 2013 for metrics of such a society). Arguably, the western model of development is not sustainable and it's very destructive in many ways. This includes the western standard array of problems, including lack of exercise, obesity, domestic violence, diseases, media-dependence, educational debt, constant need for massive amounts of cash and the effect on 'new' dreams and wishes. An ancient society breaks down within just a few years and cultures get lost. Virtually all energy projects have associated road developments, e.g. to assess the turbines, maintain them, and for electricity lines, including shops and housing. Around dams a vastly increased transportation footprint can be found, airports included. Often, such concepts increase dependencies and destroy traditional societies and life-styles (grown over centuries and usually linked with a language and culture). It is nothing uncommon that hydro-dam energy is used for international mining operations on the grand scale, as well as for export to other nations. Who can deny that hydro dams do not present another form of social engineering: the '*homo electricus*' is created and promoted? The HKH region is full of such projects and concepts (Buckley 2014). Nepal, couched between India and China, is a good example for outside nations and corporations trying to dominate Nepali waterways. There are many related issues that affect the political fabric in the nation and region, as most hydro dams need permits and approvals from agencies and politicians. The biggest issue remains the one on warfare and civil conflict and unrest. That's because water provides a production and food security item to operate. Shutting water off, as one can do from the roof of the world (e.g. Nepal, Tibet and parts of India) can be used as a political strategy, specifically when nations downstream are having other conflicts already ongoing. The warfare in Afghanistan, or trade disputes between India, China and Nepal have shown nothing but that. Hydrodams, their water, electricity and money provide tools for political means of elites while the local community suffers (Buckley 2014; Barlow 2016).

32.5 Worker Impacts

There are additional issues with hydro dams, one is the labor force required to build them, and the experts needed to run and maintain them long-term. Such labor is specialized and usually not available and supplied locally. Most of it are (young) males, in high numbers brought in from outside, and they usually live in dense compounds (Fig. 32.5). Conflicts can be predicted accordingly, policing is on the rise

Fig. 32.5 A typical worker's camp for the HKH region; the barb wire speaks for itself

(bringing in other problems). There are some relevant and urgent questions to be dealt with when it comes to unions and work protections. One important side-aspect is that those outsiders bring with them a 'culture' that is not local, for instance disrespecting local rules and policies, e.g. poaching whatever can be collected as 'bush meat' and resources to make additional money. Hydro-dam construction can easily increase stress and poaching pressure on natural resources, for instance. Further, the spread of (domestic) violence as well as diseases, including sexually transmitted diseases (STDs) is commonly observed when industrial projects hit rural communities and landscapes. Experiences from mining show us no other.

32.6 Spoiling Landscapes

Anybody who saw and experienced wild natural landscapes, and then compares them with the ones that carry hydro-dams or entire barrages of them will agree that the landscape got spoiled in a bad way (Fig. 32.6). Something ancient got broken. The western world is so used to that concept (=that industrialization destroys wilderness) that they usually lost any sensitivity, tend not to realize the impact or perceive it as normal and usual even. Many westerners and their politicians even think it's part of life! However, for people who grew up in wildness areas and who have kept their sensitivity and aesthetics, a sustainable lifestyle, the spoilage of the land is a big issue. It can result into a lost connection with the earth, and a disconnection of a formerly harmonic relationship with nature (Suzuki and Knudston 1993). These are aspects that are difficult to grasp for urbanites or westerners, but they are severe either way. A typical example is to use those man-made reservoirs as

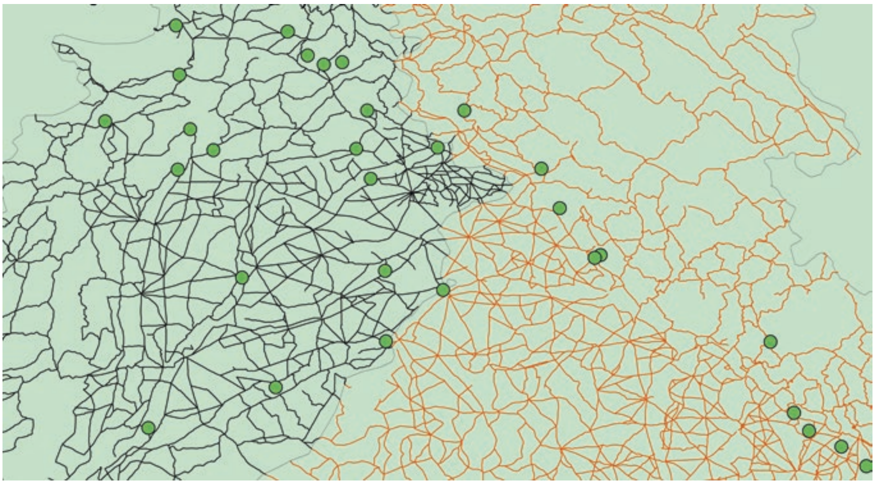

Fig. 32.6 Road systems (Pakistan in black, India in orange) connect and serve hydro dams (green dots), based on public data GIS maps. (DIVA GIS; data credit Sriram and Huettmann unpublished)

protected areas for wildlife as found in Nepal RAMSAR Sites in Jagadishpur Reservoir near Lumbini (Baral et al. 2018; see for declining species within) as well as Mai Pokhari in the Kanchenjunga area (Fig. 32.7)! It flips the entire idea of protecting nature and wilderness because what is now protected, with the means of 'nature conservation' and holy sites, actually is the western industrial water scheme; it's gets now declared a holy grove! Thus, a destructive unsustainable (western) system now gets protected, maintained and worshipped claiming to protect nature as the

Fig. 32.7 RAMSAR sites in industrial reservoirs and managed ponds flips wilderness conservation on the head. (**a**) Jagadishpur Reservoir (Lumbini, Nepal), (**b**) Mai Pokhari pond. Those are not wild but man-made and industrial products

ultimate – wrongly so! It just flips the basic concepts on its head and nobody gets served, long-term.

These six examples might suffice to show that hydro-dams are not a small feat. To make it worse, there is only little synergetic and cumulative impact studies done on the topic (Lacerda dos Santos et al. 2018; Rohlfs et al. 2018; Shivers et al. 2017 for examples).

It's easy to see that hydrodams are a big deal, either way and not to be taken lightly. They are certainly life-changing construction projects on a vast scale affecting watersheds (Fig. 32.8), human society, nations and the world's atmosphere. By no means they should be seen as a 'fix all' or as 'green'. With climate change on the rise, many additional complexities enter the landscape, such as GLOFs and changed water levels that even make the energy production itself doubtful (the core argument for accepting the environmental changes in the first place). Hydrodams do not make it better and are not designed even for catering them. Apart from microgrids perhaps, traditional-style hydrodams are an inherent part of the industrial society and create waste.

Lastly, the biggest argument might well be a democratic one, and where the local people are said to want those projects to happen and demand them '*to get out of the dark ages*'. But due to bad experience last decades there is not much truth in that statement: Resistance in those projects is widely known in the HKH region (Buckley 2014; Barlow 2016) and elsewhere (Siegmund-Schultze et al. 2018), and even sophisticated PR campaigns cannot change that much. Civil war-like conflicts are fought around the subject. As a matter of fact, democracy tends to be one of the first victims of large hydro-dam projects, together with the loss of independent media! If large hydro-damn projects have two features in common, then that they serve specific interests and ownerships, and that they tend to corrupt the political process and

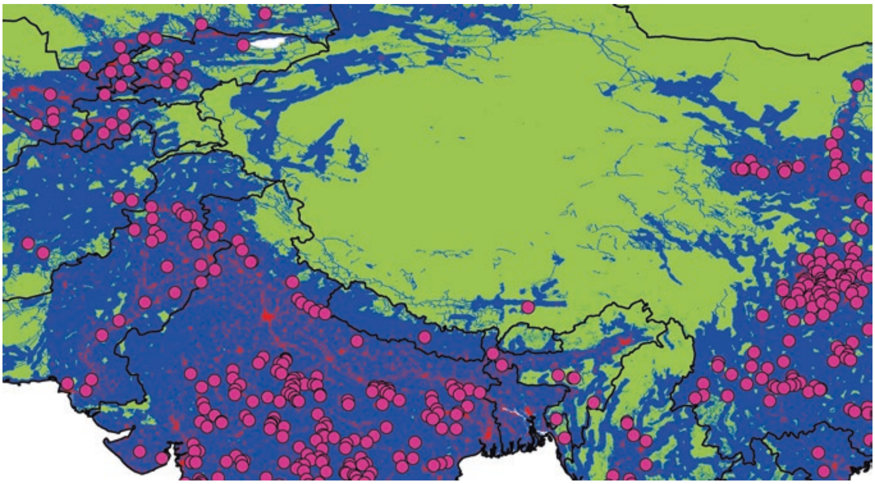

Fig. 32.8 Human footprints in the HKH region (red high, green medium, blue low): much is fueled by electricity and as provided by hydro dams (Shown as pink dots; data credit Sriram and Huettmann unpublished)

democratic policy,–including the media–helping to empower cliques that enjoy military and international banking support and use it. In the HKH region, India, and China specifically, now sit in the decision-seat for such topics and drive the development of watersheds to their liking. Beyond the wildlife and the environmental loss, the winner is simply the iron triangle (=politicians, industry and military) all awhile moral and honest citizenship of this world looses, once again. That's not a governance model in harmony with earth, and the legacy is dramatic (Siegmund-Schultze et al. 2018). It can only be suggested for any hydro dam that they are openly exposed and re-considered for a more complete and holistic assessment of their 'true' impacts (see for instance Arunkumar and Manimekalari 2019 for open access data as one of the very few examples). Eventually though, a better way is to be found how to operate on and with Mother Earth and what she provides.

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Chapter 33
Persistent Evidence for a Dramatic Decline in Langurs (*Semnopithecus* spp.) in Nepal and Elsewhere: Science Data and Personal Experiences Converge On a Landscape-Scale

Purna Bahadur Ale, Kamal Kandel, Tirth Raj Ghimire, Falk Huettmann, and Ganga Ram Regmi

33.1 Conservation Background for Langurs

The wide diversity of primate sizes – from the wee mouse lemurs to the gorilla – as well as the diversity of their diet, social systems and habitats, combine to provide fascination but also deep challenges for the science of conservation biology and management. The larger primates are widely hunted, many of the smaller ones are prized for commerce and the pet trade, and all suffer from habitat loss, wider global decay and environmental injustice, a so-called sustainable development in the Anthropocene (Rosales 2008). Primates play significant roles in the ecosystem, for example, as part of the food chain and for seed dispersal of precious plants and trees. Even where their pristine forests remain, subsistence and commercial hunting in West and Central Africa as well as South-east Asia are resulting in vast areas of silent and empty forests (forests that do not reproduce and die off eventually; many forested landscapes suffer from this problem these days; see Allen 2003 for an example). Similarly, many forests in Nepal are now reported to be without primates,

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P. B. Ale (✉) · K. Kandel · G. R. Regmi
Third Pole Conservancy, Kathmandu, Nepal
e-mail: purnale76@gmail.com

T. R. Ghimire
Animal Research Laboratory, Faculty of Science, Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur, Nepal

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA

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particularly langurs due to hunting for bushmeat and traditional practice for curing many diseases like tuberculosis, asthma, and arthritis. Besides hunting, langurs are also declining due to encroaching human expansion, rapid urbanization, and forest fragmentation (Nowak 1999a, b). Those trends are easily mirrored by many people with long-time experience working in the environments of Nepal, the Hindu Kush-Himalaya region as well as Asia (Fig. 33.1).

For a more detailed assessment, in 2011–2012 we carried out detailed population monitoring of primates using standard and the most acceptable line transect distance sampling surveys in Lower Kanchenjungha Area (LKA) in Eastern Nepal (Regmi and Kandel 2012). Ninety line transects were walked totaling of 179.29 km in which 35 observations of Assamese macaques (*Macaca assamensis*) were made with the macaque group encounter rate 0.19521 groups/km and group density 1.2253 (±0.21569) groups/km^2 with the estimated population density and the total number of macaques 32.733 (±6.454) and 1015.0 (±200.13) respectively. However, we did not encounter any single group of langurs there except two solitary males in three different sites (Regmi and Kandel 2012). We were amazed by this finding which triggered a crucial question in our mind: *where have those langurs gone?* The langurs in the mid-hills and mountains in Nepal are sympatric with the Assamese macaques, and all the predicted potential habitat of Assamese macaques (Regmi et al. 2018) in Asia is conceptually suitable for langurs.

Fig. 33.1 A langur exposed in its habitat. (Photo credit: Kamal Kandel)

33.2 What Are Langurs?

The langurs (Primates: Colobinae: Cercopithecidae) are a group of old world monkeys and they make up the entirety of the genus *Semnopithecus,* and all distributed in South-Asia. They are mostly folivorous and inhabit trees, but they also walk often on the ground. In Nepal, by morphological characters and pelage color, three subspecies of langurs are assumed to occur: Tarai langur or Hanuman langur (*Semnopithecus entellus hector*), Pale-armed Himalayan langur (*Semnopithecus entellus schistaceous*) and Dark-armed Himalayan langur (*Semnopithecus entellus ajax*). These three distinct species of langurs are also identified by the Conservation Assessment and Management Plan (CAMP) workshop 2003 for Nepal referred to there as the Lesser Hill Langur (*S. hector* – conservation status: Near Threatened), Nepal Grey Langur (*S. schistaceus* – conservation status: Least Concern), and Western Himalayan Langur (*Semnopithecus ajax* – conservation status: Endangered (but genetically not confirmed)). However, all these three species of langur are now grouped under category 'Appendix I' of CITES (CITES 2017). These langurs are the largest primates in Nepal having a body length (head-plus-body) up to 1 m, and along with the tail it can reach up to two meters. The body size of the male is larger than the female, and their weight ranges from 7 kg to 20 kg (Chalise 1995; see Fig. 33.2 for a langur sighting).

33.3 Where Are Langurs Distributed?

The langurs are a widely spread non-human primate. They occur throughout various habitats of the Indian sub-continent (Vogel 1976), as well as in Sri Lanka in the south and from Kathiwar in the east to the Shan state of China in the west (Roonwal and Mohnot 1977, 2014). In Nepal, the langur monkeys are distributed in different topographical locations from the Terai plain to the valleys of high mountains (Chalise 1995). Their presence has been reported up to 4000 m asl in canopies near tree line (Chalise 1995; authors pers.com.). These langur species inhabited particular areas; for example, *S. hector* was reported from Central to Western Nepal in the outer Terai, *S. schistaceus* was reported from south to north in central Nepal (Chitwan, Kathmandu, and Langtang), and *S. ajax* was reported from east Langtang and Melamchi (Chalise 2003, 2010).

Like found with many species in Asia, and endangered ones (e.g. Kandel et al. 2015; Regmi et al. 2018), there is a typical but persistent and unnecessary lack of data for langurs in the public realm. That is despite decades of funded field and museum research, many publications, 'best professional' practices and legal mandates, e.g. Rio convention, GBIF.org agreements and similar efforts (also applicable to researchers and funders acting from other nations like in the U.K. U.S.; compare for instance with Zuckerberg et al. 2011). Figure 33.3 shows the world's best

Fig. 33.2 A typical langur detection hidden in the canpoy. Langurs can be difficult to detect and to count. (Photo credit: Kamal Kandel)

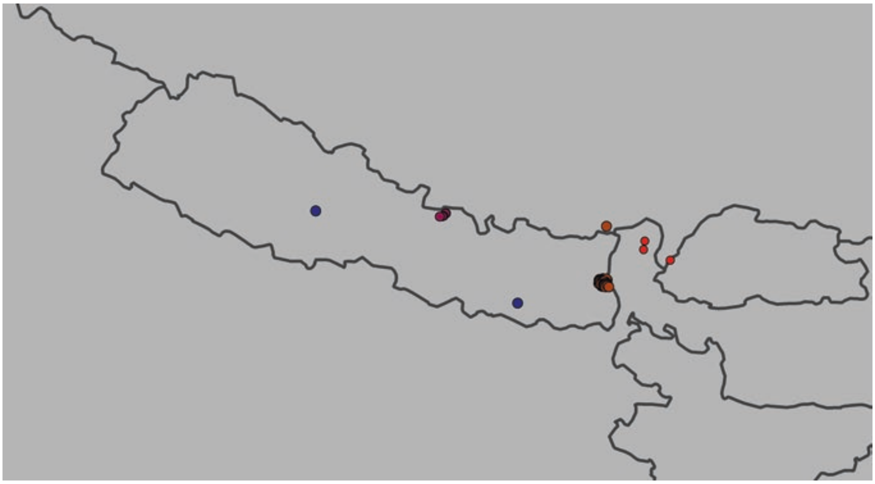

Fig. 33.3 Best-available public langur data worldwide; map shows Nepal in the center. (11 localized records come from GBIF.org (shown in red); whereas over 60 records come from the Global Primate Network Nepal)

available dataset for langurs we are aware of (only 11 local geo-referenced records are available from GBIF, whereas over 60 records are provided by the Global Primate Network Nepal).

Langurs tend to occur in large groups, for example, 15 individuals, but those now seem to get smaller (smaller groups of 3–5 individuals are frequently observed instead of big agglomerations). These species prefer the forest habitats near the major rivers and streams in protected and unprotected forests in Nepal (Regmi and Kandel 2008; Ale 2010). Authors found langurs ranging from valleys of Nepal to Tibet and interestingly, those valleys have been used by people for hundreds of years implying the probable existence of a certain co-evolution. Thus, it is not surprising that those monkeys play a spiritual role in Buddhism and Hinduism (e.g. Sommer 1996).

33.4 Ecologic Relationship of the Langur with Water

Many primate species are dwellers of the riverside forest; it provides succulent herbs and other food items including insect larvae (Chalise 2003). The Assamese monkey mainly ranged over the Tarai and mid-hills, and it was found sporadically along rivers in tropical and subtropical forests (Wada 2005). Most of the research (Chalise 2003; Regmi and Kandel 2008; Ale 2010) showed that langurs and Assamese macaques mostly select rocky cliffs; river gorges usually include steep banks of streams and rivers that can provide some security from the predators while sleeping at night. Wang et al. (2011) also reported a similar behavior for Francois's Langurs who ranged in the river valley of the Mayanghe National Nature Reserve and in Guizhou, China. Researchers observed that these langurs used to drink water while traveling through the river in an undisturbed habitat, whereas when langurs stay the night away from the river valley, they came back and drank after the arrival of the site next day. It showed a strong positive correlation between sleeping sites away from the river valley and nearby seasonal sources of water. Mishra et al. (2012) noted that hanuman langurs in the Chitrakoot forest range of Madhya Pradesh, India showed a shift of the roosting sites for the trees around natural or artificial water sources during hot weather in order to obtain more humidity. Since langurs are adapted to folivory and prefer forests abundant with the family Leguminosae, Southwick and Lindburg (1986) supposed that their preference is for riverine forests. Similarly, Oates (1978) analyzed the diet of colobus monkeys (*Colobus guereza*) which frequently visited a swamp area and consumed water plants at a site in western Uganda, indicating there the highest level of minerals such as sodium, magnesium, iron, and zinc when compared to any dry land plants in their diet. On the other hand, the researcher also claimed that the gathering of colobus monkeys in the swamp could be an anti-predator response to the dangerous situation as they can escape easily from the predation. While it remains untested for the HKH region, we think similar can apply to langurs.

33.5 Why Do Langurs Matter?

Hanuman langurs are well adapted to arboreal as well as terrestrial habitats and they are vegetarian (Chalise 1995; Sugiyama 1964; Srivastava 1989). More than 200 plant species were recorded as food items in arid areas (Srivastava 1989) while 76 species were shown in subtropical regions (Chalise 1995) and 45 species in subalpine regions (Sayers and Norconk 2008). Their feeding habitat includes trees, shrubs, herbs, and grasses (Chalise 1995) although found rarely, insects as food items have also been observed. Since the langurs consume a large number of plants and their products in a wide variety of habitats from sea level to >4000 m asl, they play an essential and inevitable role in seed dispersal and forest regulation, including for some endemic species. Moreover, the highland langurs are crucial for seed dispersal because they show long daily foraging path lengths for searching feeding locations in the draught season and in harsh climatic conditions where the food items are patchily distributed (Sayers and Norconk 2008). In addition to seed dispersal, the langurs are one of the dominant prey species of the big cats such as the Royal Bengal tiger and common leopard (Bagchi et al. 2003; Bhandari et al. 2017). The diet of leopard contains about 21% (Mukherjee et al. 1994; Wegge et al. 2009) and for tiger it contains about 5.7% of langurs (Wegge et al. 2009). Noteworthy here is also the 'ecology of fear', as langurs must be stressed about predators, even if the predation event is rare! Those aspects are not well studied yet.

33.6 Status of Langurs in Nepal

There are many aspects of research linked withthe status of langurs in the Himalayan nations including India, Nepal, and Bhutan. The nationwide primate survey conducted by Zoological Survey of India from 1978 to 1983 showed the populations of common langur were the most abundant monkey species in India (Southwick and Lindburg 1998) where Rajasthan, Gujarat, Bihar, Orissa, Himanchal Pradesh, Uttar Pradesh, Madhya Pradesh and Maharashtra had contained back then a relatively good number of langurs (Tiwari and Mukherjee 1992; Pirta et al. 1997). Although its population was estimated to be 233,800 in India, it showed already a decreasing trend in many areas (CAMP 2003). Likewise, the population trend of langurs was unknown in Bhutan (CAMP 2003). It is interesting to note that the population of golden langur was found to increase though in Assam in India as well as Bhutan by 12,000 individuals from 2007 to 2012 after the golden langur conservation project begun in 1998 (Horwich et al. 2013).

In Nepal, a small and fragmented population of langurs was reported by the census of non-human primates that was conducted in some parts of Nepal (Chalise 2001, 2006, 2016). The limited information on population distribution has been collected by some researchers from specific areas (Chalise 2003) and primarily, most studies focused on wild forests of different topographical locations (Bishop 1977). As a result, many areas have been left unsurveyed. Since the last decade, however, information has been obtained through field visits, questionnaire surveys, and anecdotal survey from local villagers especially farmers, herders, and forest visitors throughout the country. Even though primate and other mammalian research was started a long time ago, its comprehensive study and data are unsatisfactory for Nepal (Katuwal et al. 2013; compare with Kandel et al. 2015 and Regmi et al. 2018 for open access and model prediction inference).

Most of the previous studies have just been focused on national parks, conservation areas and some surroundings of the Kathmandu valley. The available information is sporadic, as judged by the research sites and author's census. The Biodiversity Profile Project initiated to collect data; however, it mostly relied on secondary data, and it could not trace all of the primate research completed in Nepal around the 1980s and 1990s (Chalise 2008). Chalise and Johnson (2005) reported a total of 719 langurs at different locations, in 2008, he counted 734 (482 + 252) langurs from the mid-hills and central Himalaya (Chalise 2008) and in 2016, he counted 1113 langurs living in 67 groups in different vegetative and climatic zones of Nepal (Chalise 2016). In the latter case, 529 *S. hector* were reported for Terai (500–1000 m asl), 564 *S. schistaceus* in mid-hills (1000–3000 m asl), and 20 *S. ajax* in the high mountain forest of Langtang National Park (LNP) (3430 m asl).

Bishop (1977) reported few troops of Himalayan grey langurs (*S. ajax*) from the Melamchi-Helambu valley (data unknown). Similarly, Sayers and Norconk (2008) sighted 55 Himalayan grey langurs (*S. ajax*) in LNP while Ale (2010) observed six troops of langur consisting of 7–48 individuals across the different elevations in LNP. Katuwal et al. (2013) also reported troops of Nepal grey langurs (*S. schistaceus*) in Manaslu Conservation Area (MCA) and in the Dhudhkunda and Dhudkoshi valleys of Sagarmatha National Park (SNP), but the data was not available. Our work also revealed that langurs are relatively safer and have a higher density in protected areas when compared to non-protected forest. The census data also shows that the langur species are more common in broader areas of Nepal and that they inhabit close proximity to human settlements and crop fields. Such regular findings of langurs indicate that continuous survey and research should be done to establish the scientific status of the langur in Nepal and to obtain basic distribution pattern, habitat use and availability of the species.

Regarding the current status of langurs, the people of the western region (Pokhara and Baglung) believe that their numbers were decreasing since the beginning of Chinese road development projects in these areas. Few vigilant solitary male langurs have been reported from the eastern and western sub-alpine marginal forests (Chalise 2016). As langurs are social and need larger groups, the conservation outlook of such population fragments is usually suggesting the local extinctions in these areas of the country. Here humans and governance are to blame. This pilot survey concluded that populations of langurs have dramatically declined in many other regions too mainly following anthropogenic activities primarily in the marginal and non-protected forest areas.

Although Chalise (2006) enumerated the occurrence of langurs during the rainy season in Kavre – the area that surrounds the forests of the Kathmandu valley and Phulchowki- researchers could not well reproduce those sightings (Chalise 2016). Previous studies reported just a small troop containing ten langurs in the Suklaphata Wildlife Reserve (SWLR) and the most massive troop consisting of 300 langurs in Ramnagar, Chitwan (Chalise 1995, 2006, 2008). It is critical to note here that the population of *S. schistaceus* in Chitwan, Syafru, Shorgadwari, and Shankhuwasabha was stable due to the natural mortality processes of langurs (CAMP 2003, Chalise 2008). But man-made climate change may be responsible for influencing the population distribution, temporal variation, dispersal, and density all leading to a higher risk of local extinction. However, no detailed long-term demographic study of langurs has been attempted in the country. Relevant data are thus widely missing and are not publicly available (for instance, compare with Regmi et al. 2018 as well as Kandel et al. 2015). Therefore, the status of population density, abundance, and distribution of langurs has remained unknown. That is why it is essential to monitor the present population, and it requires urgently a long-term study to develop appropriate conservation and management strategies with a proper governance framework to safeguard this species and its habitat.

33.7 Known Threats to Langurs

The loss of the *S. entellus entellus* population in Rajasthan area in India is said due to habitat destruction like urbanization and other anthropological causes and adverse climates, electrocution, natural predators, and infanticidal effects (Ram and Rajpurohit 2015), as well as extreme road accidents (Chhangani 2004). In Nepal, infanticide has been reported as a male reproductive strategy among seasonally breeding langurs (Borries 1997). CAMP (2003) reported 18 langurs killed due to accidental death within 1 year in Ramnagar, Chitwan indicating road kills as a critical factor for the loss of langur population along the national highways.

Although deforestation due agriculture and development practices along forest areas principally play a role in the reduction of food and adverse effects on these primates (Nowak 1999a, b), other factors like overgrazing, chopping down trees and the widespread use of fire are also important. Few critical underlying threats are due to predation by carnivores like leopards and tigers in the central and western India (Biswas and Sankar 2002; Bagchi et al. 2003). While these factors are critical, coprological analysis and *in vitro* and *in vivo* data show that many parasitic, viral, and bacterial infections may actually lead to severe loss of langur populations from the world including India and Nepal (Anderson and Goldberger 1912; Prakasan 1964; Hawkins et al. 1953; Baviskar et al. 2009; Overskei et al. 1994; Joseph et al. 1999; Rajendran et al. 2004; Chen and Meyer 1965; Singh and Thakur 2017; Nandi et al. 2003; Adhikari and Dhakal 2018). Notably, the recent expansion of agricultural fields, logging, induced landslide, initiation of road and hydro dam projects, and increased tourism, hunting practices, poaching, slash-burn agriculture practices, stress due to the fear of roaming dogs, as well as diseases caused by parasites have been observed to be detrimental to the survival of the langurs, especially in the Tarai and Himalayan landscapes of Nepal. Revenge killing by the Nepalese farmers because of the crop damage from langurs has been reported from eastern Nepal (Dikpal Karmacharya, pers. comm.)

33.8 Discussion & Conclusion for Langur Conservation Management

Evidence from research, personal and experts' opinions show that langurs are declining at a fast rate throughout Nepal, although the decline depends on forest types, location and attitudes of local peoples, and presence of canine and felid adversaries. It is widely believed that the largest hunting pressures are found in the community forests, when compared to that in the protected areas. Several studies (Chalise 2001; Regmi et al. 2013; Katuwal et al. 2013; Kandel et al. 2015) showed that there was a huge amount of crop loss annually in most of the protected areas of Annapurna Conservation Area (ACA), Kanchenjunga Conservation Area (KCA), Langtang National Park (LNP), Makalu Barun National Park (MBNP), Sagarmatha National Park (SNP) and Shivapuri Nagarjun National Park (SHNNP) and non-protected forests in mid-hills of western and eastern parts of Nepal. However, people in those areas are usually not compensated well by the authorities that then trigger the local farmers to hunt them illegally and clandestinely (Katuwal et al. 2013). Besides, there is no strict monitoring by government authorities outside of the national parks and conservation areas. Although hunting is prohibited by the wildlife laws (National Parks and Wildlife Conservation Act 1973) of Nepal, its enforcement is often tough in remote areas, and even local communities are unaware of the regulations. Proper guidelines and awareness to the people and implementation of the law are critical in the conservation management of the langurs in the Himalayan countries.

The Raute are one of the last forests dwelling nomadic people in Nepal. Monkey hunting is considered to be the fundamental event of the traditional and cultural hunting life of the Rautes from the ancient time (Bista 1978; United Nations Development Program 2011) in order to fulfill the regular protein supply in their diet (Kawamoto et al. 2016). Hunters-gatherers like the Raute hunt the monkeys using weave nets and ropes made of jungle vines, but they do not use guns and bows (Bista 1978). The langurs are sacred for them and considered as a living incarnation of Lord Hanuman, or monkey god in Nepal. However, the farmers ignore it now and excuse the killing of monkeys because the local people suffer from the menace of monkeys loosing modern-day money; whereas it provided earlier a symbiotic relation with the local community without relevant conflict (Bista 1978). Besides the Raute, recently indigenous people and other communities also began hunting langurs for medicine and food (Kawamoto et al. 2016). In times of globalization the 'holy' langurs became a cash cow instead. However, there still is virtually no population monitoring of langurs and other monkeys in such hunting-prevalent areas. How can that ever be good conservation management and achievement, while the global community and the UN are watching it?

In addition, people who came in contact with, or worked in, Chinese development projects such as hydro-electric projects and road development projects learnt and started hunting langurs in those project sites and elsewhere. It's a certain new 'culture' that lost its respect with nature and that transferred from Han China into Nepal and the HKH region. Without a strict monitoring and relevant enforcement by government authorities outside national parks and conservation areas bush meat is essentially freely available. It's like a subsidy for destruction fueled by industrialization and its 'modern' governance (see Czech et al. 2000 and Rosales 2008 for a global pattern). Langurs pay the prize. Further noteworthy in that discussion is the concept of 'ecology of fear' which stresses populations without killing them directly (Clinchy et al. 2013) but which drives them out. Hunting as such is not the only factor for declines and stress factors, but also free roaming dogs can contribute. Stray dogs can be found in most parts of Nepal (Regmi and Huettmann pers. com.). Many study sites showed already uneven distributions of langurs such as a being clumped ("packed") in the protected pristine forests, at steep slopes and with less langurs in the unfragmented, easy accessible and unprotected forest. This is a typical pattern found elsewhere too ("protection by human inaccessibility").

Additional mortality factors come to play. In India for instance, Rajpurohit (2006) reported a mass mortality of more than 80 langurs due to a skin disease (Sarcoptic mange) in the Arna area of Jodhpur during 1999 to 2001. Still, no research has really been conducted on the pathogens that causes the mortality of langurs in Nepal.

Kumara et al. (2010) suspect that hunting and trapping langurs for meat contribute as major factors for declining the population of Hanuman langur in Karnataka, India. Other researchers (Srivastava 2006; Choudhury 2008; Horwich et al. 2013) also strongly supported that crop raiding primates are subsequently killed by people, tribal communities and dogs in different parts of India. This topic is widespread and reported for Rhesus macaques in most of Northeast India, for pig-tailed macaques in Meghalaya, stump-tailed macaques in Nagaland, Assamese macaques in Arunachal Pradesh, and golden langurs and primates in Assam, India (Vogel 1976; Choudhury 2001). However, Choudhury (2008) and Horwich et al. 2013 showed that there was no such an organized poaching or trade of any primates and hunting langurs in Bhutan and presumably the population of langurs was decreasing due to habitat fragmentation. As outlined already by Czech et al. (2000) we think this is not a simple question of one versus the other factor, but instead it comes as a wider package of factors and all are contributing to wider stress and declines for langurs. Usually, human economy and governance explain the major problems in such questions (Daly and Farley 2010). Arguably, the role of climate change for this species is not really assessed or discussed even (compare with Assamese macaques Suwal et al. 2018).

Therefore, all these details can be considered as a sufficient, at least very worrisome, evidence for the landscape-wide decline of langur populations in Nepal, and likely beyond. Much needs to be learned about this species, including human co-evolution (Sommer 1996) and the role of diseases for their population survival. However, it is very clear that the population reality for this species currently is very grim, that much has been lost already, and that virtually all relevant metrics show a very non-sustainable trend. The outlook and governance for this species and its habitat is therefore very poor and did not address yet a vastly improved conservation management and done in a transparent and proactive fashion (as legally required and for a best-professional practice demanded by the United Nations: https://www.unisdr.org/we/inform/publications/49574).

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Chapter 34
Snow Leopards in 2100: Towards a Real-World Nepal Perspective

Rinzin Phunjok Lama, Tashi Rapte Ghale, and Ganga Ram Regmi

34.1 Snow Leopards: A Brief Global Overview

The snow leopard (*Panthera uncia*; Fig. 34.1) is an elusive keystone species of the high mountain and alpine desert ecosystem in South and Central Asia (McCarthy et al. 2016; McCarthy et al. 2017). It is distributed over an area of 1.2–1.6 million km^2, spreading over 12 countries in Asia (Fig. 34.2); namely Afghanistan, Bhutan, China, India, Kazakhstan, Kyrgyzstan, Mongolia, Nepal, Pakistan, Russia, Tajikistan and Uzbekistan with a potential occurrence in Myanmar (Jackson et al. 2010; McCarthy et al. 2016). It mostly inhabits high alpine areas between tree line and snow line (Snow Leopard Network 2014; Li et al. 2016), at an elevation between 3000 and 5400 m in the Hindu Kush-Himalaya and Tibetan Plateau, but as low as 500 m in Mongolia and Russia (Snow Leopard Network 2014; McCarthy et al. 2017). The snow leopard is listed in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) with a strong legal restriction on killing and trading of its body parts. But recently, the snow leopard has been downgraded to Vulnerable from Endangered in the IUCN Red List of Threatened Species (McCarthy et al. 2017), acclaimed as a result from long-term conservation efforts or improved knowledge of status and trends (Mallon and Jackson 2017). The species has gained significant conservation priority as an iconic and charismatic species of the Asian mountains. However, its sightings remained very rare for most of the global audience like as its elusive behavior.

Throughout the snow leopard range, agro-pastoralism is a dominant land use practice (Mishra et al. 2003). Due to overlapping habitat with the traditional

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R. P. Lama (✉) · T. R. Ghale · G. R. Regmi
Third Pole Conservancy, Kathmandu, Nepal

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Fig. 34.1 Photo of a snow leopard family detected in Nyesyang Valley, Manang district. (Credit: Tashi R. Ghale)

agro-pastoralism landscape, snow leopards often come in conflict with local households over livestock depredation (Jackson et al. 2010; Suryawanshi et al. 2013, 2017; McCarthy et al. 2017). In many of the incidences, locals do kill snow leopards in retaliation for livestock losses (Snow Leopard Network 2014). Apart from the human-snow leopard conflict, the long-term persistence of snow leopard is constantly threatened by poaching and illegal trade (Theile 2003; Li and Lu 2014; Maheshwari and von Meibom 2016; McCarthy et al. 2017), prey base decline (Bagchi and Mishra 2006; Jackson et al. 2010), habitat loss and fragmentation (Jackson et al. 2010; Forrest et al. 2012; Li et al. 2016; McCarthy et al. 2017). The issue of climate change and landscape change from large-scale development projects, cordyceps harvesting etc. have been identified as emerging threats to snow leopards (Snow Leopard Working Secretariat 2013; Li et al. 2016; McCarthy et al. 2017). There is very limited study on the health and disease aspect of snow leopards, except few earlier studies undertaken in the captive individuals (Munson and Worley 1991), however, mortality of individuals in the wild from diseases are expected which needs further investigation.

34.2 Snow Leopards in Nepal

In Nepal – one of the central snow leopard nations – snow leopards are distributed throughout the northern region of the country, including both – inside and outside – the protected areas. The potential snow leopard habitat in Nepal is predicted to

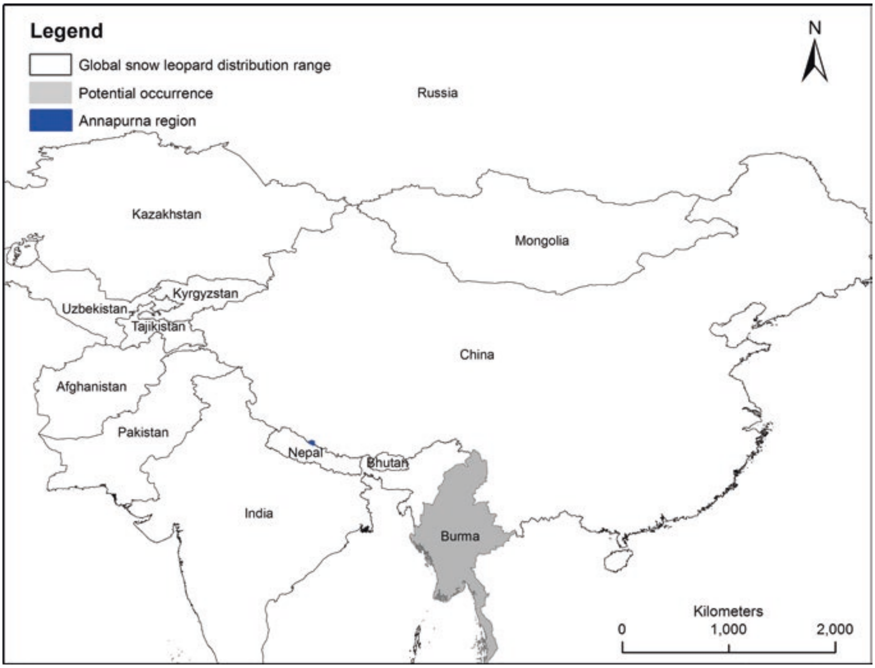

Fig. 34.2 Global snow leopard distribution range

cover 22,625.34 km^2 (Aryal et al. 2016), with an estimated population of 301–400 individuals (DNPWC 2012). The current protected area network covers 66% of the potential snow leopard habitat in Nepal, with highest potential habitat occurring in the Annapurna Conservation Area and Shey Phoksundo National Park (Aryal et al. 2016). In this investigation here, we present a general overview on the estimated future of snow leopard conservation scenarios in Nepal. We base our estimates on current threats and conservation practices focusing on the possible impacts of climate change on snow leopard and its habitats along with human consumptions and development lead landscape changes. The impact of climate change on the snow leopard in Nepal has been attempted by Aryal et al. (2016), which predicts the reduction in snow leopard habitat by 3.80% in 2050 based on climate model only. The area outside the protected area network such as the Humla district is predicted to suffer the highest from the impact of climate change. However, the districts such as Mustang, Dolpa, and Manang seems to benefit with an increase in suitable habitat (Aryal et al. 2016), which needs follow up studies. However, the impact of human consumption and development activities remained unstudied in Nepal but it is assumed to have a significant impact on snow leopard and its prey. Every year, thousands of people invade into the prime snow leopard habitats. More commonly this happens in the western part of Nepal, in districts such as Gorkha, Manang, Mustang, Dopla, Rukum, Mugu, Humla, Bajura, Bajhang and Darchula for harvesting Non-Timber Forest Products (NTFPs) also including high value Medicinal and Aromatic Plants (MAPs) such as Caterpillar fungus *Ophiocordyceps sinensis* locally known as 'Yartsagunbu' (RPL unpub.). These area covers about more than half of the snow leopard territory in Nepal, henceforth the disturbance and associated impact can be expected to be serious. On one instance a serious harassment on young snow leopard cubs from cordyceps harvesters was reported in the Dolpa district (TLL pers. com.). It is an area that supports the highest density of snow leopards in Nepal (DNPWC 2012). Similar incidences can be expected in other areas as well where the NTFPs and or MAPs collection is more common. Similarly, trapping and hunting of wild prey such as blue sheep were also reported during MAPs harvesting season in areas such as Humla (RPL unpub.). The northern part of Nepal is relatively isolated and underdeveloped with rough and difficult terrain. But, in recent days, government's priority to build a road in order to connect these areas with the Southern part of Nepal as well as to link with ancient trade routes of the Tibet Autonomous Region of China brings up large concerns over snow leopard habitat modification. The road project and other structures through snow leopard habitat may increase human visitation and disturbances directly or indirectly through prey, considering already existing threats from increasing livestock grazing and induced conflict with wildlife.

34.3 Snow Leopards and Climate Change in the Annapurna Region of Nepal

The Annapurna region covers one of the largest snow leopard habitats within the protected area networks in Nepal (DNPWC 2012). The upper Annapurna region is located in the rain shadow, a cold steppe desert type landscape extending to the Tibetan Plateau in the north (Aryal et al. 2014a). The region is rich in high altitude wildlife such as Snow leopard but also wolf (*Canis lupus chanco)*, Red fox (*Vulpes vulpes*), Blue sheep (*Pseudois nayaur*), Argali (*Ovis ammon*), Himalayan marmot (*Marmota himalayana* and, Pikas (*Ochotona* spp.) (Chetri et al. 2017).

As found globally, and in most parts of the Hindu Kush-Himalayas, the wider Annapurna region is experiencing a dramatic change in climatic pattern in recent decades (Shrestha et al. 2012). The mean annual temperature increases in the area like upper Mustang region between 1987 and 2009 was reported 0.13 °C per year, which is predicted to be doubled to reach 20 °C in 2161 based on the best fit temperature and rainfall model (Aryal et al. 2014a). Such rise in the temperature could result in changes of weather patterns, accelerate glacier retreat and affect the snow leopard habitat (Forrest et al. 2012). A significant loss in high altitude habitat due to ascending tree line shift and shrinking of alpine zone was already reported (Forrest et al. 2012; Lovari et al. 2013; Aryal et al. 2016). It makes it already as one of the major conservation threats to snow leopards and its sympatric species (Li et al. 2016). Such changes have a significant effect not only on snow leopard persistence but also for the entire agro-pastoralism system which makes a dominant source of income for local people. Watersheds downstream are also affected. Additionally, human-induced disturbances such tourism activities, cordyceps harvesting as well as road construction are expected to increase further in the future, which might accelerate habitat alteration and landscape change. The land cover change detection between 1979–2009 using remote sensing imagery showed already a significant loss of grasslands and forest cover in the Annapurna region (Aryal et al. 2014a). We also support the view that such changes could increase human-wildlife interactions such as crop raiding by blue sheep and livestock depredation by snow leopard, all as predicted by Aryal et al. (2014b). But it is highly possible to observe a decrease in livestock depredation from snow leopard and other predators such as wolf in Nepal Himalaya in just 3–4 decades from now. We forecast a significant decline in the livestock number particularly. This will affect yaks and horses in Nepal – including the Annapurna region – due to change in livelihood measures such as tourism, remittance, and services sector growth. The educated generation doesn't seem to continue the traditional livestock rearing culture like the grandparents did. Such trends have already been witnessed in trans-Himalayan valleys of the Humla district such as Limi and Nyinba in Western Nepal (RPL pers. obs.). And so, a similar trend can be observed and predicted in the case of the Annapurna region also. Such changes in socio-economic phenomenon could lead to reduced number of livestock's in the pastures and in the reduction in vulnerability to predation, which might result in higher dependency of predators on wild preys; large and small.

The small mammalian herbivores such as lagomorph and rodents constituted of about 16% of the snow leopard diets in the upper Mustang region (Aryal et al. 2014a, b) and 13.5% in the larger Annapurna-Manaslu landscape (Chetri et al. 2017). The changes in habitat composition over a longer period could lead to the extirpation of many small mammalian species such as pikas *Ochotona* spps. For instance, a sharp increase in local extinction and higher elevational shifting of American pika *Ochotona princeps* was already reported in the Rocky Mountains due to climate change caused habitat loss (Beever et al. 2011), which could be the case in Nepal too. Further, the limited habitat availability might lead to an increase in competition among wildlife species for food and shelter such as blue sheep and other mammalian herbivores, snow leopard and wolf in the region, which provides interesting opportunities to study competition and co-existence among the sympatric mammals.

34.4 Summarizing the Conservation Threats

From global to regional scenarios, it shows that snow leopard habitat is highly vulnerable to be shrinking from an effect of climate change which has emerged as one of the biggest threat to its distribution (Forrest et al. 2012; Aryal et al. 2014a, 2016; Li et al. 2016). Particularly, the Himalayan ranges are predicted to be more vulnerable to climate change including the mountains of Nepal (Forrest et al. 2012; Li et al. 2016). Within Nepal, the area outside of the protected area network such as north-western Nepal (Humla) is expected to face the highest threat of habitat loss for both snow leopard and its prey (Aryal et al. 2016). In the Annapurna Conservation Area, climate change along with human consumptions and development-induced habitat modification is expected to rise human-snow leopard conflicts through increased livestock depredations (Aryal et al. 2014a). With an increase in human-snow leopard conflict, retribution killings of snow leopard are likely to rise in the future. Anywhere in the world big cats such as snow leopard are known to be highly affected by conflict-induced retribution killings (Inskip and Zimmermann 2009). In general, the snow leopards in Nepal might face serious conservation consequences because of an increase in the human footprint and conflict-led persecution for the next few decades but with a reduction in prey base and competition with sympatric superior carnivores such as common leopard and wolf for food and space in the long term (Lovari et al. 2013; Chetri et al. 2017). The climate-induced tree line shift in the high mountains are reported benefiting common leopard with an extension on its range and habitat where the situation is opposite for snow leopard (Lovari et al. 2013). Therefore, our assumption regarding the future of snow leopard, its habitat and prey base is in some way in line with few predicted species-habitat-climate modellings such as Aryal et al. (2014a). But, we believe, based on the changing socio-economic context in the Nepal Himalaya particularly the livestock-based economy is experienced to decline after 3–4 decades, so will the conflict and livestock loss. Thus, we highlight the role of climate change and human consumption as a leading force threatening the survival of snow leopard in a direct way through habitat loss or an indirect way through landscape change and increased interaction and prey base decline.

34.5 The Fate of Snow Leopard Conservation

Though the snow leopard has been downgraded from Endangered to Vulnerable, on the IUCN Red List, some scientist suggests this change to be too premature to celebrate (Ale and Mishra 2018). However, the threats such as human-snow leopard conflict and retribution killings, poaching and trade, prey base decline, habitat loss and fragmentation are widely acknowledged among the scientist's and among range countries government (Snow Leopard Working Secretariat 2013). Thus, priority must be given in mitigating human-snow leopard conflict through conservation incentives (Mishra et al. 2003). Habitat conservation and prey base restoration can be undertaken through a livestock free zone and via a grazing management (Mishra et al. 2003; Jackson et al. 2010). Furthermore, awareness and education programs need to be extended through the promotion of community-level conservation institutions (Jackson et al. 2010). Trans-boundary cooperation must be given a high priority in order to control the trading of snow leopard's parts and to promote travel corridor and connectivity (Snow Leopard Working Secretariat 2013). Eventually, the fate of snow leopard depends on our collective efforts on a landscape-scale in reducing threats and continuous enforcement of conservation programs and engaging the local communities in the fore front by promoting their long-term conservation stewardship.

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Chapter 35
The Fate of the Great Woodpeckers and Hornbills in Nepal: No Big Trees, No Life

Hem Sagar Baral and Falk Huettmann

35.1 Introduction

There are many species of birds in the world that use cavities for nesting. Cavities are usually in trees/plants but also on the rocks, mud, banks, sand, etc. Human housing offers here an entirely new habitat type, e.g. used by pigeons and sparrows. However most cavity-nesting birds use trees and these birds belong to the forest bird communities (Martin and Eadie 1999). Mature primary forests are known to have higher densities of tree-cavities for nesting. Urban areas, or streamlined tree plantations cannot offer such habitats. As the protected areas preserve old growth forests they are teeming with birds that prefer to nest in tree-cavities. Even among the cavity nesters there are primary and secondary cavity nesters. Primary cavity-nesting species are very important as they excavate cavities themselves with the help of their powerful beaks (e. g. woodpeckers) whereas secondary cavity-nesting species depend on the holes made by others or by the limited set of naturally created cavities (e. g. the case for hornbills). For many cavity-nesters, the cavity resource presents a limit for their survival!

It is believed that generally cavity-nesting species have evolved with larger clutches, slower growth rate and less predation when compared to open-nesting species (Martin and Li 1992). The species that only nest in cavities (there are actually

H. S. Baral (✉)
Zoological Society of London Nepal Office, Kathmandu, Nepal

School of Environmental Sciences, Charles Sturt University, Albury-Wodonga, Australia
e-mail: hem.baral@gmail.com

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department,
University of Alaska Fairbanks, Fairbanks, AK, USA

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some more adaptable species that can nest both in open and in cavities), and due to their specified nesting habit and imperilled habitats, can be lacking sufficient nesting holes and then can easily get pushed to the verge of extinction.

Hornbills and woodpeckers are well-known cavity nesting birds; they also occur in Nepal. Of the 57 species of hornbills living in the world (Poonswad et al. 2013), four species have been recorded in Nepal–all with different genera (Table 35.1). The Rufous-necked Hornbill *Aceros nipalensis* was described to science to occur in Nepal (Hodgson 1829) but sadly this species is now considered extirpated from the

Table 35.1 Hornbills and woodpeckers recorded from Nepal

	Physiographic Region
BUCEROTIFORMES	
Bucerotidae	
Indian Grey Hornbill *Ocyceros birostris*	Lowland
Oriental Pied Hornbill *Anthracoceros albirostris*	Lowland
[a]Great Hornbill *Buceros bicornis*	Lowland
([a]Rufous-necked Hornbill *Aceros nipalensis*)	Lowland to Midhills
PICIFORMES	
Picidae	
Speckled Piculet *Picumnus innominatus*	Midhills
White-browed Piculet *Sasia ochracea*	Foothills
Rufous-bellied Woodpecker *Dendrocopos hyperythrus*	Midhills
Indian Pygmy Woodpecker *Dendrocopos nanus*	Lowland
Grey-capped Pygmy Woodpecker *Dendrocopos canicapillus*	Lowland
Fulvous-breasted Woodpecker *Dendrocopos macei*	Lowland to Foothills
Brown-fronted Woodpecker *Leiopicus auriceps*	Midhills
Yellow-crowned Woodpecker *Leiopicus mahrattensis*	Lowland
Scarlet-breasted Woodpecker *Dryobates cathpharius*	Midhills
Darjeeling Woodpecker *Dendrocopos darjellensis*	Midhills
Himalayan Woodpecker *Dendrocopos himalayensis*	Midhills
Rufous Woodpecker *Micropternus brachyurus*	Lowland to Midhills
Lesser Yellownape *Picus chlorolophus*	Lowland to midhills
Greater Yellownape *Chrysophlegma flavinucha*	Lowland
Streak-throated Woodpecker *Picus xanthopygaeus*	Lowland
Scaly-bellied Woodpecker *Picus squamatus*	Upper midhills
Black-naped Woodpecker *Picus guerini*	Lowland to midhills
Himalayan Flameback *Dinopium shorii*	Lowland
Black-rumped Flameback *Dinopium benghalense*	Lowland
Greater Flameback *Chrysocolaptes guttacristatus*	Lowland to foothills
White-naped Woodpecker *Chrysocolaptes festivus*	Lowland
Pale-headed Woodpecker *Gecinulus grantia*	Lowland
Bay Woodpecker *Blythipicus pyrrhotis*	Foothills to Midhills
[a]Great Slaty Woodpecker *Mulleripicus pulverulentus*	Lowland

Notes: [a]Means extinct or globally threatened. A species in brackets means it's already extinct in Nepal country (Inskipp et al. 2016). It is also a globally threatened species (BirdLife International 2018).

For woodpeckers, a total of 239 species have been described from the world (Gorman 2014). Nepal boasts 25 species of varying sizes, colours, and in altitude (Grimmett et al. 2016). The Rufous Piculet is Nepal's smallest and the Great Slaty Woodpecker is the largest woodpecker species. All woodpeckers of Nepal are resident species except the primitive form, the Eurasian Wryneck *Jynx torquilla* which is a frequent passage migrant and winter visitor (Inskipp et al. 2016). The Eurasian Wryneck breeds in northern latitudes well beyond Nepal's geographic boundaries (BirdLife International 2018).

This study will provide an overview for these two species groups, and it will assess whether and how the loss and constraint of habitats – especially in regards to the primary forests with mature stands of trees – results into species loss and reduction primarily focused on hornbills and woodpeckers as the two families of cavity nesting birds in Nepal. We decided to remove the Eurasian Wryneck from the discussion due to its migratory non-breeding status in Nepal. In this paper, we discuss 28 resident breeding species of hornbills and woodpeckers combined.

35.2 Status and Distribution of Woodpeckers and Hornbills in Nepal

After the loss of Rufous-necked Hornbill, Nepal now has just three species of hornbills. All are found only in southern Nepal and they are distributed throughout the lowland but with a patchy occurrence where suitable habitat and conditions exist. Great Hornbill *Buceros bicornis* is the largest followed by Oriental Pied Hornbill *Anthracoceros albirostris* of medium-size and finally the Indian Grey Hornbill *Ocyceros birostris* much smaller in size. Great Hornbill is recently considered as globally threatened by IUCN and has been classified as Vulnerable (BirdLife International 2018).

As the woodpeckers have higher diversity in the country and in the way they are distributed, interesting patterns can be observed. The largest and smallest woodpeckers inhabit the lowland tropical and subtropical forests. The midhills and higher hills provide habitat mostly to medium-sized woodpeckers. The Scaly-bellied Woodpecker *Picus squamatus* is the highest-elevation dwelling woodpecker species in Nepal.

35.3 Spatial Species Variation

Within their range, spatial variation of woodpecker and hornbill species can generally be considered in terms of altitudinal gradient and east-west distribution. Of the 25 species of woodpeckers, nearly one fourth of the species (=six) are endemic to the Indian subcontinent. Indian subcontinent for the purpose of this paper are following countries Afghanistan, Pakistan, India, Nepal, Bhutan, Sri Lanka, Bangladesh and Myanmar. As many as six species are considered 'eastern' (where the distribution does not touch Pakistan) whereas only three species are considered 'western' (where the distribution does not extend to Bhutan/Bangladesh). It is interesting to note that western species are those that only inhabit midhills and higher altitudes. On this background one may probably say that western species are more Palearctic in origin than the eastern species, or subcontinent endemic which are mostly Indo-Malayan in their origin.

Altitudinal variation in terms of Nepal also means north-south variation. Of the 24 resident species of woodpeckers in Nepal, nearly half of the species are confined to the lowlands (Fig. 35.1). In fact, as many as 14 species of woodpeckers and hornbills are totally confined to the lowlands below 500 m. Another four species that extend to foothills and midhills are also found in the lowlands. Surprisingly the midhills are quite rich for woodpeckers where seven species are found only in the midhills and one species in the higher midhills. In addition to these seven, three additional species are also found here, bringing the total to 10. The Scaly-bellied Woodpecker is the highest-dwelling species of all in terms of altitude, and regularly recorded up to a height of 3,700 m (Inskipp et al. 2016). Arguably this is a range where old-growth forest can be found with thick moss layers in the clouds.

On the conservation status assessment of Nepal's birds, three species of woodpeckers are listed as nationally threatened: White-browed Piculet *Sasia ochracea*, Pale-headed Woodpecker *Gecinulus grantia* and Great Slaty Woodpecker *Mulleripicus pulverulentus*, the last species is also considered globally threatened since 2010 (BirdLife International 2018). All these threatened species can be found to in lowland tropical to subtropical forests.

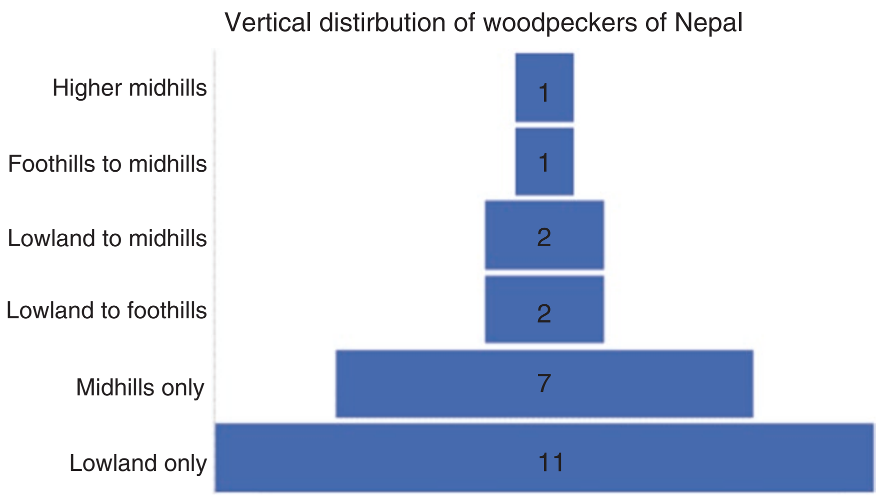

Fig. 35.1 Vertical distribution of woodpecker species in Nepal

The White-browed Piculet is the smallest woodpecker of Nepal. It is described as a rare resident mainly inhabiting central and eastern parts of Nepal and is said to inhabit the dense low vegetation in broadleaved forests often close to a water source (Inskipp et al. 2016). Chitwan National Park in central Nepal is actually the only protected area from where most of its recent records have come. The western limit of its world distribution ends in the Chitwan valley and associated hills. The Pale-headed Woodpecker is perhaps the rarest of all woodpeckers in Nepal. It has been recorded only two times in the south-eastern lowland forests, the last record was in 1981. The species is said to be dependent on lowland bamboo forests, most of which has been destroyed in Nepal; also, Nepal is on the edge of its westward distribution. And even if the species exists in the country, its population will be very small. It is listed as Critically Endangered in Nepal's national red list on birds (Inskipp et al. 2016).

The Great Slaty Woodpecker is considered as the largest living species of woodpecker in the world (Lammertink et al. 2009, Martjan Lammertink in litt to Hem Sagar Baral 2011). Two larger species, Imperial *Campephilus imperialis* and Ivory-billed Woodpeckers *C. principalis*, found in the southern part of North America down to to central America, and although kept as Critically Endangered in the IUCN red list (BirdLife International 2018), have possibly gone extinct from the world already in the mid to late twentieth century (del Hoyo et al. 2002). And even if a few sightings were made, they are not verified with acceptable photos nor can such few individuals even reproduce well and sustain themselves in a formerly and documented wide spread range. Ivory-billed Woodpecker, slightly smaller than the Imperial, was primarily found in the south-eastern United States and with a subspecies in Cuba. Arguably forest loss in the breeding and winter habitats is to blame lacking big trees to build nests in. Dwindling populations were noted as early as the early 1900s, still the most powerful and richest nation on the earth failed to save a species on the verge of extinction while development, urbanization, and forestry kept rising to cater economic gains. Such is the dilemma and difficulties of saving species on the verge of extinction and when they rely on old-growth forest wilderness landscapes and big trees. The prime factor for the possible extinction of the two species is clearly attributed to habitat loss. A country like Nepal and others in the range where the Great Slaty Woodpecker range is found will be faced with similar challenges trying to save this globally declining species even with less research and resources at their disposal. Results from a Nepal survey have already indicated that this species may have a smaller population than predicted globally (Baral 2011). How can we save this species before they are critically threatened?! Habitat remains the key questions here. If we do not think along this line then we may also lose this species in another 40–50 years.

Nepal's recent assessment on hornbills has put 2 out of 4 species as threatened on a national level (Inskipp et al. 2016). The Rufous-necked Hornbill has been already extirpated from the country and is also a globally threatened species (BirdLife International 2018). Considering the species was actually described to western science from a specimen collected from central Nepal (Hodgson 1833), the loss of this species from Nepal is rather tragic notwithstanding its scientific name.

This species was unique in the sense that it roamed not only the lowland forests but also the midhill forests of Nepal. Before 1950, as the midhills were the most populated region of Nepal for this species, the species got exterminated possibly due to disturbance, hunting and habitat loss (del Hoyo et al. 2001; Inskipp et al. 2016). Of the remaining species, all of them are exclusively lowland forest hornbills. The Great Hornbill deserves a special mentioning as it is the largest forest hornbill of the world and it is declining globally. For a number of years, the species featured as Near-threatened in IUCN Red List but a review in 2018 prompted reviewers to put it under Vulnerable threat category (BirdLife Internatioanl 2018). Nationally, Nepal has declared the species as threatened for a number of years already (Baral et al. 1996; Baral and Inskipp 2004; BCN and DNPWC 2011; Inskipp et al. 2016, 2017) and the Nepali government enlisted the species as protected in National Parks and Wildlife Conservation Act 2029 – the main act that protects Nepal's biodiversity – which was enacted in 1973 with additional eight species of birds (Table 35.2). A recent more comprehensive work by DNPWC has recommended as many as 40 species of birds to be included in the Appendix 1 of the National Parks and Wildlife Conservation Act 2029 in the proposed sixth amendment (DNPWC 2018).

Further, Nepal's detailed assessment on this bird shows that what was once a continuous distribution for this species, is now just a small but viable population mainly found in Chitwan valley followed by much smaller populations in the south-western Nepal in the Bardia and Shuklaphanta National Parks. Although recorded also outside protected areas (Inskipp et al. 2016), habitat loss and hunting are so rampant that the bird's future in these isolated populations remains uncertain and rather bleak. Therefore, this hornbill species that requires undisturbed, mature old growth sal forests is now just left concentrated in the best protected park of Nepal, the Chitwan National Park.

Elsewhere in the world, many studies have been made about cavity-nesting birds, and which species play a key role in constructing the nests, thereby not only making home for the 'driller', but also for myriad of other species, even beyond birds (Saab

Table 35.2 Bird species listed in schedule I of NPWC Act 2029 (1973)

White Stork *Ciconia ciconia*
Black Stork *Ciconia nigra*
Himalayan Monal *Lophophorus impejanus*
Satyr Tragopan *Tragopan satyra*
Cheer Pheasant *Catreus wallichii*
Bengal Florican *Houbaropsis bengalensis*
Lesser Florican *Sypheotides indica*
Sarus Crane *Antigone antigone*[a]
Great Hornbill *Buceros bicornis*

[a]The scientific name for this species printed on the gazette as *Grus grus* is a mistake and belongs to Common Crane; it needs to be instead *Antigone antigone*

et al. 2004). There is an entire succession of species and ecological processes that make use of those cavities. It comes without big surprise then that a recent study on tree cavities in a lowland forest in central Nepal, woodpeckers have been considered as very important cavity providers for secondary users (Bhusal et al. 2015; Baral et al. 2018). In another study the relationship of fungus and woodpecker nest cavities has been described. Fungal attack soften the wood area for quicker decay for woodpeckers to chisel and to make cavities and at the same time woodpeckers help spread the fungus to other areas in forests as their beaks have been found to carry fungal strains in larger amount compared to other bark-feeding bird species (Farris et al. 2004). Clearly, woodpeckers play a keyrole to maintain ecological old-growth forest processes!

In nature, every species has a role in a given ecosystem. Woodpeckers and hornbills are prominent species of forest ecosystems. Hornbills are, biologically-speaking, one of the most fascinating bird families of the world and are also very charismatic species in the public eye (Poonswad et al. 2013). Both Hornbills and woodpeckers are good indicators of the diversity and health of wooded habitats, specifically old-growthness. They are particularly suitable as indicators because they are diurnal and usually sedentary, making them arguably better indicators than migratory songbirds which are often affected by conditions elsewhere and with a lag effect. Many woodpeckers can also be considered as keystone species – animals that play an important overall role in an ecosystem—as other wildlife benefits from their cavities and activities. Further, keystone species have been defined as those that exhibit a disproportionate influence over the structure and function of their community due to some specific life-history trait or interactions with other species (Paine 1969). A lack of tree cavities can hinder secondary cavity-users (species that use tree holes as breeding or sleeping sites, but which cannot excavate themselves) (Gorman 2014). Examples of these in Nepal include some ducks, owls, hornbills, trogons, and several species of songbirds.

There are many aspects of hornbills and woodpeckers that are benefiting also the human beings. For instance, woodpeckers are known to feed on insects, grubs and beetles. If left unchecked a lack of woodpecker populations can likely result into the fact that the insects' population increase on a scale that could be quite harmful to humankind and their livelihoods. For example, there could be a loss of crops/ fruiting trees or vegetables due to the invasion of insects. Entire forested landscapes are known to be affected. Woodpeckers are part of healthy landscapes and they can help to control such pest populations. Woodpeckers have inspired human kind even after we learned how to fly in the manner of birds! The protective shells of 'black-box' flight recorders and various electronic devices and crash-helmets have all been modelled on woodpecker heads and skulls (Gorman 2014).

Most hornbills and woodpeckers are threatened because of the loss or degradation of wooded habitat combined with poaching especially in terms of hornbills (Poonswad et al. 2013; Gorman 2014). Due to their large sizes, interesting looks and characteristic far-carrying sound, hornbills have drawn human attention for a long period of time (del Hoyo et al. 2001). Further, Rufous-necked Hornbill's decline all over its range is also credited to specific hunting pressure. For the lowland-dwelling

Great Hornbill it can also be easily guessed that it has declined in the country due to hunting pressure. Fleming et al. (1984) writes that it is quite shy and frequently hunted by villagers who claim its oil will restore and cure hair loss in humans. The other possible but still not understood threat is climate unpredictability. Climate change has been affecting a suite of birds more than others. Studies elsewhere in the world have found that birds that feed on insects and their larvae have been highly affected. Climate change and its impact to hornbills and woodpeckers would be a fascinating subject as to how this two different suite of cavity nesting birds feeding one on fruits and the other almost exclusively on worms and insects. Similarly it is yet to be explored how the yearly and repeated forest fires in protected area as well as outside the protected area affect woodpeckers in terms of their nesting-cavities and food supplies.

The Timber Corporation of Nepal (TCN) – established in 1954 with the Royal blessing at the time– set the beginning of major systematic destruction of large trees in Nepal. This practice was supposed to be a management scheme and done in a somewhat sustainable fashion. But when big old trees are harvested, such schemes tend to fail and turn exploitive, as the global evidence shows and large wood peckers and hornbills can attest to. It was a massive undertaking with a slow beginning but soon flourished during the reign of the Panchayat System, especially in the 1970s creating quick cash income to appointed groups. During this time many old, stunted, diseased trees with cavities were rampantly fell down by the TCN. These trees were, perhaps the most important habitat that provided shelter and food, for woodpeckers, and partly hornbills. Habitat wise not only woodpeckers but also other primary as well as secondary cavity-nesters lost their habitat. These include barbets, bee-eaters, kingfishers, rollers, owls, parakeets, starlings, etc. Forests were cleared to settle ever land-hungry people in the name of land-less citizens, and ‘progress’. Virtually anybody who claimed to be ‘landless’ received a landless status by the government. That’s because the government had no mechanism really to check against false claims, and cutting trees helped monetary gains too. Part of this phenomenon still continues today with support from some political leaders who persevere ‘landless and poor’ as their vote bank.

Afforestation work in Nepal through the community forestry programme is lauded as a success, not only nationally but globally. While many communities were handed over nearly bare hills with a few scattered mother trees here and there, as part of community forest, there were some communities that have also received good condition old-growth forest including high value sal trees; especially in the lowlands. Where the bare hills and lands were transferred, community members have put great effort restoring the original vegetation in many places. However, the meaning of conservation everywhere especially in community forests that hold a large amount of mature trees, has come with great cost to cavity nesters. Afforestation does not mean at all ‘old-growth forests’; far from it. And according to the constitution of the most community forestry groups, trees can be felled with appropriate permission if old, decaying, or dead. These are the most important nesting sites and food source though for many of the cavity nesting birds (Widman et al. 2003). Old trees provide the ecology structure! If forest groups have to utilise a tree, then again rather than cutting a ‘green tree’ they will cut a ‘brown tree’ (=an old tree), likely to be the most suitable nest tree for woodpeckers or hornbills. Old trees obviously provide not only home to cavity nesting birds but also home to their prey-base such as ants, termites and other insects.

Woodpeckers and hornbills are all about old growth primary forests. They need these mature trees and landscapes for food and nests. Research carried out in community managed forests have advised community groups to cut green trees when in need rather than brown if the community is really to benefit from biodiversity gains of having forests nearby, especially benefiting cavity nesting vertebrates as well as insects (Widman et al. 2003; Bhusal et al. 2015). Although some difference in woodpecker communities have been noted between protected park and community managed forests (Bhattarai 1998; Bhusal et al. 2015), the importance of community managed forests is very complimentary to even more important protected park forests which happen to preserve the natural structure of cavity-nesting bird communities. Such old-growth forests are known to be essential for water management and provide a carbon sink! Community-managed forests continue to improve towards preserving old and mature trees that can help many of our cavity nesting birds as suitable dispersing and breeding areas in addition to the well-protected national parks and reserves.

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Chapter 36
Poaching and Illegal Trade of Wildlife: What Do the Media Say for the Nepali-Chinese and Nepali-Indian Border?

Ganesh Puri, Yajna Prasad Timilsina, Falk Huettmann, Ganga Ram Regmi, and Rinzin Phunjok Lama

36.1 Introduction

The term 'wildlife trade' mostly refers to a legal practice. It covers a wide spectrum of everyday activities and products, for instance, timber used for furniture or building materials, exotic flowers, plants or pets, 'wild' ingredients sourced for medicines and cosmetics, clothes, shoes or bags made from reptile skins. Almost all sea life (other than farmed fish) is obviously wild too. So, most people, whether we think about it or not, are involved in wildlife trade in some way – even if it's just as end consumers of wild products. Wildlife trade only becomes a problem, when the trade becomes unsustainable and puts the future survival of a species at risk (Dongol 2015). Often such

G. Puri (✉)
Department of Forests, Ministry of Forests and Environment, Government of Nepal, Kathmandu, Nepal
e-mail: gpuri.forestry@gmail.com

Y. P. Timilsina
Institute of Forestry, Tribhuvan Univeristy, Pokhara, Nepal

F. Huettmann
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA

G. R. Regmi
Third Pole Conservancy, Kathmandu, Nepal

R. P. Lama
Third Pole Conservancy, Kathmandu, Nepal

Workgroup on Endangered Species, J.F. Blumenbach Institute of Zoology and Anthropology, Georg-August-Universität Göttingen, Göttingen, Germany

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trade is on an industrial scale and even linked with other criminal actions such as drugs. The illegal trade in wildlife and timber has escalated rapidly and globally, and now encompasses a wide range of flora and fauna across all continents, including terrestrial and aquatic animals, forest and other plants and their products. Overall global environmental crime, which is worth up to US $213 billion a year, is helping finance criminal, militia and terrorist groups, threatening the security and sustainable development of many nations (Steiner 2014). The increased threat of poaching has been one of the major challenges in conserving several endangered species including the rhinoceros, tiger and leopard in their natural habitat. Lately, there has been an unprecedented rise in poaching of large mammals, trade in their parts and destruction of their habitat. This has raised concerns about their threat of extinction (Bhuju et al. 2009).

Poaching of protected wildlife species began long before the present national parks and wildlife reserves were gazette notified. Poaching records show that prime targets for poachers are one horned rhinoceros (*Rhinocerous unicornis*) followed by spotted deer (*Axis axis*), wild boar (*Sus scrofa*) and then tigers (*Panthera tigris*). While rhinoceros and tigers are killed for the value of their horn and bones, deer and boar are hunted for meat by local people (Chaungyalpa 1998). Layers of networks play their roles in this lucrative illicit business, players range from those luring local shooters to middleman and international smugglers to illegal sellers and finally to consumers (DNPWC 2007).

International trade in wildlife is the principal cause of biodiversity loss, involving hundreds of millions of plants and animals each year (Bhuju et al. 2009). Yet, wildlife trade records are notoriously unreliable (Blundell and Mascia 2005). Accurate wildlife trade data on bio-security are essential in managing sustainable trade and border issues because the data contribute to issues such as intelligence, enforcement, monitoring and decision making (Gearson et al. 2008). Illegal trade is directly correlated with demographic factors, potentials for profit and lack of adequate resources for law enforcement (MFSC 2007).

In Nepal, trade in wildlife parts and live animals is geared mostly toward international market rather than local market. Nepal is not regarded as a major consumer of wildlife; however, it is used as a source and as a transit point for the international wildlife trade (Shakya 2004). Nepalese territory acts as a “safe passage” or “gateway” for smuggling contrabands to and from China’s Tibetan Autonomous Region in the north, and India in the east, west and south (Aryal 2004). For traditional medicine, and ornaments, China has found India along with other south Asian countries as its source for wildlife parts. In this covert trade, Nepal suffers more by being both transit and source point where Tibetans, Nepali and Indian traders and poachers all operate (Yonzon 2006).

The majority of poachers come from local ethnic communities. The average poacher is a local villager who earns many times more than a year’s income from the yield of one poaching (Bhuju et al. 2009). Often poaching is perceived as an isolated incident. In actuality, there is an intricate relationship involving middlemen, wildlife product dealers, traders and consumers (Chaungyalpa 1998).

The routes used by wildlife smugglers are often complex, making it difficult for the authorities to track and intercept shipments. Therefore, wildlife trade involves serious offences, many committed by serious offenders (Cook et al. 2002). Most illegal wildlife trade occurs outside protected areas and beyond the jurisdiction of wildlife authorities, calling for coordination and cooperation among several departments and line agencies of the government (Bhuju et al. 2009).

Biodiversity conservation issues are beginning to gain prominence in the media. According to Global Sherpa (2011), internationally, media coverage of environmental conservation and biodiversity has experienced a steady increase since 1990, when it hardly showed up in newspapers. The newspapers' usage of the term biodiversity has grown to nearly 0.1 articles per newspaper in 2000 and 0.2 articles per paper in 2010. The role of media in building environmental friendly civil society and practically assisting in solving local problems by providing the public and decision makers with information for informed participation in decision-making is crucial (CEPF 2004). Most citizens get their information on the government through the media. According to Hesselink et al. (2007), to have an agency's messages reach the general public, the agency has to build a sound relationship with the media. The press is thus an important channel to reach decision-makers and opinion leaders (GreenCom 2001). For example, reportedly, newspapers and television news is the best channels for reaching urban opinion leaders, while national and local radios are best for reaching rural audience (GreenCom 2001).

The problem in part has been insufficiency of environmental information in printed and electronic media and the lack of depth of writers on the subject (Ongkili 2004). Such contributions by the press according to Ongkili (2004) have been adhoc and the problem sounding rather than problem solving. Media reports on the environment always focus on crisis or problems. The quality of environmental journalism and broadcasting is usually fairly poor (GreenCom 2001). The media's appetite for confrontation and bad news continue to make it difficult to reach out with positive messages in editorial media, creating a need for much more direct (unmediated) engagement with stakeholders (Kitchin 2010).

In general, media helps the community in different ways. Often the community does not go to the authorities directly, but tries to solve an issue by themselves, no matter how serious it is. In such a situation, journalists provide information relating to illegal wildlife trade and poaching that has happened in the community (Gurung 2011). However, there have not been any significant research seeking to understand the media's treatment of illegal wildlife crime in the Nepalese environment or the frameworks or models developed that may explain the media's approach. The Nepalese media outlets mostly cover news relating to current affairs, politics, business, technology and arts (Adhikari et al. 2011). A study about the news content has highlighted that Nepalese media are not balanced in reporting news because of the dominance of current affairs and politics, business and technology and the arts and culture respectively (Adhikari et al. 2011). Whereas the frames used in the media release from the government agencies and news reporting of the media itself vary according to the primary roles.

Newspapers actually are key actors in the identification and interpretation of wildlife trade issues (Boyko and Boyko 2007). Therefore, the coverage of wildlife trade issues in newspaper is becoming essential. Covering trade stories in newspapers helps to increase public attention in wildlife importance and its conservation. Sometimes, media are quick in breaking news, which leads to negative impact.

When news is disseminated, smugglers or other culprits hide or cross national international borders. However, overall, media had played an active role in creating public awareness and alerting government officials and traders (Bhuju et al. 2009). The nature and level of reporting of wildlife trade news is one of the most important factors to influence the perception and understanding of the wildlife value. Wildlife crime news is generally extracted by publisher through field based investigations by reporters and/or from press release statement by concern authorities (Personnel Com). In Nepal, the environmental journalism evolved during late '70s but started in organized way only after the establishment of NEFEJ in 1984 AD (Shrestha 2008). Nowadays, some newspapers are covering wildlife issues by separating a different beat for environment.

Nepal publishes newspapers in as many as 40 languages with Nepali and English being the most dominant. Predominantly, these are published from the capital city of Nepal i.e. Kathmandu. Currently there are 29 national dailies are published (e.g. Gorkhapatra, The Rising Nepal, Nagarik, Republica, Kantipur, The Kathmandu Post, Annapurna Post, The Himalayan Times, Nepal Samacharpatra, Rajdhani Daily, Naya Patrika, Karobar Economic Daily, Aarthik Abhiyan Daily, Aarthik National Daily, Nigrani Daily, Blast Times, Pratidin Daily, Rastriya Samachar Patra, Nepali Times) (PCN 2013). Unlike in many other emerging economics, the press is free in Nepal and the government does not exercise any control over its free and fearless functioning. However, a few national dailies like Gorkhapatra, Nagarik, Kantipur, and Annapurna Post belong to the big business and industry house that might have their own ideologies. Gorkhapatra and The Rising Nepal are the only two governmental newspapers in Nepal which are oldest too published by Gorkhapatra Sansthan. They were launched as weekly newspapers in May 1901 but have been published as dailies from 1961(GS 2015). Kantipur Publications (non-governmental) has a deep-seated belief in the power of democracy and freedom of press as agents of social change. It publishes seven different newspapers. It has two national dailies i.e. Kantipur in Nepali and the Kathmandu post in English started in 1993 (KP 2015).

36.2 Illegal Wildlife Trade: A Common Conservation Problem in HKH and Worldwide

Illegal wildlife trade is a global conservation challenge (Wyler and Sheikh 2013; Brown and Davies 2014). Many charismatic species including tiger (*Panthera tigris*), rhinoceros (*Rhinoceros* sp.), and snow leopard (*Panthera uncia*) are threatened with extinction (Baillie, et al. 2004). For instance, wild tigers numbered over 100,000 a century ago, now reduced to a few hundred surviving individuals (Banks et al. 2006). Similarly, numbers of rhinoceros have been reduced by more than 90% since the beginning of the twentieth century (STRI 2015). Illegal wildlife trade is among the leading causes for rapid wildlife species decline globally (McMurray 2008). It is also an industry rooted in illegal networks that transcend international borders and generate billions of dollars of revenue annually (Broad et al. 2003; Dongol and Heinen 2012; Wyler and Sheikh 2013; Brown and Davies 2014; CITES 2014).

Asia is considered as the region with the highest demand for wildlife parts and an illicit trade on wildlife is flourishing in the region, particularly in the Southeast and South Asia (Wyler and Sheikh 2008). Despite the considerable national, regional and international efforts to control illegal wildlife trade, wildlife parts are traded extensively for meeting demand in oriental countries including China (Dinerstein et al. 2007; Wyler and Sheikh 2008; Stoner and Pervushina 2013). In China, wildlife demand is high for different purposes such as medicines and supplementary diet, which are fulfilled from neighboring countries including India and Nepal (Yi-Ming et al. 2000). India is also considered as a resource center for illegal wildlife trade since it harbors enormous biodiversity including rhino, tiger, and others. Although Nepal is a small country compared with China and India, it plays a vital role as a provider of illegal wildlife resources, thereby endangering its biodiversity. Due to the clandestine nature of the illegal wildlife trade, it is difficult to understand the prevailing extent of illegal wildlife trade and driving factors behind it.

Nepal is facing a persistent challenge in combating the illegal trade in wildlife, which is demanding a multi-facet solution (Brown and Davies 2014). However, conservation effort in the country has a promising prospect for success in restoring some flagship wildlife species such as Bengal tiger (*Panthera tigris tigris*) and Indian rhinoceros (*Rhinoceros unicornis*) (WWF 2014). Enforcement agencies have accelerated their field activities across the country and have been successful in number of seizures and arrests related to the illegal trade of wildlife (DNPWC 2014).

36.2.1 Role of Nepali Print Media in Revealing Illegal Wildlife Trade Information

Illegal wildlife trade becomes visible to the outside world mainly when concerned authorities disclose reports of seizures. Additionally, the existing limited information on illegal wildlife trade is often focused on particular wildlife species, but time series and analyses of trends are lacking (Felbab-Brown 2011). This study attempted to understand the nature of illegal wildlife trade in the Nepal, providing baseline information on it. Furthermore, discussion of print media involvement on wildlife crime cases can be helpful to gain understanding about the media attentions and general public awareness level. Therefore, this study was significant to find out ground reality of wildlife trade scenario in launching wildlife conservation program effectively and recommend proper action for the wise use of media in nature conservation in days to come.

Nepalese print media is an important source of wildlife crime information but researchers have paid little attention to it. Very few studies have been done on illegal wildlife trade in Nepal but media related study is virtually none. Among many of its different roles, the media has social audit as its vital role. Moreover it should provide honest, broad-based, specific, and appropriate information to the people about wildlife illegal activities. However there is no any measure how aware news publishers are about wildlife trade and wildlife news quality.

With this background, this study was carried out to understand the nature of illegal wildlife trade in Nepal through print media data sources. It tried to assess the existing scenario of illegal wildlife trade in Nepal, specifically in relation to the targeted wildlife species and various wildlife parts that are being traded, to understand social characteristics of groups that are involved in the illicit activities and route generally they used for trade, and to find out attention towards wildlife crime cases.

The study's geographical scope focused on Nepal. Under the main stream print media the study paid special attention to newspapers that are currently the most trusted, most available and the most influential section of the media: the Kantipur and the Gorkhapatra. Time scope of the study was the whole 5 years of 2011–2015.

36.3 Materials and Methods

36.3.1 Research Design

The research design applied retrospective study design. A retrospective study generally means to take a look back on events that have already taken place. Secondary data used in this study were extracted from the *Gorkhapatra* and the *Kantipur* newspapers articles for the whole 5 years of 2011–2015.

36.3.1.1 Study Area

The focused area of the study is the whole Nepal. Located between two large Asian countries, Nepal shares border with China to the north and the remainder with India. The Great Himalayan range runs along the entire northern region, providing a geographical barrier to china, as a result of which, there are very few roads connecting the two countries. The borders with India to the south, east, and west, however, are very porous. The southern belt consists of plain lands known locally as the Terai region and is a part of the Indo-Gangetic plains. The mid region consists of mountain ranges known as Mahabharat range (also known as Lesser Himalayas) and Sivalik range (also known as Outer Himalaya). Owing to this elevation gradient from south to north, the country has diverse climatic conditions, ranging from tropical in the south to alpine in the north.

The study specifically targeted both the Gorkhapatra and the Kantipur newspapers for all the 5 years from 2011 to 2015, with a special focus on news related to illegal wildlife trade.

36.3.2 Data Acquisition and Analysis

In order to find out answers to the research question about illegal wildlife trade in Nepal through print media, content analysis was applied to two Nepalese newspapers which were chosen on the basis of their popularity, ownership structures and validity of news. Purposive sampling was used to select stories that contained materials that I found useful for this study. The study deliberately targeted newspaper stories containing illegal wildlife trade news from both the Gorkhapatra and the Kantipur national dailies.

The data collection procedure used for the study was based on a document review method. It was used to extract the necessary information (news articles) from the respective newspapers. The data were collected through scrutiny of the newspaper articles.

Developing the data extraction tool was the last step in designing the study after all variables, and their indicators of interest had been identified. The tool was made as simple as possible and was used to collect the most relevant information to ensure accuracy and validity.

Data extracted were coded to facilitate ease of analysis. The coded information was further recorded in the code sheet. In coding, each newspaper article was given a serial number (for example in G/Y/M/D/N/I), the G was coded for Gorkhapatra while Y/M/D for the date the news appeared (this would vary from 1st January 2011 to 30th December 2015) and N represented the number of total news and I for number of wildlife trade news on that particular day. The name of the newspaper, the date of publication of the item and the page number on which it was published were noted. Each item was codified into a trade and poaching sub-discipline based on the headline and the content. Also, on each clipping the type of item (story or article), visual/s, if any, number of column spread and quantum of space measured in square centimeters (cm^2) was recorded.

Between November and December 2015 data was collected on seizures and arrests from news published in the Gorkhapatra and the Kantipur national dailies. The newspapers have published all the data of seizures and wildlife crime cases prosecuted. The news information included case, seizure date and location, wildlife species and parts, quantity of seized parts, price of the wildlife parts, from where the parts were obtained, intended uses, and destination. Multiple wildlife species and animal parts confiscated during a seizure were combined under on case number.

The information collected on suspects involved in wildlife trade news included name, address, gender, age, ethnicity, origin of criminal data. However, in some news some information such as age and gender of arrested people were missing. Various issues concerned with wildlife trade published in selected newspapers were captured photos from the main newspapers for further analysis. The data collected (extracted) were neatly sorted and then coded according to the objectives, after which it was analyzed using document analysis and thematic analysis techniques, based on the emerging issues (themes) under the study. The results were then presented in the form of frequency tables, narrative, pie charts and bar graphs; this ensured uniformity in presentation and enabled ease of interpretation and conceptualization of the presented results and findings. Based on the information collected during the desktop review, data were analyzed as follows.

36.3.3 Illegally Traded Wildlife Species Identification

A table of illegally traded wildlife species was prepared by sorting information of wildlife crime news. Scientific names of the wildlife species were identified reviewing literature and books based on local names. However some animals could not be identified to a species level and were reported as 'unidentified'.

The version 2014.3 of the IUCN red list of threatened species was followed for assessing the global conservation status of the wildlife species. The database on the Checklist of CITES species maintained by United Nations Environment Program – World Conservation Monitoring Center (UNEP – MCWC) was followed to assess CITES Appendix of the species. Similarly, the national protection level of the wildlife species was assessed based on the National Parks and Wildlife Conservation (NPWC) Act 1973 received from the official website of Nepal Law Commission.

36.4 Results (Table 36.1)

Table 36.1 Wildlife species poached and traded in Nepal from 2011 to 2015

S.N	Common name	Scientific name	Taxonomic Serial Number (TSN)	IUCN	CITIES	Nationally protected
1	Chinese pangolin	*Manis pentadactyla*	584931	Critically Endangered	II	Yes
2	Tibetan antelope	*Pantholops hodgsoni*	625113	Endangered	I	Yes
3	Asian Elephant	*Elephas maximus*	584938	Endangered	I	Yes
4	Swamp Deer	*Rucervus duvaucelii*	898209	Endangered	I	Yes
5	Himalayan Musk Deer	*Moschus chrysogaster*	625039	Endangered	I	Yes
6	Red Panda	*Ailurus fulgens*	621846	Endangered	I	Yes
7	Rhinoceros	*Rhinoceros unicornis*	625005	Endangered	I	Yes
8	Snow leopard	*Uncia uncia*	183811	Vulnerable	I	Yes
9	Royal Bengal Tiger	*Panthera tigris*	183806	Endangered	I	Yes
10	Eurasian Wild Bore	*Sus scrofa*	180722	Least Concern		

(continued)

Table 36.1 (continued)

S.N	Common name	Scientific name	Taxonomic Serial Number (TSN)	IUCN	CITIES	Nationally protected
11	Leopard Cat	*Prionailurus bengalensis*	552763	Least Concern	II	Yes
12	Spotted deer	*Axis axis*	552474	Least Concern		
13	Porcupines	*Hystrix* spp.	825287	Least Concern		
14	Northern Red Muntjac	*Muntiacus vaginalis*	898562	Least Concern		
15	Golden Monitor lizard	*Varanus flavescens*	202169	Least Concern	I	Yes
16	Himalayan Goral	*Naemorhedus goral*	625149	Near threatened	I	No
17	Eurasian Otter	*Lutra lutra*	621916	Near threatened	I	No
18	Common Leopard	*Panthera pardus*	183804	Near threatened	I	No
19	Bear	*Ursus* sp./ *Melursus* sp.	180541	Vulnerable	I	Yes
20	Black buck	*Antilope cervicapra*	552478	Vulnerable	III	Yes
21	Nilgai	*Boselaphus tragocamelus*	552477	Vulnerable	No	No
22	Bat	Unidentified				
1	Great Hornbill	*Buceros bicornis*	554426	Critically Endangered	I	Yes
2	Bengal Florican	*Eupodotis bengalensis*	176435	Endangered	I	Yes
3	Impeyan Pheasant	*Lophophorus impejanus*	176067	Least Concern	I	Yes
4	Little egret	*Egretta garzetta*	174816	Least Concern	No	No
5	Kalij pheasant	*Lophura leucomelanos*	553882		No	No
6	Vulture	Unidentified				
8	Owl	Unidentified				
1	Sea horse	*Hippocampus* spp.	166487		No	No
2	King Cobra	*Ophiophagus hannah*	700646	Vulnerable	No	No
3	Asiatic Rock Python	*Python molurus*	202187	Vulnerable	I	Yes

36.4.1 Seizure of Primary Wildlife Parts

A wide variety of wildlife parts had been seized from traders, poachers and middlemen (Figure). Skin of tiger and leopard, horn of rhino and scales of pangolin were the most dominant primary wildlife parts seized by enforcement agencies (Figs. 36.1, 36.2, and 36.3).

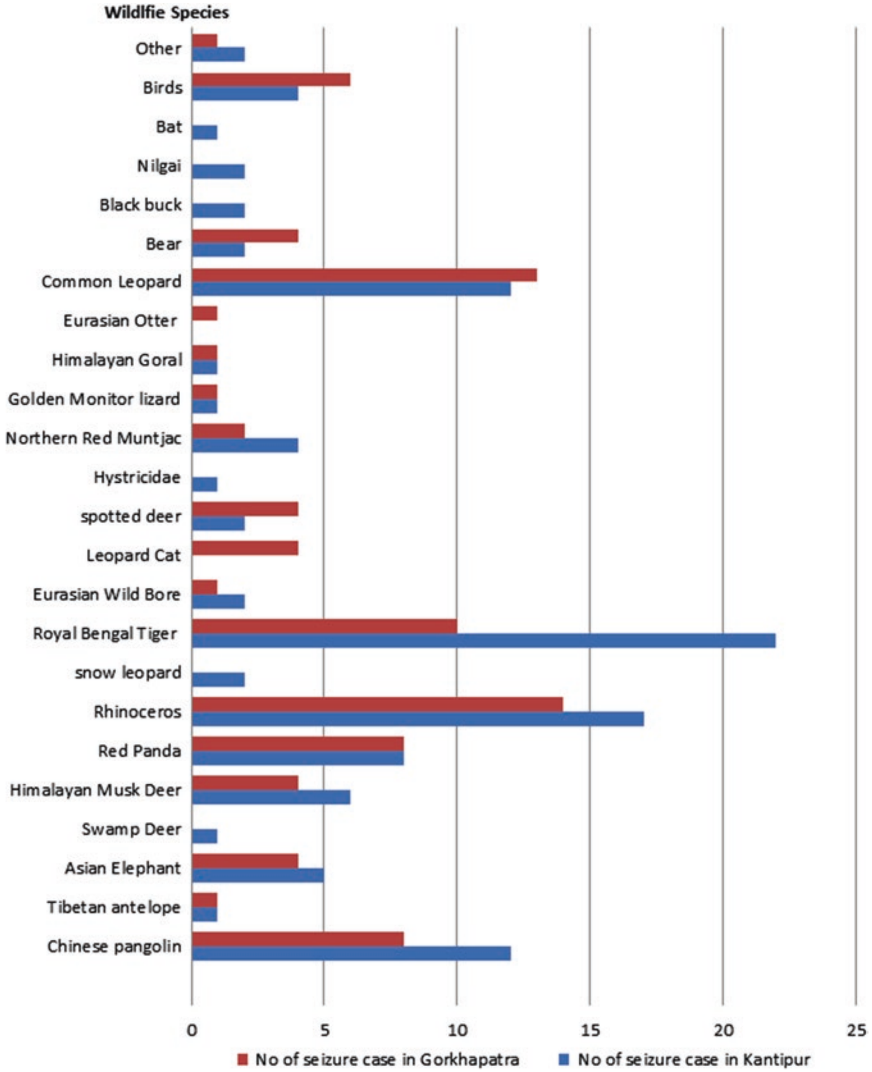

Fig. 36.1 Frequency of wildlife traded and poached from 2011 to 2015 in Nepal

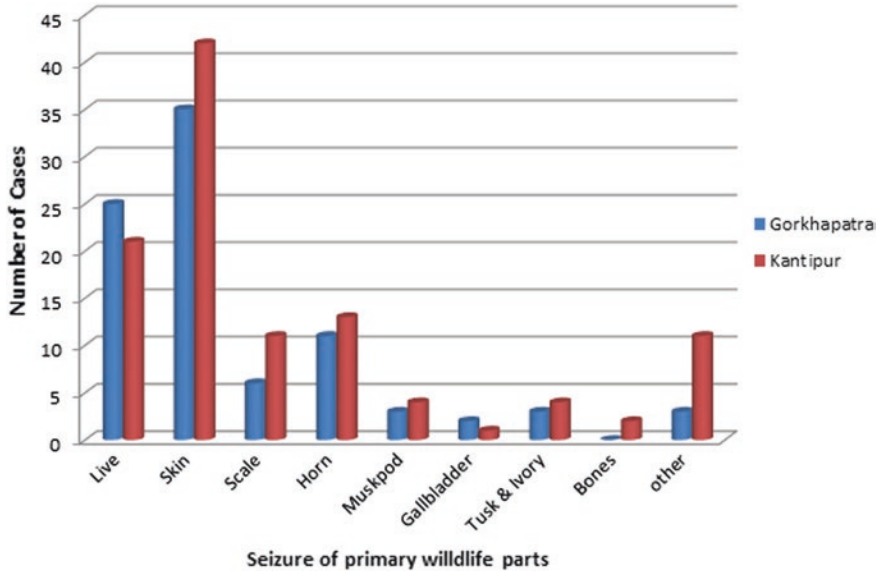

Fig. 36.2 Primary wildlife parts seized in Nepal from 2011 to 2015

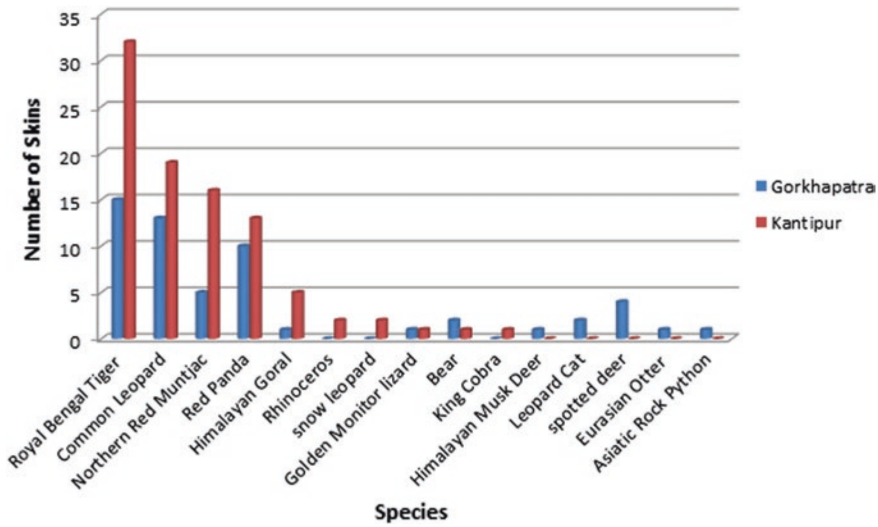

Fig. 36.3 Species details of wildlife skins seized from 2011 to 2015 in Nepal

36.4.2 Temporal Trends in Seizures and Arrests (Fig. 36.4 and 36.5)

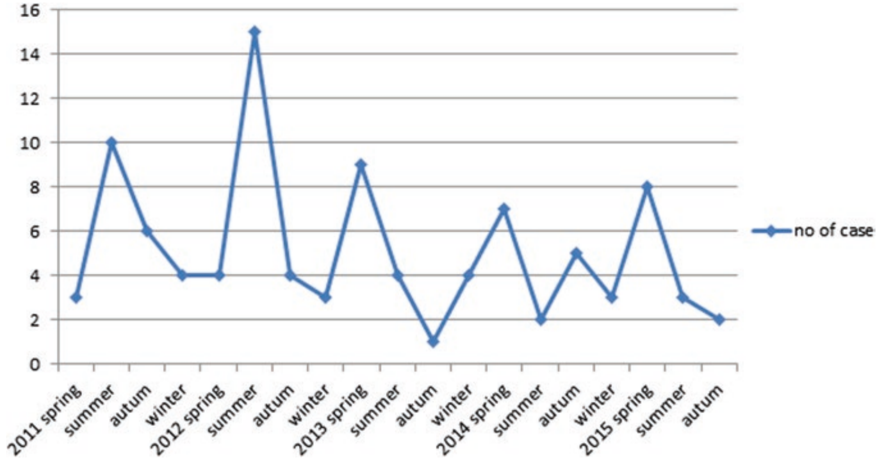

Fig. 36.4 Temporal trend of wildlife crime cases based on seizures and arrests over the years from 2003 to 2013

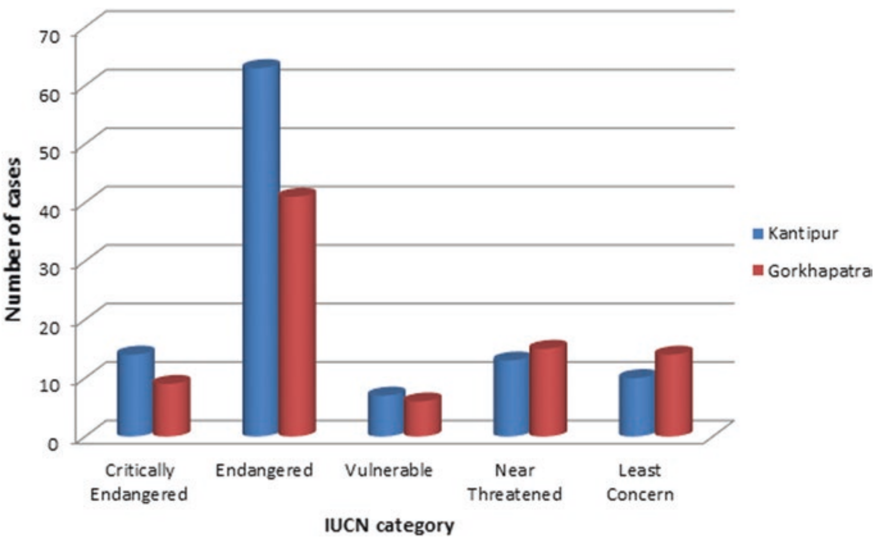

Fig. 36.5 Number of wildlife crime cases from 2011 to 2015 based on the IUCN red list of threatened species category

36.4.3 Vulnerable Districts

Among 75 districts of Nepal 53 districts have crime cases where Chitwan, Kathmandu, Sankhuwsabha, Morang, Bardia and Sindhupalchowk are more vulnerable than others districts for wildlife crime (Figs. 36.6 and 36.7).

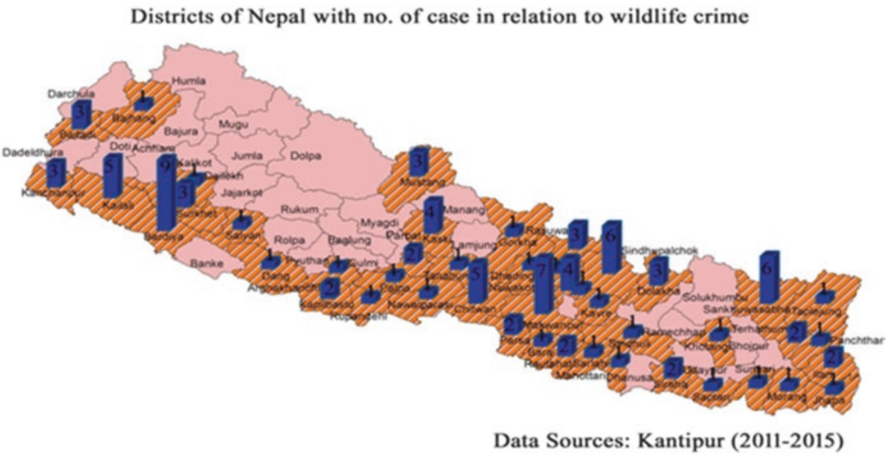

Fig. 36.6 Districts of Nepal in relation to wildlife crime in Nepal (2011–2015) from the Kantipur

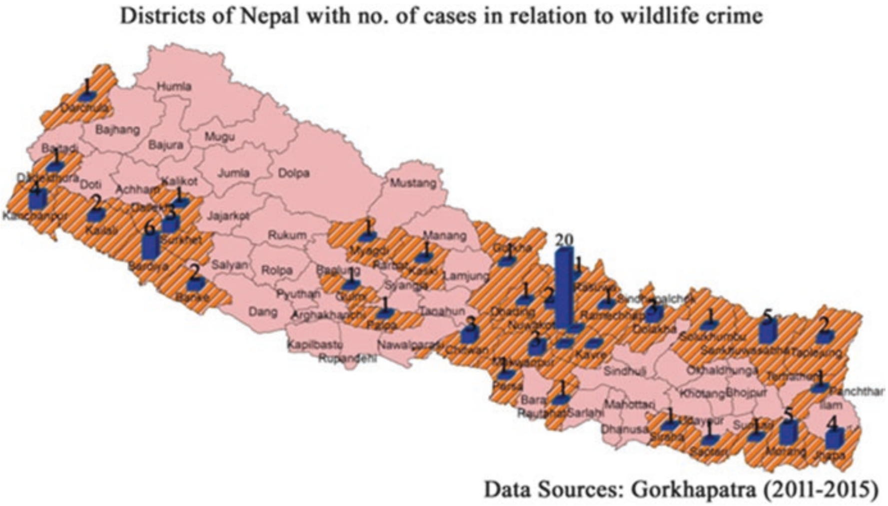

Fig. 36.7 Districts of Nepal in relation to wildlife crime in Nepal (2011–2015) from Gorkhapatra

Fig. 36.8 National prominent route of wildlife trade for exporting to International markets

36.4.4 Probable Trade Routes

Among 104 crimes news in the Kantipur 14 crime news was given trade route information. Among them most of the wildlife parts were passed through the Tatopani, Chadanidhodhara, Tinkar and Kimathanka border respectively. Similarly in the Gorkhapatra 12 crime news was given trade route information which also showed the similar frequencies border as in the Kantipur (Fig. 36.8).

36.4.5 Speculated Suspects and Convicted Perpetrators of Wildlife Crime

36.4.5.1 Ethnicity and Geographical Origin of People

The Gorkhapatra had published 88 crime news in which 164 criminals had been involved. Among them 135 and 113 criminal's origin and ethnicity had been given respectively. Similarly, the Kantipur had published 104 crime news in which 206 criminals had been arrested. Among them 175 and 177 criminal's origin and ethnicity had given respectively. In both the newspapers the highest numbers of individuals involved in illegal wildlife crime belonged to janajati (the Gorkhapatra (50%) and the Kantipur (60%)). Among foreign nationals, Indian nationals were dominating the wildlife crime (Figs. 36.9, 36.10, 36.11, and 36.12).

36.4.5.2 Group Sizes of Individuals Involved in Illegal Wildlife Trade

An average group size of individuals involved in illegal wildlife trade was 2.5 individuals per case in both news papers, ranging from 1 to 17 in Kantipur and 1–14 in Gorkhapatra (Fig. 36.13).

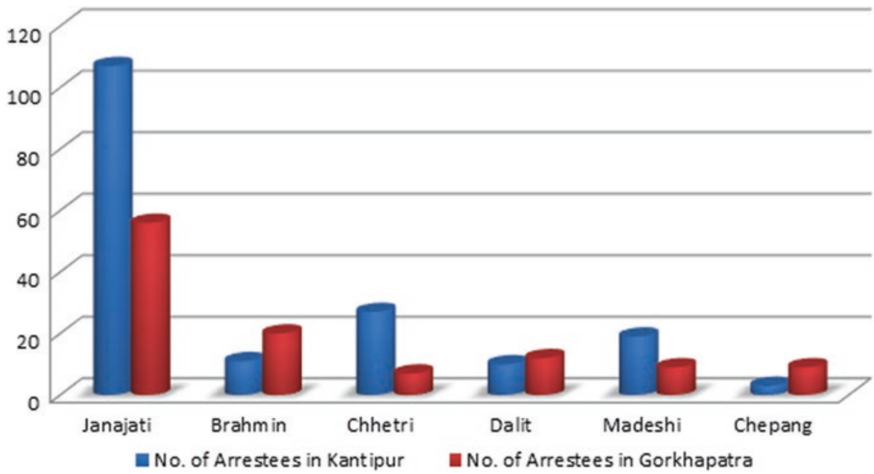

Fig. 36.9 Ethnicity of people involved in wildlife crime in Nepal (2011–2015)

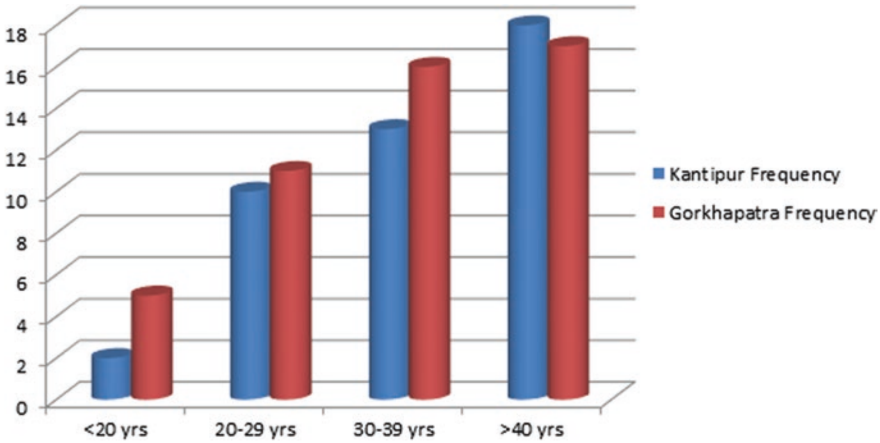

Fig. 36.10 Age group of arrested people involved in wildlife crime in Nepal from 2011 to 2015

36.5 Discussion

The main purpose of the study was to describe and summarize illegal wildlife trade in Nepal during the past 5 years, based on print media (the Gorkhapatra and the Kantipur) coverage. Specifically the study aimed to answer: Which wildlife species are being poached and trade illegally? What are the primary wildlife parts that are seized? How is the temporal trend in arrests and seizures? What are the ethnic background and geographic origin of arrested individuals? What are the sizes of the arrested group? Wildlife trade in total, both newspapers had 193 different types of wildlife crime news in the print media, consisting of trade news 73% and 37% poaching news.

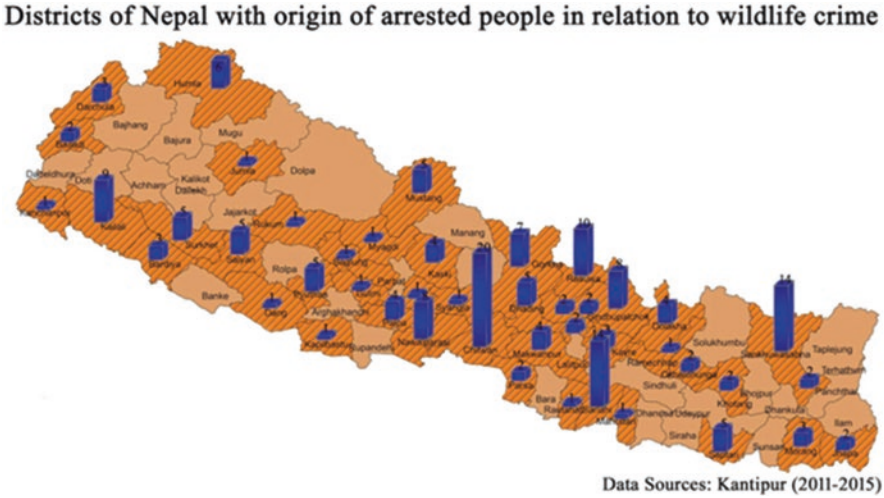

Fig. 36.11 Districts of Nepal with origin of arrested people in relation to wildlife crime in Nepal (2011–2015)

Fig. 36.12 Districts of Nepal with origin of arrested people in relation to wildlife crime in Nepal (2011–2015)

Illegal wildlife trade is prevalent in Nepal and is apparently decreasing, at least according to the news of seizures and arrests from 2011 to 2015.

The evidence shows that a wide range of species is targeted by illicit trade including some globally threatened species such as tiger, rhino, elephant, musk deer, red panda, bear, and pangolin. Dozens of wildlife species have been killed for illegal

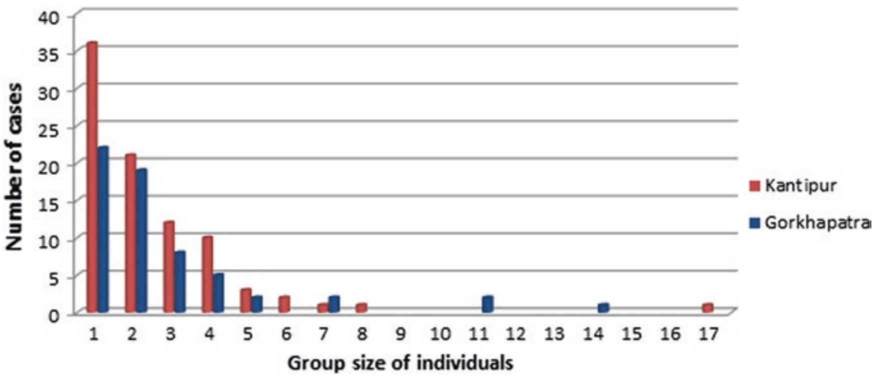

Fig. 36.13 Size of the group of individuals involved in the wildlife crime cases from 2011–2015 in Nepal

wildlife trade. The actual number of wildlife species may increase because the mentioned species are based only on evidence of news papers and especially successful seizures. It is obvious that the number of the species and volume of illegal wildlife trade is higher than those confiscated, but these numbers are exceedingly difficult to estimate (Yi-Ming et al. 2000). Four out of ten cat species in Nepal are illegally traded. Wild cat species are commonly killed in retaliation for livestock depredation or attacks on humans (Inskip and Zimmermann 2009). Niraj (2009) found that the tiger, leopard, rhino elephant, birds, and snake are the most frequently poached wildlife species in India in the period between 1992 and 2006. Barnes (1989) found the fur coats in the shops of Kathmandu made up of seven cat species including clouded leopard and wolf (*Canis lupus*). These two species are not found in this study.

Wildlife is killed mainly for its body parts, which have high market value. The wildlife parts are used for different purposes such as traditional medicine, costume, food, and faith and ritual activities. Bones of tiger and leopard, horn of rhino, gallbladder of bears, musk, and pangolin scales, are used for oriental traditional medicines while skins and wool are used for fur products and clothing (Chapagain and Dhakal 2002; Dinerstein 2003; Pokharel et al. 2008; KC and Kharel 2011). Similarly, claws of bears, hoof of rhinos, hair of elephants' tail, feathers of peafowl are used for religious and other ritualistic purposes in Nepal while meat of pangolin, deer, and pheasant are used as food. Skins of wild animals are the most commonly confiscated parts in the reported cases followed by live animals, horns, musk pods, and gallbladder. Rosen and Smith (2010) have also reported that the majority of wildlife seizures across the globe in the period from 1996 to 2008 are skins, pelts and furs of tigers and leopard. Moreover, skins and pelts constitute the highest of all seized mammal wildlife products illegally traded. Tiger skin seizures are the highest in India and Nepal among 11 tiger range countries in the period from 2000 to 2010 (Verheij et al. 2010).

Among all of the seizure cases, the top five wildlife species are tiger (*Panthera tigris*), common leopard (*Panthera pardus*), rhino (*Rhinoceros unicornis*), Pangolin, and red panda. Nijman (2010) found that the most abundant wild cat species in trade at Mong La and Tachilek towns of Myanmar is leopard cat (*Prionailurus bengalensis*) and clouded leopard (*Neofelis nebulosa*). Similarly, Niraj (2009) reported that the most apparent poached species for illegal wildlife trade in India from 1992 to 2006 are the tiger and common leopard. Wildlife species have been assessed categorically based on threats posed for survival in the natural habitat. The numbers of threatened species have increased over a decade in the world (Smart et al. 2014). The global IUCN conservation status of the traded species in Kathmandu ranges from Critically Endangered to Least Concern group. Though pangolin (*Manis pentadactyla*) is enlisted as a Critically Endangered species globally, it is just endangered for the country. This species is highly threatened globally and nationally with poaching and illegal hunting for meat and scales in the country (Jnawali et al. 2011). Moreover, IUCN upgraded its conservation status from endangered to critically endangered in the red list of threatened species because of the high level of poaching for international trade (Challender et al. 2014).

In reality it is difficult to find the real status of illegal wildlife crime in Nepal. The sources of news for the newspapers are government officials, experts as well as local people. According to both the newspapers out of 75 districts 53 district's news cases are found. On the basis of crime case in district most vulnerable listed districts are Chitwan, Kathmandu, Morang, Sankhuwasabha, Sindipalchowk and Bardia, probably for the reason that main transit cities are located in these districts. According to sources of newspapers, the northern border is highly potential for export of wildlife, probably because China imports these species for different purpose of uses. Tatopani border, Kimathanka border, and Tinkar border are highly used for illegal wildlife trade and similarly Chadani dhodhara border is highly used trade way in southern belt of Nepal.

One of the main driving factors behind the increasing illegal wildlife trade in Nepal is earnings. It is considered as a lucrative business, and local people are attracted to it. A local poacher can earn more than his annual income by accomplishing a single deal of poaching (Bhuju, et al. 2009). The country is listed under a transit state or zone of distribution for illegal wildlife body parts especially for tiger parts in the world (Stoner and Pervushina 2013).

The issue of individuals' involvement in illegal wildlife trade is complex. People of various levels are involved in the illegal wildlife trade such as local poachers, intermediaries, national, international traders, and consumers (Broad et al. 2003). It is a combined effort of a network, which makes an illegal wildlife trade a complete chain, from local harvesters at resource area to end users (Wyler and Sheikh 2013). The majority of poachers in Nepal are local villagers from ethnic communities who have little or no understanding of the long-term consequences of decreasing in wildlife populations (Bhuju et al. 2009). There are cases of significant wildlife poaching committed globally which are related to opportunistic locals who subsist on very small income (Pires and Moreto 2011). Therefore, creating awareness amongst local people on values of biodiversity is necessary, together with providing alternatives for income generation.

Between 2011 and 2015, the Gorkhapatra and the Kantipur report wildlife crime cases against 370 individuals including 30 foreign nationals. Among all individuals involved in the illegal wildlife trade, the dominant ethnic groups are Janajati, and followed by Chhetri, Bramin, Madeshi, Dalit and Chepang. Among Janajati, Tamang has the highest frequency of involvement. This may be due to the strong physique of Tamangs, their risk taking attitude and nearness to Tibet. The involvement of Newars, Lamas, Gurungs, etc. is also inescapable.

There is a wide geographical representation of the individuals involved in the wildlife crime in the Nepal because suspects and convicted perpetrators are from 54 districts out of 75 districts of the country. Almost all districts in the eastern and central part of the country are involved in the illegal trade. In 45 districts, less than five individuals are involved in the wildlife crime cases. The top five leading districts are Chitwan, Kathmandu, Sarlahi, Sankhuwasabha, and Morang, with between 38 and 10 individuals associated with seizures and arrests. This reveals that the individuals from other districts are more dominant in the illicit activity.

Individuals with a wide range of ages were involved in the illegal wildlife trade in Nepal. Swanepoel (1998) also found, in his exploratory study on illegal trade of rhinoceros horns in South Africa, that offenders where individuals with ages ranging from 20 years old to 65 years old, with a mean age of 35 years. In my study, involved individuals were between 13 and 76 years old. Among them, the most vulnerable age group in committing wildlife crime is more than 40 years.

Group sizes of individuals involved in the crime cases are diverse. Average group size was small (2.5 individuals per case), but up to 17 individuals were found to have been involved in some cases. The small group size of individuals may indicate that either enforcement agency overlooked in tracing involved individuals or local poachers came in front for dealing wildlife parts to buyers directly. EIA (2004) has mentioned that enforcement agencies are not interested in tracing to reach the main connection of the illegal wildlife trade in Nepal. However, we cannot say that enforcement agency did not trace at all because 17 individuals at a time were arrested in one case. However, it seems that enforcement agencies do trace suspects based on a selective case.

36.6 Conclusion

This study has found that the illegal wildlife trade is prevailing in the Nepal with wide varieties of wildlife species originating from tropical to alpine regions. Altogether 193 wildlife crime cases were recorded over the last 5 years in two national print media where 370 individuals including 30 foreigners were involved. The dominant suspected groups involved in the crime were Janajati, and followed by Chhetri, Bramin, Madeshi, Dalit and Chepang. Tatopani-Sindhupalchok, Kimathanka-Sankhuwasabha, and Tinkar-Darchula boarders were frequently used as an exit point for illegal wildlife trade in North where as Chadani Dodhara-Kanchanpur border in southern belt. The coverage of wildlife related news in print media was very low; 2 cases month-1; and received less importance. The media were not in the forefront to report wildlife related crimes and did not remain in their priority reporting too.

The basic information and parts of all wildlife species traded illegally in and outside Nepal are compiled, thus representing baseline information for future comparison and trend assessments. A study of crime investigation reports in detail and appellate cases will also provide a clearer picture of the legal practices for handling wildlife crime cases in the country.

Acknowledgements The study would not have been accomplished without the generous supports from many individuals and professionals. We thank Prof. Abadhesh Singh, Suman Bhattarai and Bijendra Basnet of Institute of Forestry Pokhara for their support and encouragement for this research. We acknowledge National Trust for Nature Conservation (NTNC). We extend our thanks to Staff of Moti Library, Parbat; Library of Institute of Forestry Pokhara and Western Regional Library, Pokhara for assisting me in the data collection during Paper Review. Gorkhapatra and Kantipur Publication, Pokhara deserve thanks for their cooperation during data collection.

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Chapter 37
Looking at Road and Railroad Development Data in the Hindu Kush-Himalaya: Rock-Solid Impacts Created by Globalization, the World Bank and Its Affiliates, As Well as by the Great Himalaya Trail

Falk Huettmann

37.1 Roads, Wilderness and Humans

The Hindu Kush-Himalaya (HKH) region was pretty pristine, once. After it elevated from the sea floor up to over 8,000 m high, water flowed down the mountains through valleys and their rivers as it could, and access support was almost not existing. Humans lived in the area for probably over 40,000 years and were found up to 4,000 m high (Chen et al. 2019). In the human history of the HKH region access always was a major problem (e.g. Hooker 2012) and people walked along routes of convenience; mountain passes became strategic locations for access, and control (Baumgartner 2015). As far as we know, 'modern' humans entered this landscape in dominating terms as late as the sixteenth century (Whelpton 2005), and many 'remote' parts remained more or less untouched – in the modern sense- for a few more centuries. Modernity – as we know it in the western world – started there perhaps in the 1950s (Diamond 1999, see Lama 2012 and Baumgartner 2015 for some Tibet-Nepal border areas). Regions like Everest remained widely unsettled till recent decades even (NAST 2010). For centuries many of those regions were virtually free

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F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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of relevant human impact and, at best, they just were intersected with a few trails connecting areas and regions of low human population density, apart of the few exchange hubs often linked with royal courts, e.g. Kathmandu in Nepal, Lhasa in Tibet, Thimphu in Bhutan, Darjeeling and Leh in Ladakh/India. Those hubs often were island-like -similar to an oasis likely – in the mountain deserts and located in few fertile and subsequently wealthy plains and valleys; water remained a key driver to fuel their farming harvests. It should be mentioned that traditionally grazing animals, specifically yaks and goats, can add to a 'benign' impact, but by far are less severe than what the Anthropocene caused last 50 years (Harris 2008; Steffen et al. 2015).

And many of those connecting trails were widely controlled for access as late as 1950s (Kingdoms like Sikkhim, Bhutan and Nepal were widely closed to foreigners; Harrer 1952; Whelpton 2005; van Schaik 2013), often access restrictions remained even later, e.g. some remote regions in Nepal etc. til the 1990s (see Lama 2012 and Buckley 2014 for Tibet).

The infamous salt caravans make for a good example how trade routes were used, and to access and navigate those represent a means of wealth (e.g. Whelpton 2005; Lama 2012; Baumgartner 2015). And during time of repression and dispute, remote tracks were taken into exile by escapees, asylum seekers and expelled members of communities (Harrer 1952; Lama 1990, 2012). Being able to hike over remote passes could mean the way into freedom. Many of those trails and concepts are still in use today, legal or illegal. To this very day, yak and mules, as well as human carriers, play a major role for transportation and income (Fig. 37.1). Yaks have special breeds to cater specific elevational and seasonal zones.

While not wide nor even paved until recently (Figs. 37.2 and 37.3), those narrow Himalayan 'trails' are no to be underestimated for their impacts. During the recent earthquake in Nepal most evacuations and supplies were done through those routes and trails. Those trails are centuries-old and deeply entrenched in the minds of the people and their actions. They are true life-lines, provided by the topography, supported by prayer temples, food sources (e.g. markets or shops) and part of an inherent (landscape) culture. Widely sustainable human societies and cultures evolved around them, with a very strict, quite happy, sustainable but tough lifestyle though. The transhumans described for Rolwaling in Beding and Na – between Nepal and Tibet – are good examples; it could mean a back-breaking live but one for where happiness and dancing was abundant too (Lama 2012; Baumgartner 2015). There is a reason why Bhutan claims happiness as a national asset (see for instance at https://www.ted.com/talks/tshering_tobgay_this_country_isn_t_just_carbon_neutral_it_s_carbon_negative).

Those routes saw major religions, cultures, goods and wars spreading throughout the region, and through the entire continent (Chopel 2014). Those paths have a certain crime and policing aspect too and it can be found til this very day (Green 2006; Lama 2012; Baumgartner 2015, see this book for wildlife poaching). Also, the different waves of diffusion of Buddhism – from Lumbini into the HKH region and Mongolia – are driven by those routes, which in turn are driven by geography, topography and associated weather patterns (Xiaoming 2004; Karmay and Watt 2007; Chopel 2014). High-altitude passes present the obvious bottlenecks. Negotiating those passes sets a skill and requirement for new cultures and events spreading into the wider regions and across Asia. Usually, villages – offering porter expertise and paid labor – are found

Fig. 37.1 (**a**) Yaks-like mules - used for transport in the Rolwaling trail. (**b**) Human carriers are often main supporters of infrastructure. (Photo credit: author)

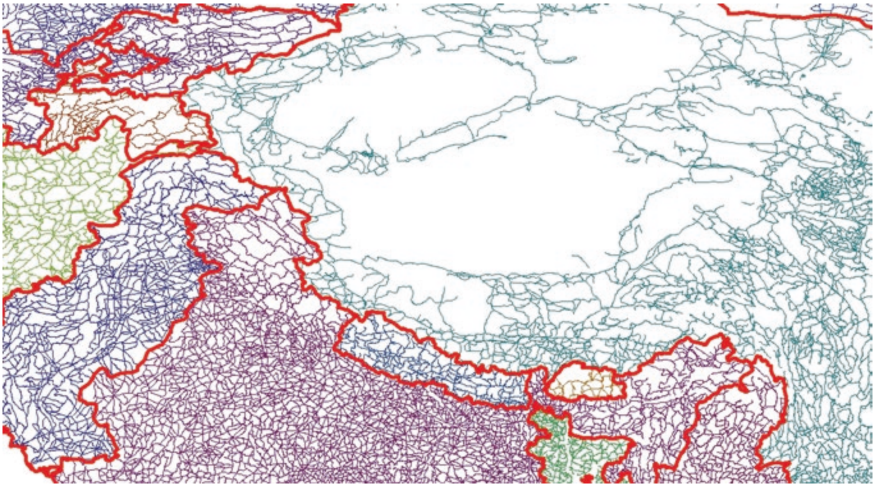

Fig. 37.2 Map of known roads in the HKH region, country borders are outlined in red. (Compiled data taken from National DIVA GIS mapped with QGIS and ArcGIS. Data available in Appendix)

nearby those passes (see Baumgartner 2015 with Sherpas for Rolwaling and wider Everest region). One way or another it affects millions of people (which at that time was almost all people in the HKH region). Porters and guides to overcome the passes become essential to win a war. The recent Mao insurgency in Nepal has shown that clearly with the passes connected to India playing important roles (Whelpton 2015).

Fig. 37.3 Zoom-in map of known roads in the HKH region using OpenStreet Project example for Pokhara; airport can be seen lower right corner. (Data sources see Chap. 21 of this book)

37.2 Cars

The advent of the combustion engine has changed – but not fully resolved – those situations where trails and passes are the bottleneck. And like elsewhere in the world (Forman and Sperling 2002) cars affected HKH in serious ways. For one, it changed the power fabric that evolved over the last centuries in the region (Chaudhary et al. 2007; Baumgartner 2015 for examples). The car, and the motorbike, want a paved road; it's for the protection of their investment…. Thus, those vehicles get their roads soon or later, as well as their gas stations (Forman and Sperling 2002; Czech 2002; those are now also found in high abundance in various shapes and form. Whereas oil changes are still done in rivers!). Roads are built now everywhere in the HKH. And Nepal gets hammered with road construction, bridges and new projects, often driven from the outside. Much of it is suboptimal though (Fig. 37.4) and impacts are poorly planned and addressed. Already food safety with flying traders and road kitchens remain widely unregulated.

And who pays for the road construction? Usually, that is done through tax and gasoline money, or even road tolls or with industry help. It's a common business model that creates slush funds and further stimulates car purchases, automobile loans with local banks, and which promotes 'consumption' (Czech 2002), any consumption, including real estate, commercial electricity, as well as medicine and education for the workforce to further an industrial machinery to consume. Dependence of oil and gas increases with devastating effects (e.g. Fig. 37.4). But the tax system in Nepal is not allowing for expensive basic infrastructure and for many roads. Thus, other concepts come to play then, namely, industry, foreign donors, development aid or The World Bank and its affiliates, e.g. Asian Development Bank (https://www.adb.org/). Roads are the arteries to get products out of a (neo-colonial)

Fig. 37.4 Siphon'ing gasoline at a sub-optimal gas station (this is known to cause cancer, besides soil and water contaminations etc; a widely known issue throughout the world, specifically with 'modern' high-volume gas stations in the western world but not so well 'celebrated' there)

location and straight into the global market. Japan entertains such concepts all over the world, certainly in Asia and usually in exchange of water or for trading fisheries and rice. Needless to say that roads will create a fabricated demand for Japanese-built cars, and subsequent fuel consumption and climate change. These road-promoters and builders -on a global scale- are big supporters of making the HKH region equal to their own mindsets and for such landscapes: Like in their own nations, roads and their destructive business models will be everywhere then for progress and commerce, supported by an electricity scheme (in Asia this usually means nuclear, hydrodams or coal-fired plants)?! It's nothing new really and just part of a wider global model (e.g. Czech 2002; Forman and Sperling 2002; Buckley 2014; see Belanger 2017 for the Extraction Empire). Roads, fueled by cars, need resources, from mining to gas and oil fields. But even further, they leave pollution behind, namely air contamination (or car battery materials etc), which can be seen allover the Asian continent, if not globally. It's certainly seen in the atmosphere.

By now, the human foot print in the Himalaya region is massive and found all over (Figs. 37.2, 37.3 and 37.5). Nations like India plastered roads all over the nation, and so did many other nations (more difficult to do in remote rugged terrain, like Bhutan or parts of Tibet, where large tracts of national protected and roadless areas are actually found now by coincidence; see Bocharnikov and Huettmann 2019 for an example). It's only Tibet that has received less development thus far (Fig. 37.5), but which is catching up steeply (Buckley 2014; Xuesong et al. 2017 for GDP growth of over

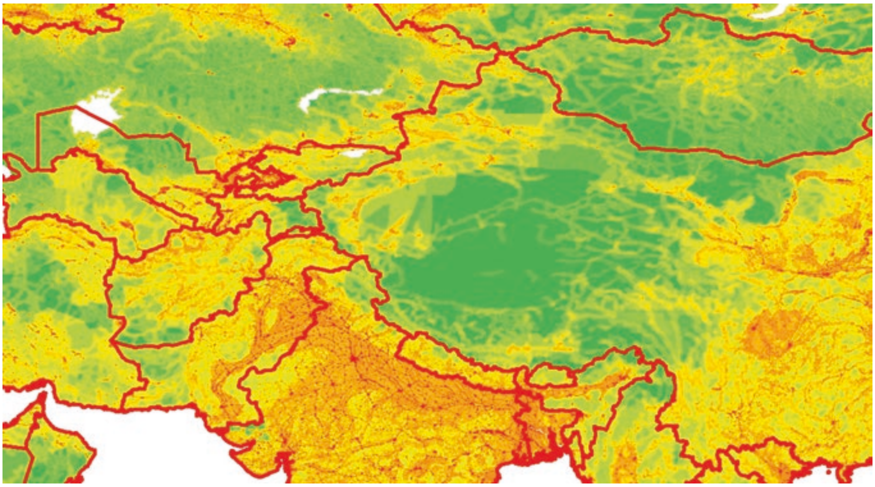

Fig. 37.5 Heatmap of the human footprint in the HKH region; roads play a central role for human impacts. (Source: CIESIN.org)

100%). And roads need an entire support system, namely bridges (in many nations, those things are institutionalized and come with a tax system, an associated income system including pension plan and social-welfare to make it all happen and remain viable). As shown in Baumgartner (2015) the Suisse government happily plastered its bridge expertise all over mountain areas in the world, as part of development aid (see also with ICIMOD.org). That has certainly happened in the HKH region and in Nepal specifically. It comes as a well-fueled system of international aid and diplomacy. And thus the Alps, most mountain areas in the EU, and certainly Switzerland itself, are far away from what one may perceive 'wilderness' or sustainable landscapes. Like most of the western world, the EU is virtually free now of any untouched wilderness landscapes, except for its margins and remote tiny valleys. It is therefore somewhat unclear why the 'Alps concept of development' is allowed and exported elsewhere (e.g. with http://www.mrd-journal.org/ims.asp, ICIMOD.org or http://www.futureearth.org/projects/gmba-global-mountain-biodiversity-assessment) when it is so-well known to be plagued with vast problems, including destruction of wilderness and loss of ecological services (Czech 2002; Daly and Farley 2010). It does not really make other areas better or more sustainable, rather it damages landscapes and watersheds more and being worse off. Those bridges -coined as help or development aid- can be seen as pre-cursors to open up a remote and wild landscape and to the so-called model of sustainable development that even the least critical person would have doubts about. More western globalization is to come, and it is known to destroy wilderness, besides other things (Alexander 2013). A case well documented for such metrics can be seen in Madang (Chaudhary et al. 2007), as studies and efforts there were supported by the Volkswagen Foundation and the Norwegian Development Aid etc. And transportation development in the Everest region, namely helicopters and airports but as well trails, are well described in NAST (2010). The Everest region has for years demands for more airports and one closer by, e.g. Namche Bazaar (which is not

Fig. 37.6 Major railroads (green lines) and airports (black dots) in the HKH. (Source: http://www.naturalearthdata.com/downloads/10m-cultural-vectors/)

promoted to keep remote Lukhla in good business). Usually, it's an explicit aim of The World Bank and its affiliates to develop regions and use roads, railways and airports to do so as a central effort (Christoph and Eckersley 2013; Rich 2013; Fig. 37.6). It certainly was an objective when Sir Edmund Hillary engaged in the Rolwaling region and the airport was built in Lukhla (Baumgartner 2015). This is a model that was applied world-wide for the last decades (Forman and Sperling 2002) but widely ignoring relevant impacts and what it does to people and societies (Rich 2013). Many of the latter evolved in harmony with the environment for hundreds if not thousands of years over many human generations (Knudtson and Suzuki 1993; Ostrom 2010).

And it does not end there: It's clear to most people, governments and developers that the paved road surface consists of bitumen or asphalt; none of those are substances that are to be brought into close contact to human skin, even the water run-off is. Or in other words, it's rather toxic, to say the least. And it does not end there, roads used by cars involve 'brakes' to regulate speed and traffic. Brake pads get used up, and together with exhaust the break dust is known – world-wide – to create dust, sediment and impacts, e.g. in ditches and air nearby. It's a toxic cocktail/tort. Some studies show the heavy metal burden accordingly in those areas and certainly in road ditches (e.g. Apeagyei et al. 2011).

Roads are usually placed where it is easy to build them: flat areas and along valleys. Not surprisingly, many roads are found aside rivers. Suddenly, rivers now become a problem due to the (steep) river banks or flooding; so they must be controlled. But roads also tend to follow earlier routes and existing paths, starting to connect population centers and hubs. The last place where roads are usually put are steep slopes, wetlands and high altitude peaks. HKH has much to offer of those ones and due to lack of space, other areas than the traditional sites are now explored and built up, including building tunnels. Such efforts of drilling up the ground stand in deep contrast to the local views that earth is to be respected (e.g. Karmay and Watt 2007; Buckley 2014).

Virtually all relevant valleys in Nepal have a road by now. And if not, at least roads are planned there and trails exist that are usually used by motor bikes. Specifically, building roads to China remains the big deal of the day. This is very obvious in all border zones to Tibet, e.g. Lantang in Nepal, or Rolwaling and Humla (as documented in Harris 2008; Lama 2012; Baumgartner 2015). While roads already exist, they are also to be discussed for improvement, widening to cater more commerce, which includes electrical extensions and they harbour conflict (e.g. Agence France-Press 2017).

37.3 Walking the Hindu Kush-Himalaya

As mentioned, the HKH region has a wide but not well documented network of (ancient) foot trails; see for instance Chopel (2014). Nowadays those trails are 'stair'ified' (see textbox on Stair'fication of the world's mountains) serving tourists but usually were already in use for centuries. The historic descriptions of such trails provide a priceless resource for the HKH scholar and to draw inference on 'before' and 'after' globalization. It is usually here where the tourist take advantage of those 'public' trails but engaging a porter and a tour guide company, for instance. This now too turned big business, and it's just a matter of time when the franchising of all lodges and guest houses occurs on those tracks and pilgrimages (in Mekka that has already happened decades ago). Franchises can be expected on those remote trails soon while plastics are already found 'everywhere'.

As in other parts of the world, while cars matter, the bigger versions, trucks, matter even more. But in HKH, the role of foot passengers, and specifically now the motorbike, still remain a key driver for such connections and demands. Perhaps it is surprising that ATVs do not matter in the HKH region much yet, but surely they are on the rise also. Snowmobiles are of no big value, yet. Mountain biking is more of a tourism activity, but equally contributing to opening up, and developing, landscapes. The best routes are scouted out already decades for such 'action rides', that incudes Everest ones and everything that goes downhill 'with a view' but has a nice shuttle service 'up'.

In this context, the Great Himalaya Trail (GHT) must be mentioned as a central scheme (Fig. 37.7; Hinze 2019). While this is meant to be hiked by tourists and a wilderness trail, featuring the roof of the world and one of the most stunning vistas in the world (Boustad 2010; Pauler 2013), reality is that it needs logistical support, access and tea houses, hotels and lodges, all connected with roads, trails and even heli-pads to supply goods. Hikers want their daily supplies delivered. And the athletes and VIP tourism will not wait long to show up, demanding helicopter and lobster, and a warm ('civilized') shower, e.g. in support of their facebook postings to receive global fame in-time (Krakauer 1997 for Everest climbing example via satellite phone and messages). Soon or later the GHT will take the path of the Chinese Great Wall or Antarctica (a venue of marathons, rock concerts and fashion model shootings) and of Machu Pichu (a place that is widely overcrowded by now creating environmental havoc). Everest is already there (for crime and even DJ

Fig. 37.7 Map scheme of the Great Himalaya Trail (GHT)

dance parties see Kodas 2008, https://www.independent.co.uk/news/world/asia/crime-rate-sky-high-at-the-top-of-the-world-1036902.html; http://www.bbc.com/news/av/world-asia-39586287/dj-paul-oakenfold-hosts-everest-party).

37.4 Access as a Geo-political Strategy

But this is not where it even ends. Roads are not only paths of consumptive terror, but clearly strategic, usually geo-political. They affect warfare and conflict on a global level. This is even more so the case when not many roads exist and valleys and passes with roads present a bottleneck. Besides the infamous Kashmir situation (a mountain pass and road that lies between the recent nations of India and Pakistan -both recently created by western colonial powers – and where both nations stand in an ongoing warfare-like struggle), there are also road conflicts between India and China in the Doklam territory (Donglang in Chinese). Officially, the last fight in India was 1962 at the border state of Aruchnal Pradesh. Smaller border disputes are common and can be found today, e.g. Agence France-Press (2017). But real tensions along the Line of Actual Control (LAC) started again in 2014 when Chinese soldiers moved into India-claimed land, resulting into a 2 week military stand-off related to a visit by China's president Xi Jinping (Lamsang 2017). Chinese troops are reported to have threwn stones at Indian soldiers in the Pangong Lake region in Ladakh, Jammu/Kasshmir. There is also an associate road dispute behind it in the Doklam territory (Donglang in Chinese). This area is actually disputed between Bhutan and China, with India being an ally of Bhutan and China wanting India to withdraw troops there. The plateau is of strategic relevance because it gives access to a 'chicken neck', and roads are at the center of the attention. Historic claims and disputes relate to Sikkhim, India, Buthan and China and their convoluted histories (Lamsang 2017).

37.5 Grand Plans and Bad Ideas

But also, there are many grand plans in the HKH region to build more roads, railways, airports and connections. These developments are part of a global network and come with wider commercial contexts, agendas and ideologies, e.g. capitalism or communism. Recent work on connecting Kathmandu, Nepal with Beijing, China via railway show us nothing but that. And why not having a nice stop-over, railway station, at Everest base camp tunneling across the border between Nepal and China? Like the railway on the Tibetan Plateau connecting Lhasa daily with Paris, Moscow and Beijing has shown us, the sky is the limit in HKH. Such plans are floating around, including the ‘One Belt and One Road Initiative’ by China (e.g. ICIMOD 2017; Ling 2018; Wang 2018; see also online library at https://iias.asia/research/belt-road-initiative-electronic-library).

The Belt and Road Initiative:

> *The Belt and Road Initiative, reflecting common ideals and the pursuit of fairer, more connected human societies, endeavors to seek new models of international corporation and inject a new sense of positivity into efforts aimed of promoting world peace and development*. (China Daily newspaper, June 3rd 2019, p. 4)

Protected areas are couched into areas of high development like roads, railways and airports; this can easily be seen in Figs. 37.8 and 37.9 for the Hindu Kush-Himalaya regions. Tibet stands out as a last wilderness area without relevant road network (Harris 2008; Buckley 2014).

But in the wider HKH region, the push for a widely connected road and transportation system is found all over. As a matter of fact, it is part of the Silk Road, an ancient travel network affecting generations and cultures severely, all over the ‘Old World’: From Japan over China, Southeast Asia, Mongolia all the way to Europe. Similar development ideas exist for the HKH region, including now Southeast Asia involving Vietnam, Thailand and China (Buckley 2014).

A key scheme in this concept of ‘access’ remains the ‘Chinese Belt’ (Fig. 37.10) though, connecting Beijing with EU, Paris and Warsaw, and also linking Beijing with South East Asia, beyond other linkages across the continent, and cutting through HKH in a geo-strategic way (Wang 2018). The only limit that stops those engineers with full banking and political support, always hungry for new projects and tool application for gigantic budgets and interests, sits in the mind. This mind went loose and lost all taboos by now (Buckley 2014); impacts remain widely unclear and the track record of such a ‘Green Economy’ remains nothing but devastation for cultures, societies and wilderness. The Tibetan Plateau example has shown that it is a rather wild and unhealthy ride for anybody involved (Elvin 2004; Harris 2008; Buckley 2014; Baumgartner 2015; Xuesong et al. 2017).

So far, this elaboration of networks and access had left out the air links (see Hilton 1933 for a plane stranded in the HKH region setting up a ferry-tale narrative with a global audience: Shangri La, the lost valley paradise). Many nations in the HKH region lack a good airline connection. And although China and India can

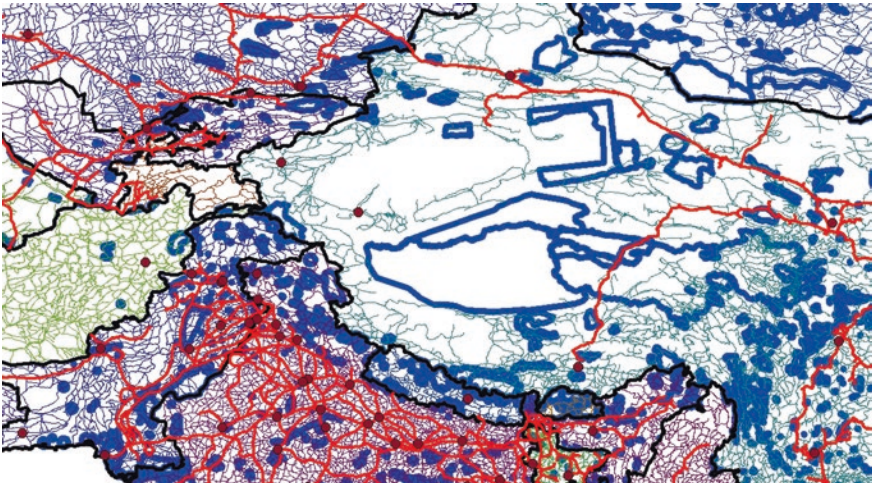

Fig. 37.8 Protected areas (=blue thick outline) in the Hindu Kush-Himalaya region within a 'sea' of transportation networks, e.g. roads, railroads. Note the largest roadless areas in Tibet/China

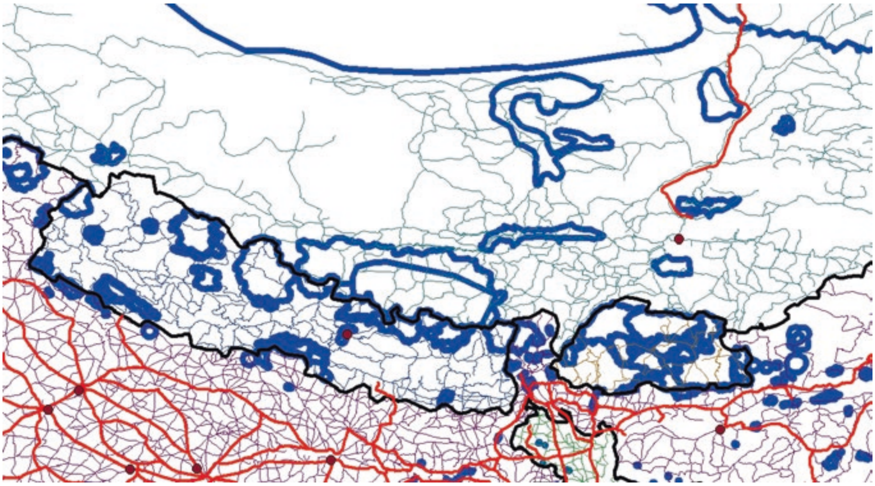

Fig. 37.9 Protected areas, zoom in from Fig. 37.8 for the Nepal-Tibet border area with high mountains

boost otherwise, much of the air traffic in HKH is not considered 'safe'. Almost no American or EU planes land in Kathmandu, or on many other airports of that sort. To no surprise, the airport of Lhukla – the only fly-in option for Everest basecamp – carries the label of 'the most dangerous airport in the world' (for list of incidents and updates see here https://en.wikipedia.org/wiki/Tenzing%E2%80%93Hillary_Airport). Hillary's wife died there in a plane crash, as did many others (Baumgartner 2015).

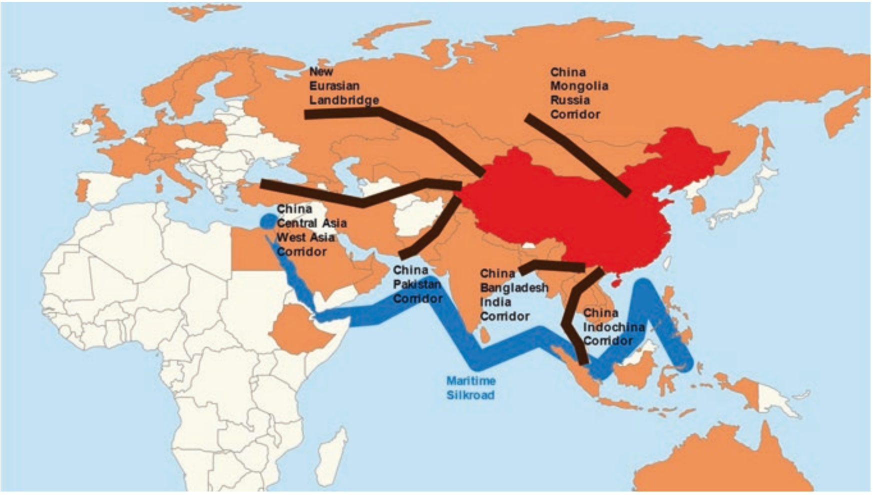

Fig. 37.10 Map scheme of the future connections (black for land, blue for ocean) pursued by China, India and other funders imposed onto the HKH

While land-locked nations rely on air traffic, many of the poor nations cannot afford navigation and pilot schools, e.g. to be done to international standards. And thus, many of the Nepali airlines act on an international substandard and essentially are still 'black listed', which excludes them for part-taking in many international opportunities and funding. Nations like Nepal or Bhutan, already land-locked, are not given a fair and equal chance to participate in globalization, either way. Airline technology includes satellites, navigation technology, GPS and kerosin refineries and sources. A good example of this was shown during the recent earthquakes in Nepal when the bridges got destroyed and were not rebuilt nor re-opened. Nepal got cutoff from the China supply via Tibet ('Friendship bridge') and India became a monopoly that it clearly used. Fuel prices skyrocketed and the poor paid the price; so did the landscape and its resources. All of this came during a time when Nepal was trying to finalize its constitution, which then India tried to influence with its fuel and refinery product deliveries, or lack thereof, while China products could not cross the border due to the prolonged situation of a lacking bridge not re-built for long time (~ years closure). Bhutan shows equal patterns and is essentially widely delivered to India and its political will, which India also uses while China plays it on the other side! Travel networks can clearly allow for independence and wealth.

Despite the rise of democracy movements, and with NGOs and human rights on the forefront, it's not much what the local population really can control, beyond their access perhaps. People of the HKH region traveled and connected internationally since deep time (Karmay and Watt 2007 and Chopel 2014 for such connections across all over Asia). Whereas modern roads, planes and railways come with massive impacts, socially (see the classic world poetry by Hauptmann 1973 displaying a subsequent psychopath massacre and its lead up), ecologically (invasive species and fragmentation, e.g. Bender et al. 1998; Haider et al. 2018), diseases (Saksena et al. 2014), economically (Czech 2002) and overall (Alexander 2013; Cockburn 2013; Christoph and Eckersley 2013). Like much of industrialization, roads have essentially brought us not only a new type of human being, but also a new society, spread diseases (Finucane et al. 2014) and crated a culture that devastates landscapes, resources and cultures as we knew them (Takehiko et al. 2018 for a widely discussed case). A meaningful sustainability still remains here far out of reach, thus far, globally.

Textbox 1: Stair'ification of Nepal's Mountains Through Switzerland and International Development Is Not Sustainable, Nor Beautiful or Much Appreciated for Wilderness Regions

Stairs are an ultimate urbanization feature in steep terrain; they are favored by urbanites and developers alike, even perceived as a sign of progress and making landscapes accessible and 'humane'. But like with roads, they are just part of industrialization trying to tame the wilderness and are to provide modernity and civilization of the 'raw wild'. Instead, we are short of areas that are not built up (see for instance Harris 2008 and Bocharnikov and Huettmann 2019; Pauler 2013 for the Great Himalaya Trail across the Hindu-Kush-Himalaya HKH region).

Like widely found and promoted in the EU, nations like Switzerland have plastered this concept throughout their own mountain terrain (Central Alps; in Switzerland virtually all mountain peaks are fully accessible and connected by railway, roads, with stairs and boardwalks provided maps and cable cars from all urban centers and adjacent villages in just a few hours). It comes as no surprise that Switzerland features already the longest staircase in the world (https://www.cntraveler.com/story/the-worlds-longest-staircase-is-in-switzerland). And so they happily export it elsewhere too and with a financial gain. It caters tourism and associated business models and their beneficiaries, and it is linked with bridges and development aid (Chaudhary et al. 2007; Baumgartner 2015); many examples can be found in the Himalayas.

Now, what's wrong with one set of stairs to avoid erosion, a slip and associated danger? Well, for a start, the amount of concrete needed, and the employed engineering expertise and workmanship is not a small feat in remote regions that are difficult to access. Arguably, some nations and cultures developed a specific expertise about mountains, e.g. Switzerland and then are eager to export and sell their skills. But who pays for it, and why done?

Most hiking trails in the HKH region actually follow –exploit- ancient trails (e.g. Chopel 2014; Baumgartner 2015; see Pauler 2013 and Hinze 2018 for the Great Himalaya Trail). Wheres those trails and areas are now part of an urbanization development – so-called Sustainable Mountain Development (Spehn 2003; Ives 2004, http://www.icimod.org/) – but which compromises

(continued)

wilderness for good. Roads will follow next, and then come all the problems (social, economic and ecological) which we all know and see globally now (e.g. Alexander 2013).

And it is the development aid which makes for an ideal vehicle for exporting such expertise to 'poor' nations in a presumed need, while the international community supports it but such a help comes with strings attached (development aid tends to have has a return of investment of 130%; see Rich and Basu 2013 for concept). Landscape features like roads, bridges and stair walkways are an ideal example for such a rational applied globally.

There is argument presented then, usually by the donors and funders, that "*the locals really would want the development done*". While this sounds reasonable to outsiders and urbanites, reality is: if the locals would know what is coming upon them, and how, and if they are correctly informed about all impacts, locals actually tend to speak out against development (Buckely 2014 for an example). The local approval/permit is usually swinging against foreign development and involvement, or such money-making schemes. Arguably, many Sherpas had to leave their land already and now live in Kathmandu (Baumgartner 2015 for Rolwaling Himal). It's a destruction of the local fabric and culture (see Chaudhary et al. 2007 for Annapurna). With more tourism on the rise, the hotel business will not be local anymore, and Kathmandu business will increase, eventually leading to more international owners and 'franchising'. This is a real-world scenario, as the Suisse Alps – as a prime example of an international commodity – show us clearly.

Rolwaling Himal is described as a very remote and almost pristine area with a central valley along the Tibetan border (Baumgartner 2015). But the hike to Tashi Lapcha pass and Tso Rolpa lake make for a classic example of this concept of stair'ification. The hike is very steep, app.15 km long, and takes 4 days to complete. The terrain is rugged and steep, and long; so why not just putting stairs everywhere; as the western mind might ask? Clearly, the entire trek (=valley) is now done with concrete stairs (May 2019)! And when asked, a road is coming and planned. Visiting expert committees from Switzerland and with the help of Indian engineers and the Nepali government contractors assessed and confirmed this to me (Huettmann pers. com. May 2019). Arguably, it will likely take another 10 years to get it all done, but the Rolwaling Himal, as you know it, a major wilderness place and the land of the Sherpas, a valley adjacent to Mt. Everest (Khumbu) is done with. Land speculators are awaiting their feast. Wilderness no more. See textbox photos for a visualization in Rolwaling: (a) a staircase, (b) a typical bridge 'western style', (c) a construction site, and (d) a wilderness path set with rocks and stairs.

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Now, all of this is not an isolated case in the HKH region. Similar examples and experiences can be found in Lantang/Gusainkunda (stairs) and in lower Muktinat in Annapurna (stairs, and the road development introduced major changes for hikers), and those type of 'developments' are reported from all over the HKH region covering hundreds of kilometers (Hinze 2018, Huettmann pers. com.).

So urbanized is now the reality of the HKH region, the top and roof of the world. If this major wilderness area is gone (Harris 2008; Buckley 2014), what is left in the world?

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Appendix GIS DATA (See Supplementary Electronic Material)

(a) Shapefile of roads for the Hindu Kush Himalaya by nation
(b) Shapefile of major railroads for the Hindu Kush Himalaya region
(c) Shapefile of major airports for the Hindu Kush Himalaya region

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Chapter 38
Why Do some Many Nepalis, Medical Doctors, CEOs and Hedge Fund Managers Get Sick or Die on Everest (Sagarmatha, Chomolungma)? A Review and Indicators that Capitalism Went Awful while Searching Human Dignity and Itself

Falk Huettmann

"It's all Bullshit on Everest these days"
Sir E. Hillary (2006), (https://www.snewsnet.com/news/did-you-hear-its-all-bullshit-on-everest-these-days) first western climber to reach Mt. Everest.

"Wir muessen zum Berg wieder Sie sagen"
R. Messner (2008), (https://www.bild.de/news/vermischtes/im-interview-ueber-alpinismus-5730964.bild.html) first climber to ascent all 148000'ers

"Don't bother Climbing Everest"
Sir C. Bonnington world-famous mountaineer

"White men climb, Sherpas carry their gear"
Proverb commonly heard in the Khumbu region

Sagarmatha (in Nepalese; Chomolungma in Tibetan, formerly called peak 'h' but now commonly referred by its English name 'Everest') is located in the Himalayas and the highest peak in the world. It was left unexplored for millions of years; the rocks are c. 60 million years old and originate from an ancient seafloor. People live in its shadow for many thousand years (20,000–40,000 years; Brantingham

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F. Huettmann (✉)
-EWHALE lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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et al. 2007; https://www.welt.de/wissenschaft/article184850222/Anthropologie-Vor-40-000-Jahren-lebten-Menschen-im-Hochland-Tibets.html). But just the last 60 years or so Everest experienced a human obsession on a global scale that was unprecedented in geological, governmental, commercial and universal history (Salisbury and Hawley 2017; see Messner 1999; Messner and Huetlin 2014; Singh 2014; Bonnington 2016; Dyhrenfurth 2018 for individual Everest accounts. Updates are found at: https://en.wikipedia.org/wiki/Timeline_of_Mount_Everest_expeditions). It makes for another arbitrary shift of a human global culture, dominated by 'the west'. Everest, the ole rock -formerly actually a sea bed with an Indian and African geology component (Wu et al. 2019)- is by now a world celebrity high in the sky, used, misused and abused by everybody who can afford to be there and who wants some global attention (Krakauer 1997; Boukreev and DeWalt 1999; Horrell 2011, 2016). It's not only that local people pay the prize, e.g. the Sherpa communities and Tibetans, but some also are part of a big global business venture (Baumgartner 2015) (Fig. 38.1).

> Why to climb Everest? "*Because it's there*" (as attributed to G. Mallory, Baumgartner 2015).

Mountains and the Hindu-Kush Himalaya occupy people's imagination for millennia (Hilton 1933; Miller 2003; Karmay and Watt 2007; Lama 2012). The pursuit of Everest captured human phantasy, and the efforts to get there are well documented. The global rise of TV, internet and media play a big role in this situation and as a marketing item to be exploited (Krakauer 1997; Horrell 2011). It's self-perpetuated. Whereas, a deeper and contrasting Nepali Sherpa view of the first ascents and its history are provided by Tenzing and Ullman (1955). Also, other nations started to deal with, and get obsessed with Everest. For instance, a lot of Suisse pre-investment

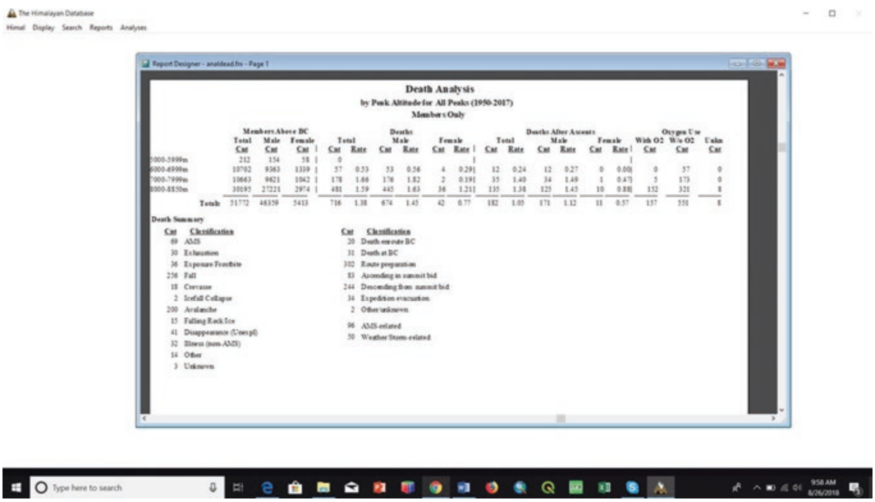

Fig. 38.1 Snapshot of the Himalayan Data Base (Climbing Everest details). (Source: Salisbury and Hawley 2017)

went into Everest in the 1940s and early 1950s, but the fame went to others. Most climbing details of Everest are provided in the Himalayan Database (https://www.himalayandatabase.com; Salisbury and Hawley 2017; see figure 1). But it should not be forgotten that Everest includes a Nepali-side as well as a Tibetan/Chinese side and which runs its own statistics (e.g. Nyima and Qiong 2019) As shown in Table 38.1, several phases of that recent 60 years Everest phase can be described. Salisbury and Hawley (2017) defined four periods for explorations of Everest:

1900–1949 – the actual exploratory period,

1950–1969 – the expeditionary period,

1970–1989 – the transitional period, and

1990–2006 – the commercial period.

These phases are interlinked with global events (e.g. end of the east-west conflict, globalization, climate change), as well as with Nepal's and Chinese history (Whelpton 2005; Baumgartner 2015 for opening up remote mountain regions and expedition paths by the Nepali Royal family). As Everest is located between Nepal and China, its warmer south-side is dominated by Nepal's governance, the cooler north-side of Everest is driven by China's governance. Historically, the south-side was more popular and received traditionally most attention. One reason is that the western media has a hard time to relate to, and operate in China. Still, the Chinese side of a climb is somewhat safer, and arguably better structured and planned (Nyima and Qiong 2019).

Baumgartner (2015) stated for the wider Everest region and its indigenous people:

> "*Today agro-pastoral livelihoods have given way to a highly successful engagement in the globalized mountaineering tourism of the Himalayas, organized from an urban base.*".

Switzerland, New Zealand, U.S. and Russia provide a rather wealthy organizational and accessible climber pool/base for instance (Baumgartner 2015 for details). Like other big mountain peaks (Horrell 2011), Everest reflects that global situation and it starts to represent a widely disturbed region: a global playground of the rich and their workers! It's a former wilderness area but still of global relevance (Jha and

Table 38.1 Phases in existence of Everest

Phase	What it means	Representative (Selection)
No humans	No human foot print	NA
Respect and taboo	Spiritual value, inherent value, peaks free of human disturbance	Indigenous people. For details see Miller (2003), Karmay and Watt (2007), Lama (2012)
National claims	Intense exploration and claims of peaks for national gain	E. Norton, G. Mallory, E. Hillary, Tenzing Norgay etc.
Alternative exploration	No limits, explore as you wish	R. Messner, C. Bonnington, J. Kukuzcka etc.
Intense commercialization	Being overcompetitive	J. Krakauer, J.Hall. D. Sharpe
Extremes and conflict	Trying other extremes and always new and more exciting routes and speeds	U. Steck (died April 2017), A.S. Kulkarni (died May 2019)

Fig. 38.2 Kala Patthar: Aspects of a high plateau wilderness surrounding Everest region in Khumbu

Kamal 2010; Fig. 38.2) and heavily changing (Byers 2017; Table 38.2) starting to be filled with large pollution, waste and dead climbers (https://weather.com/de-DE/wissen/umwelt/news/2018-06-18-mount-everest-verschmutzung/?cm_ven=focus_web_main), beyond the usual contamination (for air pollution see in-time weather station http://www.evk2cnr.org/cms/en/home.html).

But what really triggered how Everest is now used, treated and exploited by a global audience that is usually not familiar nor much sensitive with the complexities and the fabrics of this global and HKH indicator of earth's well-being? It's technology (Table 38.3) driven by commercialization (Baumgartner 2015), hype and greed (Heil 2009; Kodas 2009), and one cannot resist other than to make direct links with ruthless outfitters, poor governance (Nepal and China), money-making machines in globalization such as pharmaceutical companies, health care practitioners, stock markets and business entities and jobs, all of which allow to create such problems in the first place, usually done on the costs of people in HKH and Everest-like regions (Baumgartner 2015; Byers 2017 for wider impacts); the hype of the day is to climb all 8,000 ers in the world, Antarctica included. Modern globalization has no taboos.

App 60% of commercial expeditions for Everest and Lhotse are in the hand of foreign operators and where most money is made (Baumgartner 2015)! I personally know of operators from abroad who have climbed and guided Everest for over 20 times in 15 years. Nations with a large customer-base and climbing exploration mentality and such a drive come from Switzerland, Germany, the U.S., New Zealand, Russia Norway, Japan, China, Korea, Argentina and so on. In 2019 over 33 nations were involved in climbing Mt. Everest. All inclusive costs for an ascent are easily in the range of 70.000 US$ upwards and thus, industrialization and banking becomes a big machinery to make modern Everest a reality; it's not possible any other, aided by a governance that is thirty for money, greed and fame. The more western industrialization the more Everest…and the more deaths, and the more poor governance of mountains and wilderness areas, world-wide (because Everest is a global icon and role model. The author has for instance seen first-hand much bad

Table 38.2 Some details of Everest, the global celebrity to become a victim

Detail	Context
App. 800 people are climbing Everest every year	App 60% are achieving to be on Everest peak. These numbers are increasing every year; see Nyima and Qiong (2019) for updates. Overall, app. 4,469 people stood on the summit, thus far.
App. 297 people died when climbing Everest (2018)	This number is on the rise, too.
App. 200 dead bodies are located on Everest	Attempts have been made to bring down dead climbers but it is very costly and dangerous.
Two major base camps exist	Actually 'many' camps exist. But there are two major routes with a major base camp each, and they include smaller base camps (app 4 per route). This is for climbers, but trekkers stay in other camps and tea houses. However, new routes are set up and have more places for tents. The major base camps have administration, and several services.
High costs to climb Everest	App. 60,000US$ and more (100,000US$ is probably realistic). Most of the money in this industry does not arrive in Everest nations. Beyond money, it also costs much time to prepare, and to de-brief such a major expedition.
Time is money	Initial expeditions easily ran 2 months or longer. Nowadays, 6 weeks can be seen, and some even try for less. New techniques of high altitude adjustment done 'at home' via oxygen tents etc. provide dramatically different timings and new approaches to high altitude climbing. 'Slowliness' is a thing of the past.
Jam around the area of two ping-pong tables	The peak area of Mt. Everest, which is getting overcrowded by selfy-takers (climbers) resulting into death falls and delays in the ascent and descent with fatal consequences (Nyima and Qiong 2019). A peak jam is widely presented now and speaks to these facts.

mountain governance in the Alps and in Patagonia and with their peaks for instance). Globalization has its specific victims, beyond Everest itself.

It comes by itself then that with few exceptions, and as described by Baumgartner (2015), only rich people can really afford to be on Everest. Those are often the least trained ones (Krakauer 1997), and those are the ones that have died; apart of the supporting Sherpas to enable such operations in the first place (Table 38.4 for selected cases; see Textbox on diseases like the commonly found 'Khumbu Cough'). However, despite the western people making the news, the death list is actually widely lead by Nepalis (over 111 deaths). All of them can be classified as 'professional risk groups'. The Nepali aides are catering their richer masters from the west; all done without real unions, professional standards or training, salary structures or even ethics (see Baumgartner 2015). It should also be stated that expert Sherpas act on both sides, Nepali and Chinese, depending on offers and market demand.

High Alpine Mountaineering is a 'High Risk' activity. Accidents in climbing and mountaineering have a long history, e.g. Herzog (1952) for Annapurna. Everest is no exception but rather the rule. It's part of the game. Already the airport of Lukla (Tenzing-Hillary airport, Fig. 38.3) sets a good example (labeled as one of the most dangerous airports in the world but essentially 'the only' way to reach the Everest entry hike by air). The wife and daughter of Sir E. Hillary were among the first to be killed in Lukla (Baumgartner 2015), and so were many other people there (for

Table 38.3 Technology-events that changed Everest

Technology-change at Everest	Impact	Comment
Mapping	Location and access details became available.	This is the foundation of any exploration, as intensified during times of Enlightenment.
Establish a temporary basecamp	Exploitation infrastructure and logistics.	This became the starting point for most expeditions to Everest. The actual location got adjusted after avalanches and earthquakes to be 'safer'. It's the European style of mountaineering applied there.
Establish airport (Lukla)	This cuts short a hike to the area by 2–3 weeks	A major and dangerous bottleneck to this very day; several other airport locations were suggested too.
Use of oxygen bottles	This is a game changer because it extends the 'human niche'.	Having caches of such oxygen bottles available, and knowing how to use and share them, is a live or death factor.
Commercial guide companies	Now one can simply hire a guide (outfitter) and be successful.	A major part of commercialization where money can buy performance overcoming own shortcomings and skill!
Establish a permanent basecamp	This allows for greatly improved infrastructure and subsequent operations.	It's part of urbanizing Everest, western style.
Use of internet	Now one can connect with 'home' and global media are informed 'in-time'.	It's also part of urbanizing and globalizing Everest
Roped icefield bridges	Makes Everest (Khumbu icefield) less wild and 'more safe'.	Those roped bridge systems are to be maintained and re-done every season.
Contracted weather monitoring and forecasting	This is essential for modern expeditions to be successful, avoiding bad weather events	A major factor of success based on sophisticated monitoring, remote sensing, weather stations and expertise.
Use of helicopters	A major factor for evacuations	Until recently, helicopters could not really fly in very high altitudes. Now all can be done 'from air'.
Road access (North Side)	This can allow bus tours at the base camp	Mass tourism starts and commercialism is further achieved. A wilderness area is compromised for good.

(continued)

Table 38.3 (continued)

Technology-change at Everest	Impact	Comment
Train access (via China to Nepal); considered	Opening up Everest – and any wilderness region – for crazy development ideas. "It can be done" and no taboos exist.	While these Everest train stations currently are 'just' discussed, it sparks much associated development for such regions, e.g. tunnels, or for Mt. Kailash. A train is also discussed for Kathmandu, and it was already achieved in Tibet and Lhasa; connecting remote Tibet with Beijing and Paris and Moscow eventually, in-time! There is much precedence in the Alps (Switzerland) and certainly in the Canadian Rocky Mountains (Banff and Jasper). So why not Everest?

Table 38.4 Some widely-communicated recent accidents on Everest. Climbers and tourists as 'professional risk groups'

Accident detail	Short narrative	Source
Lost and overnight in high altitude	A Texan Doctor (Beck Weather) got lost and heavily injured for life	Weather and Michaud (2015), Krakauer (1997)
Death by exhaustion	A Japanese Doctor ("Sensei") was too exhausted to return safely	Baumgartner (2015; chapter VI)
Lost on Everest	Wealthy mountaineer (Michael Matthews); some dispute with guide on details of death	https://www.nzherald.co.nz/lifestyle/news/article.cfm?c_id=6&objectid=11678417
Assumed fall to death	Experienced and extreme record mountaineer (Uli Steck); details unknown	https://www.nytimes.com/2017/04/30/world/asia/ueli-steck-mountain-climber-dead-everest.html
Head injury	CEO (Dan Fredinburg) Google, climate activist	https://en.wikipedia.org/wiki/Dan_Fredinburg; Bloomberg (2015)
Avalanche	16 Sherpa/Nepali	Baumgartner (2015)
Exhaustion in Blizzard	Postal clerk (Doug Hansen)	Krakauer (1997)
Peak jam and overcrowding	11 climbers in 2019	Nyima and Qiong (2019); https://www.cnn.com/2019/05/27/asia/mount-everest-deaths-intl/index.html

The Everest Death list stands at 297. For a full list till 2006 see Salisbury and Hawley (2017), and for the updates https://en.wikipedia.org/wiki/List_of_people_who_died_climbing_Mount_Everest#Background; see also https://en.wikipedia.org/wiki/List_of_Mount_Everest_death_statistics

public information see for instance https://en.wikipedia.org/wiki/Tenzing%E2%80%93Hillary_Airport#Accidents_and_incidents). The bigger and better airport alternative, Namche Bazaar, was not implemented for years because it interferes with ongoing business in Lukla (Currently over 100,000 passengers per year). There are also very few pilots really that are able to fly to Lukla; hard to believe there is not a certain 'cast' that controls the market. But how many more people have to die for this?

Clearly, Everest is 'messed up' (Kodas 2009; Heil 2009; Horrell 2011, 2016; https://explorersweb.com/2018/05/11/how-to-remove-dead-bodies-from-mount-everest/). Its

Fig. 38.3 Lukla airport, Nepal, to reach Everest. Arguably one of the world's most dangerous airports in human history

million-year old peace is lost. Is a climbing embargo to be set? And with Everest, much else is broken because this is the highest peak in the world reflecting 'the world'. The deepest area on earth, the Mariana Trench (c. 11 km below sea surface) is now also polluted with plastics and otherwise! Virtually the entire range on earth with life, 8.8 km high above water and c. 11 km deep under water as well as the atmosphere is impacted, all caused by people. We live in the Anthropocene! It's not only the environment of the globe, but mankind and its values and culture that are broken, the global economy included and as the main driver (Daly and Farley 2010 see Naess 1989 for ecology, and Cockburn 2013 for a global Americanism).

The other sad story here is that not so much has been learned from the Everest experience yet, and other areas are just going through the same experience (Horrell 2011; see also Czech 2002. Huettmann 2012 for Antarctica where a basecamp is built to climb that highest peak of the southern continent: Mt. Vinson), and unless it gets addressed and constrained likely it will have similar outcomes there. Important drivers of such a highly industrialized society are the leaders and their direct beneficiaries and 'priests' of the bourgeoisie and 'business as usual', such as CEOs, Hedge Fund Managers and their well-paid care-takers in the medical community. Being in such a profession and world-leading position should come with mandatory ethics (Bandura 2007), and judged by the above-average death cases on Everest it means a stressed and dangerous life filled with the life-long quest for the real meaning of a life in balance with oneself and with Mother Earth… (Fig. 38.4).

> *"The mere living is not so important. The important thing is usefulness.*
> *So if I could get another hundred years more and be useful, then …good.*
> *Otherwise, you just create more problems for others."* (*IVX Dalai Lama in Hellstrom* 2016)

Fig. 38.4 Everest basecamp: A center and entry of globalization and human fate. Where to go from here?

Textbox

Khumbu Cough: An example of a wide-spread high altitude disease that 'everybody' there will catch

For people who decided to hike to Everest Base Camp – or similar sites in high altitude ecosystems of the Hindu-Kush Himalaya region - they are quite likely to catch the 'Khumbu Cough'. That is a relatively benign but persistent cough; it's characterized by an urge in the upper throat to cough "a lot". It's a certain form of pneumonia. But it has some unique characteristics. For one, you really do not want to get it in the way when you hike in those regions, or when wanting to climb Mt. Everest. It might easily spoil your endeavor, certainly you will be out of shape when being active. Secondly, it's rather persistent, and once you have it for a week, it might easily stay for another three weeks. You will be coughing frequently, and rather loud all the time. You can hardly communicate well because your conversations will be frequently interrupted by the strong urge "to always cough". And if you are beyond 2 weeks coughing, there is a strong danger it stays deeper and moves into your lung and sinuses. Antibiotics are the recommended cure.

Now it sounds like a good news that you are not alone with the Khumbu Cough; many people have it. Essentially, I have been in regions where virtually everybody has it. Arguably, it's a rough life at 4,000m onwards where the 'Khumbu Cough' rules. And the Khumbu Cough is not to be taken lightly.

(continued)

The author got the 'Khumbu Cough' several times, and he was lucky enough to got rid of it a few weeks later. Arguably, it was a confusing time though, specifically when back home and down from the 'Roof of the World', because it was not clear by then what a Khumbu Cough is and does…just a consistent coughing!

Somewhat mysterious for instance is the infection-path of this disease, as well as its spread. What gives you a cough, any cough ? Presumably, it enters via exhaustion and heavy breathing (which is rather the rule than the exception in such regions; so taking it easy for a day or two is never a bad idea regardless). One might also try a scarf or relaxed walking to avoid it; but shared kitchen settings, including spoiled tea cups might easily get you infected. There is hardly a way around an infection, really. One might find it very interesting that such a cough is rather widespread in the higher HKH region, somewhat endemic to 4,000m onwards. I detected it in Annapurna, as much as in Langtang and in Rolwaling as well as in Qhinghai Lake plateau and in remote Mongolia. Arguably, the western medicine has not gotten its grip yet on those regions, or its diseases. Several more diseases might be found there…Perhaps it's time to re-visit the ancient ways and Tibetan Medicine (Dhonden and Hopkins 1986) for what they really have to offer to the world while ignoring much of the western 'modern' commercial medicine, its one-sided practicioners and promoters?

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Part V
A Fresh Look and Successful Templates for HKH: ‘Business as Usual’ Is Dead

Chapter 39
Small and Effective NGOs as a Role Model for Bigger Success: The Global Primate Network (Now 'Third Pole Conservancy')

Dikpal Krishna Karmacharya, Tirth Raj Ghimire, and Ganga Ram Regmi

39.1 Introduction

Non-governmental organizations are commonly referred to as NGOs. These are usually non-profit organizations with a certain tax exempt status that are active in humanitarian, educational, health care, public policy, social, human rights, environmental, and other areas expected to bring changes according to their mission, vision and objectives. Environmental NGOs are actually less abundant when compared with all the other NGO missions that exist. NGOs are usually funded and run by private donations, charity and competitive grants but some avoid formal funding and are run primarily by volunteers. In the past few decades, there has been a rapid growth in the numbers of NGOs involved in the development. According to the Social Welfare Council, there were 50,358 NGOs registered between 1978 and July 2019 in Nepal. Majority of them were registered in community and rural development sector, followed by youth services and women services. Similarly, there were 245 international non-governmental organizations (INGOs) registered between 1978 and July 2019 (SWC 2019). The number of people working for NGOs is increasing day by day. The amount of money that flows into these voluntary agencies working in the activities such as disaster management and relief, development, public health, rehabilitation, environment protection, wildlife protection and so on

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D. K. Karmacharya (✉) · G. R. Regmi
Third Pole Conservancy, Kathmandu, Nepal
e-mail: dikpal.karmacharya@gmail.com

T. R. Ghimire
Animal Research Laboratory, Faculty of Science, Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur, Nepal

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are also raising tremendously. These organizations are supporting government bodies in diverse sectors for the development and welfare of societies. The importance of NGO involvement in environmental protection and awareness is probably acknowledged worldwide. NGOs can play remarkable role to agenda-setting and to sensitize policy makers for the priorities. They can also contribute significantly by undertaking scientific research, collaborative conservation measures, providing training to local communities and by making publications on conservation and development-related issues. We find it is worthwhile to uphold and encourage small, local level NGOs that can provide institutional support for the specific local needs.

There are actually thousands of NGOs working in the field of environment and wildlife protection worldwide. Some of these NGOs are global players and really big in terms of annual budget flow, working areas and number of staffs involved worldwide such as WWF, ICIMOD, CI, WCS, Panthera etc. Some are very small but emerging with just a little amount of money in short period of time. Here, an example of small NGOs is presented for its complexities and impacts.

39.2 Global Primate Network – Nepal

As part of a small NGO start-up, Global Primate Network (GPN)-Nepal was founded as a non-governmental, non-political and non-profit organization (Regd. no. 524/2065/2066) on 24th Nov 2008 by a team of young wildlife researchers from Nepal. It was established with the aim of promoting science-based conservation of wildlife and its habitat in Nepal Himalaya.

GPN-Nepal is dedicated to safeguard the future of wildlife through scientific research and community outreach programme. Its wider aim is to conserve wildlife through people's participation by developing and promoting local citizen scientist achieved through necessary training and skill development programmes. Also, this organization works with schools in remote community to engage young school children making them awareregarding the wildlife conservation through informal class and extra-curricular activities. This not only benefits their education but also has positive impacts on the people and wildlife in their community. Besides wildlife research and conservation, GPN also works on several other themes like livelihood improvement, climate change, biodiversity conservation and nature based tourism. Some of those are presented next:

Mission: GPN-Nepal aims to safeguard the future of wildlife along the Himalaya through scientific research and conservation

Vision: GPN-Nepal envision a future where local citizen scientist taking initiative to conserve the wildlife and local communities supporting their campaign

Priorities

- Promote the science-based conservation of wildlife
- Develop and promote local citizen scientist through necessary training and skill development programmes

- Improve the livelihood of local community through biodiversity conservation, climate change adaptation and tourism promotion.

39.3 Wildlife Research and Conservation Projects Completed by GPN Team

Nepal occupies about 0.1% of the global area, but harbors 3.2% and 1.1% of the world's known flora and fauna, respectively (MoFSC 2014). Many of them are threatened due to numbers of anthropogenic and natural threats. Some are under the blink of local extinction and some are still unexplored. To explore the unexplored wildlife, to know their ecology and to ensure safe future of existing wildlife via science based conservation in Nepal, the team is conducting good numbers of wildlife research and conservation projects supported by national and international funding agencies. Some of them are listed in Appendix 1.

39.4 Conferences/Seminars/Trainings Attended and Presented by GPN Team

The GPN team has been exposing in front of global conservation platforms by presenting their work and participating in the national and international conferences, seminars and trainings to disseminate their research and conservation work with international media, senior experts, policy makers and early researchers. Some of the conferences, seminars and trainings attended and presented are listed in Appendix 2.

39.5 Award and Felicitation Received by GPN Team

Due to continuous outstanding performance and contribution in wildlife research and conservation, the GPN team has received national and international awards and felicitation. Some of them are listed in Appendix 3.

39.6 Research and Conservation Grants Received by GPN Team

GPN has raised ~USD 300,000 between 2007–2018 (Fig. 39.1) from the international organizations, zoos and societies (Fig. 39.2) for the research and conservation of primates, red panda, vultures and wild cats in Nepal. Details of the grants are given in Table 39.1.

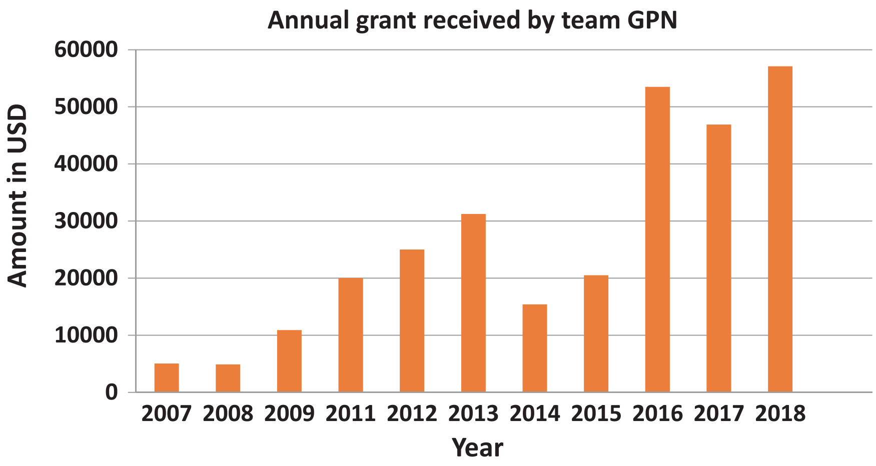

Fig. 39.1 Annual funds raised by team GPN up to March 2018

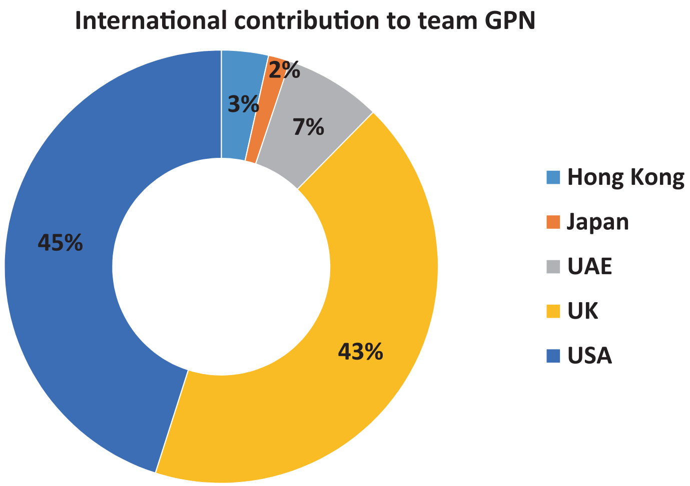

Fig. 39.2 International contribution to team GPN

The above figures and Table 39.1 show that GPN team is able to raise international and prestigious conservation and research funds though in small scale by writing grants which is very competitive process. These grants directly go to field activities which ultimately benefits the species conservation, their habitat preservation and local communities. Maximum of the funds are expended in field and project activities (Fig. 39.3).

Table 39.1 Details on grants received by GPN team

S.N.	Grant received year	Name of donor	Country	Received amount	Received for	Project geographic area	Grant in USD
1	2018	Snow Leopard Conservancy	USA	USD 57,102	Snow Leopard Conservation project	Annapurna Conservation Area, Nepal	57,102
2	2017	Snow Leopard Conservancy	USA	USD 37,900	Snow Leopard Conservation project	Annapurna Conservation Area, Nepal	37,900
3	2017	Mohamed bin Zayed Species Conservation Fund	UAE	USD 2000	Pallas's cat conservation project	Annapurna Conservation Area, Nepal	2000
4	2017	Rufford Foundation	UK	GBP 5000	Snow Leopard conservation radio programme	Nepal Himalaya	7000
5	2016	Snow Leopard Conservancy	USA	USD 25,000	Snow Leopard Conservation project	Annapurna Conservation Area, Nepal	25,000
6	2016	Mohamed bin Zayed Species Conservation Fund	UAE	USD 7500	Pallas's cat conservation project	Annapurna Conservation Area, Nepal	7500
7	2016	Rufford Foundation	UK	GBP 10,000	Vulture conservation project	Annapurna Conservation Area	14,000
8	2016	Rufford Foundation	UK	GBP 5000	Pallas's cat conservation project	Annapurna Conservation Area	7000
9	2015	Mohamed bin Zayed Species Conservation Fund	UAE	USD 6500	Pallas's cat conservation project	Annapurna Conservation Area, Nepal	6500
10	2015	Rufford Foundation	UK	GBP 10,000	Assamese Monkey conservation project	Mai Valley, East Nepal	14,000

(continued)

Table 39.1 (continued)

S.N.	Grant received year	Name of donor	Country	Received amount	Received for	Project geographic area	Grant in USD
11	2014	Rufford Foundation	UK	GBP 5000	Pallas's cat conservation project	Annapurna conservation area	7000
12	2014	Rufford Foundation	UK	GBP 5995	Vulture conservation project	Annapurna Conservation Area	8400
13	2013	Mohamed bin Zayed Species Conservation Fund	UAE	USD 5000	Pallas's cat conservation project	Annapurna Conservation Area, Nepal	5000
14	2013	Oriental Bird Club	UK	GBP 1000	Vulture conservation project	Annapurna Conservation Area	1400
15	2013	Whitley Wildlife Conservation Trust	UK	GBP 250	Vulture conservation project	Annapurna Conservation Area	350
16	2013	Rufford Foundation	UK	GBP 6000	Amphibian conservation project	Annapurna Conservation Area	8400
17	2013	Rufford Foundation	UK	GBP 6000	Cheer Pheasant conservation project	Western Nepal	8400
18	2013	Whitley Wildlife Conservation Trust	UK	GBP 500	Cheer Pheasant conservation project	Western Nepal	700
19	2013	Columbus Zoo and Aquarium	USA	USD 7000	Cheer Pheasant conservation project	Western Nepal	7000
20	2012	Rufford Foundation	UK	GBP 5950	Vulture conservation project	Annapurna Conservation Area	8340

(continued)

21	2012	Rufford Foundation	UK	GBP 11,900	Assamese Monkey conservation project	Nepal	16,680
22	2011	Rufford Foundation	UK	GBP 5950	Cheer Pheasant conservation project	Western Nepal	8340
23	2011	American Society of Primatologists	USA	USD 1500	Assamese Monkey conservation project	Eastern Nepal	1500
24	2011	Ocean Park Conservation Foundation	Hong Kong	HK$ 80,000	Assamese Monkey conservation project	Eastern Nepal	10,193
25	2009	Oregon Zoo Foundation	USA	USD 2500	Red Panda conservation project	Eastern Nepal	2500
26	2009	Rufford Foundation	UK	GBP 6000	Assamese Monkey conservation project	Langtang National Park, Nepal	8400
27	2008	Rufford Foundation	UK	GBP 1000	Assamese Monkey conservation project	Langtang National Park, Nepal	1400
28	2008	Chester Zoo	UK	GBP 2500	Vulture conservation project	Nawalparasi and Dang Deukhuri Foothill Forests IBAs, West Nepal	3500
29	2007	Primate Society of Great Britain	UK	GBP 250	Assamese Monkey conservation project	Langtang National Park, Nepal	350
30	2007	Nagao Natural Environment Foundation	Japan	Japan Yen 5,00,000	Red Panda conservation project	Langtang National Park, Nepal	4700
Total							290,555

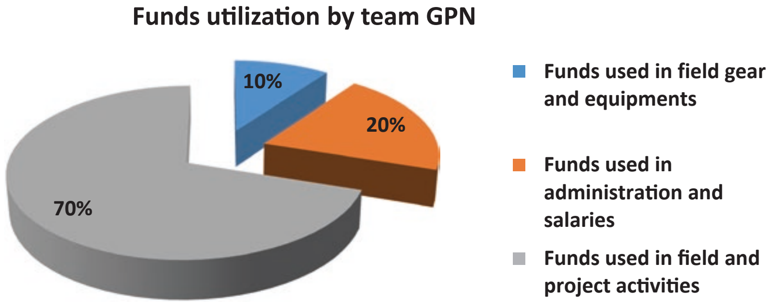

Fig. 39.3 Funds utilization by team GPN

39.7 Major Achievements by GPN (Few Examples)

39.7.1 Diclofenac Free District Declaration

Diclofenac – the non-steroidal anti-inflammatory drugs (NSAID) has been identified as major cause of vulture decline in Indian sub continent (Oaks et al. 2004; Swan et al. 2006). Global vulture conservationists are struggling for banning of this drug with the alternative safe drug meloxicam. GPN jointly with District Livestock Service Offices and Bird Conservation Nepal (BCN) organized diclofenac free zone declaration programmes in Manang (Fig. 39.4) and Mustang (Fig. 39.5) districts to remove the toxic drug diclofenac from the range of natural habitat of vulture. Manang and Mustang Districts of Annapurna Conservation Area (ACA) have been declared as Diclofenac Free Districts by Chief District Officers (CDOs), Local Development Officers (LDOs) and District Livestock Service Officers (DLSOs) of Manang and Mustang in Chame and Jomsom on 14th and 21st May, 2013 respectively. Altogether 77 people from different local government agencies, District Health Office (DHO), District Agriculture Development Office (DADO), District Forest Office, District Education Office (DEO), Women Development Office, District Finance Control Office, National Investigation Department Office, Local conservation agencies, NTNC-Annapurna Conservation Area Project (ACAP) Manang and Mustang Unit Conservation, different political parties leaders, other Governmental and Non-Governmental Organisation (NGO) representatives, Community Based Organization (CBO) representatives, journalists, media person, local farmers, parents and students were actively participated in the programmes.

39.7.2 One Day Distance Sampling Workshop

One-day Distance Sampling Workshop has been completed successfully on 25th August, 2012 at Hotel Palagya, Kathmandu. The training benefited 23 young researchers from Central Department of Zoology, Central Department of

Fig. 39.4 Diclofenac free district declaration programme in Manang

Fig. 39.5 Diclofenac free district declaration programme in Mustang

Fig. 39.6 Participants in one-day Distance Sampling Workshop

Environmental Science, Tribhuvan University and faculties from affiliated colleges, conservation agencies and Department of National Parks and Wildlife Conservation. We would like to acknowledge all the partner agencies and Professor FALK HUETTMANN, -EWHALE lab- University of Alaska Fairbanks (UAF), USA for his outstanding contribution as Resource Person and Lectures in the training workshop (Fig. 39.6).

39.7.3 Workshop on Open GIS

GPN has successfully completed a one-day workshop on 'Open Source GIS' on the occasion of World Environment Day – 2014 to upgrade the GIS knowledge of University students. Altogether 15 participants from Central Department of Zoology, Central Department of Environmental Science, Tribhuvan University, Golden Gate College, Institute of Forest, Hetauda Campus actively participated in the event. The workshop was led by Professor FALK HUETTMANN, -EWHALE lab- University of Alaska Fairbanks (UAF), USA.

39.7.4 World Environment Day Celebration

GPN is supporting to local community based organizations of Terai region and Annapurna region to celebrate World Environment Day since 2012. Annually more 300 local people from Terai region and more than 80 people from Himalayan region are upgrading their knowledge on environmental issues from such events.

39.7.5 Wildlife Week Celebration

GPN is also supporting to the Green Organizations based at Institute of Forestry, Pokhara campus to celebrate a week long educational outreach programme called ‘Wildlife Week’ since 2016, which is celebrated in every first week of Nepali New Year. More than 500 local people and forestry students improve their knowledge on wildlife research and conservation from the diverse experts during this week each year.

39.7.6 Conservation Awareness and Capacity Buildup Programmes

GPN team has launched more than 50 school and community awareness programmes as well as capacity buildup programmes for the local people from east to west and north to south of Nepal which made aware on conservation to more than 4000 local audiences. In addition, the capacity buildup programmes produces more than 30 citizen scientists that are still engaging in wildlife research and conservation in Terai region and Himalayan region staying close contact with GPN team. Most of them are making their career by earning through wildlife tourism services.

39.7.7 Snow Leopard Radio Programme

A radio programme Hiu Chituwako Serofero (Snow Leopards’ Surroundings) was started in 2016 to deliver the information and importance of snow leopard in the Nepal Himalaya. The radio programmes aired the conservation issues, challenges and possible wildlife friendly solutions to overcome these challenges to save the snow leopard and other important wildlife of the mountain ecosystems such as wolf, Pallas’s cat, vultures and principal prey species like blue sheep, Himalayan tahr, musk deer and pika. The programmes were broadcasted from 10 stations in 10 Snow Leopard range Himalayan districts of Nepal. The total estimated audience of the radio programmes was more than one million with critically living aside snow leopard habitat was 50,000 in all over snow leopard range districts in Nepal Himalaya.

Fig. 39.7 Camera trapping team setting trail camera at high in the Himalaya

39.7.8 Camera Trapping

GPN has been monitoring snow leopard and other carnivores by using remote cameras in Humla, Manang, Mustang and other remote areas of the Himalayas. The camera-trapped images and data are also sharing with the Nepal Government and NTNC-ACAP under their request (Fig. 39.7).

39.7.9 Foxlight Monitoring and Distribution

Herder-snow leopard conflict due to the livestock depredation is one of the major threats for snow leopard. Considering this fact, Snow Leopard Conservancy (SLC) and GPN have been implementing nonlethal but innovative predator deterring techniques such as foxlight since last 2 years. The GPN staffs have been distributing and installing these foxlights in the herders' camp in Manang and Mustang. In 2017, total 30 non-lethal, predator friendly and innovative foxlights were distributed to minimize snow leopard-herder conflict and to reduce the threats of snow leopard in Manang and Mustang. These lights, though still in testing phase, have been working very well to deter the predators in night time. Herders have very positive responses towards these lights and committed to protect snow leopards in their local areas. The foxlights project is successful in Nepal so far though we need to wait for next couple of years to see its effectiveness (Fig. 39.8).

Fig. 39.8 A herder with installed Foxlight

39.7.10 In-Kind Support to Local Herders

GPN team has distributed warm jackets, powerful flashlights and radios to 30 local herders in ACAP to support in mitigating herder and Snow Leopard conflict. These stuffs help them to cope with the harsh weather while herding in remote and cold high-altitude pastureland. The herders are very happy and positive towards the team for supporting snow leopard conservation programmes in their native landscapes. Flash light help them to search their lost cattle at night time, the jackets keeps them warm from windy climate and radios are their friends to communicate with conservation messages.

39.7.11 Celebrating International Snow Leopard Day in the Himalaya, Mustang for the First Time

The International Snow Leopard Day was celebrated on 23rd October, 2018 for the first time in Mustang, Nepal which was jointly organized by Modification Jomsom, Global Primate Network-Nepal, Snow Leopard Conservancy, NTNC- Annapurna Conservation Area Project Jomsom.

With the slogan of 'Unity of Mustang, Commitment to protect Snow Leopard', a team including >100 people (students, various social organization, civil societies, elected public representatives, Nepal Police, Nepal Armed Forces and Journalist groups) rallied around the Jomsom bazaar. Starting from the Jomsom airport, the rally summed up with the official programme at Janahit Secondary School (for more details on event https://www.rufford.org/files/26034-1%20December%202018.pdf).

39.7.12 Wildlife Conservation Awareness Gaijatra Festival

GPN has organized a mega conservation campaign called ‘Conservation Awareness Gaijatra’ on 1st September, 2018 on the occasion of globally renowned national festival ‘Gaijatra’. A mass of more than 200 people gathered and performed local stick dance (Ghintanghisi) with cultural music releasing wildlife conservation messages via play-cards, pamphlets, banners, masks and t-shirts. A campaign completed the circuit of ancient Bhaktapur city by three walking-hours. More than 70,000 local farmers, children, youth, national and international visitors observed and enjoyed the ‘Wildlife Conservation Awareness Gaijatra festival’ (for more details on event https://www.rufford.org/files/26284-1%20September%202018.pdf.

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Appendixes

Appendix 1: Wildlife Research and Conservation Projects Completed by GPN Team

1. Pallas's cat (*Otocolobus manul*) conservation project. Supported by Mohamed bin Zayed Species Conservation Fund in 2013, 2015, 2016, 2017. https://www.speciesconservation.org/case-studies-projects/pallass-cat/7058
2. Developing Radio Programmes for Mass Media Awareness about Endangered Snow Leopard in the Eastern Himalayas of Nepal. Supported by Rufford Foundation, UK in 2017. https://www.rufford.org/projects/ganesh_puri
3. Eyes in the Sky: Use of Conservation Drone for Long Term Ecological Monitoring and Conservation of Globally Threatened Vultures in Himalayan Regions of Nepal. Supported by Rufford Foundation, UK in 2016. https://www.rufford.org/projects/dikpal_krishna_karmacharya_1
4. Empowering and Educating Local Communities for the Conservation of Pallas's Cat (*Otocolobus manul*) in Manang Valley, Annapurna Conservation Area, Nepal. Supported by Rufford Foundation, UK in 2016. https://www.rufford.org/projects/rinzin_phunjok_lama_0
5. Mitigating Human-Assamese Monkey Conflict in Upper Mai Valley, East Nepal. Supported by Rufford Foundation in 2015.https://www.rufford.org/projects/ganga_ram_regmi
6. Abundance, Distribution and Conservation Initiative of the Pallas's Cat (*Otocolobus manul*) – The New Cat Species for Nepal. Supported by Rufford Foundation, UK in 2014. https://www.rufford.org/projects/rinzin_phunjok_lama
7. Population Modelling and Participatory Conservation of Endangered Vultures in Nepal Himalaya. Supported by Rufford Foundation, UK, Whitley Wildlife Conservation Trust, UK, Oriental Bird Club, UK and IDEA WILD, USA in 2014. https://www.rufford.org/projects/dikpal_krishna_karmacharya_0
8. Diversity and Distribution of Amphibians in Annapurna Conservation Area, Nepal. Supported by Rufford Foundation, UK in 2013. https://www.rufford.org/projects/bikas_giri
9. Educating and Empowering Local Communities for Cheer Pheasant (*Catreuswallichii*) Conservation in Western Nepal. Supported by Rufford Foundation, UK and Columbus Zoo and Aquarium, USA in 2013. https://www.rufford.org/projects/kamal_kandel
10. Extensive Exploration and Conservation of Himalayan Vulture in Annapurna Conservation Area. Supported by Rufford Foundation, UK in 2012. https://www.rufford.org/projects/dikpal_krishna_karmacharya
11. Mapping Crop-Raiding Hotspots and Predicting Actual Crop-Raiding Risk Using a Spatial (GIS) Model for Alleviating People-Primate Conflict in Nepal. Supported by Rufford Foundation, UK in 2012. https://www.rufford.org/rsg/projects/ganga_ram_regmi_1

12. Estimating Group Density of Assamese macaque Macaca assamensis using Multiple Covariate Distance Sampling (MCDS) in Lower Kanchenjungha Area (LKA), Eastern Nepal. Supported by Primate Society of Great Britain, UK (http://www.psgb.org/conservation_grants.php), American Society of Primatologists, USA (https://www.asp.org/grants/conservation/recipients.cfm?section=8) and Ocean Park Conservation Foundation, Hong Kong (https://www.opcf.org.hk/en/) in 2011.
13. Distribution and Occupancy Modelling of Globally Threatened Cheer Pheasant (*Catreuswallichi*) in Nepal Himalaya: Implications for Strategic Conservation Planning.Supported by Rufford Foundation, UK in 2011. https://www.rufford.org/rsg/projects/kamal_kandel
14. Status of Red Panda in Eastern Nepal. Supported by Oregon Zoo Foundation, USA in 2009.
15. Community Outreach and Conservation Education Programme for the Conservation of Assamese Macaques in Langtang National Park, Nepal. Supported by Rufford Foundation, UK in 2009. https://www.rufford.org/rsg/projects/ganga_ram_regmi_0
16. Population Status, Threats and Conservation Measures of the Assamese Macaque in Langtang National Park, Nepal. Supported by Rufford Foundation, UK in 2008. https://www.rufford.org/rsg/projects/ganga_ram_regmi
17. Comparing Breeding Success of Critically Endangered White-rumped Vulture Gyps bengalensis in Nawalparasi and Dang Deukhuri Foothill Forests IBAs, West Nepal. Supported by Chester Zoo, UK in 2008. http://www.chesterzoo.org/conservation-and-science
18. The red panda *Ailurus fulgens* in Langtang National Park: an assessment of their conservation status. Supported by Nagao Natural Environment Foundation (NEF), Japan in 2007. http://www.nagaofoundation.or.jp/e/research/awarded/index.html

Appendix 2: Conferences/Seminars/Trainings Attended and Presented by GPN Team

1. International Workshop on 'Silk Road and Crane Culture' held at Hangzhou Bay National Park, China on 4th December, 2019 organized by Beijing Forestry University, Beijing, China.
2. International Symposium on Crane Migration on Silk Road and Crane Culture Transmission' held at Shanghai Natural History Museum, China, on 30th November, 2019 organized by Beijing Forestry University, Beijing, China.
3. Workshop on 'Jaibik Map: Biodiversity and Climate Change Tool for the Future' held at Hotel Summit Kupandol on 21st February, 2019 organized by Ministry of Forest and Environment, and IUCN, Nepal.

4. Workshop on 'Species Distribution Modeling' held at Central Department of Botany (CDB) on 17th January, 2017 organized by Queens College, City University of New York (CUNY) and CDB, TU, Nepal.
5. Rufford Foundation's Grant Recipients Conference, Nepal, 29–30 January, 2018. Organized by Institute of Forestry, Hetauda Campus, TU, held at Hotel Marsyangdi Kathmandu, Nepal.
6. THIRD INTERNATIONAL CONFERENCE FOR COMPASSIONATE CONSERVATION, Blue Mountains, NSW, Sydney, Australia (20–24 November, 2017)
7. First International Small Wildcat Conservation Summit (10–14 September 2017)
8. Student Conference on Conservation Science (SCCS), New York, 20–22 October, 2016. Organized by The Center for Biodiversity and Conservation, held at American Museum of Natural History, New York, USA.
9. 7th National Conference on Science and Technology, 29-31st March, 2016. Organized by Nepal Academy of Science and Technology (NAST) held at Hotel Yak and Yeti Kathmandu, Nepal.
10. Student Conference on Conservation Science (SCCS), Beijing**,** 5–9 November, 2015. Beijing Forum, Peking University, China. www.beijingforum.org
11. Student Conference on Conservation Science (SCCS), Bangalore, India, 8–11 September, 2015. JN Tata Auditorium Hall, Indian Institute of Science (IISc), Bangalore, India. www.sccs-bang.org
12. Student Conference on Conservation Science (SCCS), Bangalore, India, 25–28 September, 2013. JN Tata Auditorium Hall, Indian Institute of Science (IISc), Bangalore, India. www.sccs-bang.org
13. Rufford Foundation's Grant Recipients Conference, Nepal, 13–14 January, 2012. organized by Department of National Parks and Wildlife Conservation (DNPWC), Nepal; Rufford Small Grant Foundation and WWF Nepal held at Kathmandu, Nepal.
14. Student Conference on Conservation Science (SCCS), Bangalore, India, 14-16thSeptember, 2011. JN Tata Auditorium Hall, Indian Institute of Science (IISc), Bangalore, India. www.sccs-bang.org
15. Students' Conservation Conference and Exhibition 5–7th June, 2011. National Trust for Nature Conservation (NTNC), Khumaltar, Nepal**.** www.ntnc.org.np

Appendix 3: Award and Felicitation Received by GPN Team

- Special Contribution Award at 2019 Poyang Lake International Birdwatching Competition on 8th December, 2019 from Jiangxi Forestry Bureau. Nanchang Municipal People's Government, China.
- Felicitation by Friends of Nature Nepal for the continuous contribution in wildlife research and conservation in Nepal, 2 Feb 2017.

- Best poster award 1st for presenting poster entitled 'Avifaunal diversity and distribution in Phewa Lake, Pokhara, Nepal received by Bikas Giri from SCCS Beijing 2015.
- Best poster award 2nd for presenting poster entitled 'Human monkey conflict in Pyuthan district western Nepal recieved by Shiva Hari Adhikari from SCCS Beijing 2015.
- Best poster award 3rd for presenting poster entitled 'Rays of Hope: Effectiveness of Local Conservation Efforts in Long Term Conservation of Endangered Vultures in Nepal Himalaya' received by Dikpal Karmacharya from SCCS Beijing 2015.
- Best talk award 2nd for talk presentation entitled 'Carnivores diversity and distribution in Manang, Nepal' received by Tashi R. Ghale from SCCS Beijing 2015.
- Best paper award 1st for talk presentation entitled 'Population Status, Breeding Success and Conservation Approaches Of Himalayan Griffon (Gyps himalayensis Hume, 1969) In Khodpe, Baitadi, Nepal' received by Dikpal Karmacharya from Student's conservation conference and Exhibition NTNC 2011.
- Jatayu Scholarship Award 2009–2010 for Vulture research received by Dikpal Karmacharya from Bird Conservation Nepal.

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Chapter 40
When Micro Drives the Macro: A Fresh Look at Disease and its Massive Contributions in the Hindu Kush-Himalaya

Tirth Raj Ghimire, Ganga Ram Regmi, and Falk Huettmann

40.1 Introduction

Due to changing climates, the 'new' modes of living by the people, and increased natural disasters, unprecedented outbreaks of emerging and reemerging diseases have been occurring since many years by now. Their outbreaks have been further critically important in the public and for veterinary health because of their immediate effects leading to disability, death and long-term illness of humans and animals. It's clearly a society issue and dealing with the wider public health, now on a global scale. Thus, with the emergence of suitable climates, vectors, and hosts, microspecies (ms) like viruses, rickettsia, bacteria, protozoa, helminths, and fungi actually are the underlying causes of high morbidity and mortality of macrospecies (MS) like humans, animals, and plants in a wide geographic condition. That is why presence of ms can determine the survival value of the MS with reference to geography and time. The aim of this chapter is to explain a clear causal understanding of the diseases, their causal agents (e.g., ms), and the hosts (e.g., MS) in the context of Nepal, a well-known country in the Hindu Kush-Himalaya (HKH) region and a

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T. R. Ghimire (✉)
Animal Research Laboratory, Faculty of Science, Nepal Academy of Science and Technology (NAST), Khumaltar, Lalitpur, Nepal
e-mail: tirth.ghimire@nast.gov.np

G. R. Regmi
Third Pole Conservancy, Kathmandu, Nepal

F. Huettmann
-EWHALE Lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA

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typical example of complex landscapes in terms of altitudinal gradients, climate, bio-diversity, watersheds and culture.

40.2 Biodiversity of Nepal

Nepal makes for an inherent part of the wider HKH region that comprises all of Bhutan and the mountainous parts of Afghanistan, Bangladesh, China, India, Myanmar, and Pakistan; it also reaches further than those nations. Physiographic and bioclimatic zones range from less than 500 m of terai to more than 5000 m of high Himalayan region (GoN/MoFSC 2014). Thus, the northern or Himalayan region of the country accounts for the 15% of the area. The central belts or middle hills occupy 68% of Nepal. The southern low-lying plain or terai region is susceptible to flooding following monsoon and occupies 17% of the country (Amatya 2016). In addition to this altitudinal landscape, there are a total of 118 different ecosystems with 112 forest ecosystems, 4 cultivation ecosystems, 1 water body ecosystem, and 1 glacier/snow/rock ecosystem (GoN/MoFSC 2014). This variety of ecosystem accompanied with the landscape differences are the underlying cause of existence of various floral and faunal diversities. For example, the flora comprises the tropical and subtropical rainforest, temperate broadleaved-deciduous or mixed forest, and temperate coniferous forest with high-altitude cold shrub or steppe and cold desert (Lamadrid and Kelman 2012). The country is a habitat for a total of 208 species of mammals (Jnawali et al. 2011), 879 species of birds (Shrestha 2000), 206 species of herpetofauna including 59 amphibian species (Shrestha 2001), 232 species of fish fauna (Shrestha 2008b), 138 species of molluscs (Budha et al. 2015), and 17 species of domestic animals including 5 bovidae, 7 Aves, 2 Equidae (not including mules), pig (*Sus scrofa*), rabbit (*Oryctolagus cuniculus*), and elephant (*Elephas maximus*) (Wilson 1997). This sets the stage for zoonotic diseases and for a disease reservoir.

Due to ecologic diversities, Nepal is highly preferable to the local people and outsiders. It possesses complex socio-economic, religious, ethnic, linguistic, cultural, and socio-health diversities. These diversities along with other factors like climate change, population dynamics, and land use changes and globalization directly or indirectly determine the health status of animals and humans alike. Among these factors, climate change primarily leads to a deterioration of water quality, degrades air quality with a high concentration of pollutants like nitrogen dioxide and airborne-particles, increases lower tropospheric and ground-level ozone levels, and finally follows systematic temperature increase, for example, 0.01–0.04 °C per annum enhances the spread of disease agents at higher elevations at which they did not occur before (Sarkar 2011).

40.3 The Traditional Understanding of Disease

Disease means any abnormality that affects the structure and function of a part of body, organ, tissue, cell, or a molecule of an organism. Disease may be caused by various smaller species, so called ms such as viruses, bacteria, rickettsia, fungi, protozoa, helminths, and arthropods. Interestingly, these ms have been denoted as 'agents' in the epidemiologic triad in which antibiotic resistivity, antigenic stability, antigen expressions, dose, enzyme production, host specificity, host survival, immunogenicity, infectivity, virulence, toxicity, pathogenicity, reservoirs, sources, and modes of dissemination of ms play a critical role (Wilber et al. 2017; Keane 1997; Ghimire 2014) (Fig. 40.1). In this triad, hosts including humans and animals, or MS in this text, are those species that harbor the disease agents or ms. The age, behavior, genotype, and hormonal, immune, nutritional, occupational, physiological, and socio-economic status of the MS play the role in epidemiologic triad. The MS may act as reservoir, definitive, transport, intermediate hosts, and carriers for the successful adaptation to the agents.

The ms is either directly transmitted via direct contact (e.g., HIV, *Treponema pallidum*), droplet infection (*Mycobacterium tuberculosis*), contact with soil (e.g., *Ascaris, Ancylostoma, Enterobius*), trans-placental (e.g., *Leishmania, Toxoplasma*), food (e.g., Coccidia, *Fasciola, Clonorchis*), water (e.g., Coccidia), sexual contact or inoculation into skin or mucosa (e.g., HIV, *Treponema pallidum*, *Trichomonas fetus, T. vaginalis*). In addition, indirect transmission through vehicle (e.g., mosquitoes, bedbugs, lice), air (e.g., *Ascaris*, *Enterobius*), fomite (e.g., *Salmonella*), finger (e.g., foodborne pathogens), and various arthropods (eg *Plasmodium, Trypanosoma, Leishmania*) or molluscan vectors (e.g., *Fasciola, Clonorchis*) occurs in various diseases. These vectors can obtain the ms during feeding the nutrients like amino acids and non-nutrients like blood of the MS. The ms can enter into the body of the suitable MS via different portals of entry, for example, the mouth (e.g., gastrointestinal or GI pathogens), eyes (e.g., *Loa loa*, *Thelazia callipaedia, Acanthamoeba*), ear (e.g., *Otobius*), nose (virus, *Oestrus ovis*, *Acanthamoeba,* and *Naegleria*), anus (e.g., *Giardia lamblia*, *Cryptosporidium*, *Strongyloides, Enterobius*), genital organs like vagina and penis (*Trichomonas vaginalis,* HIV*, Treponema pallidum*), and skin (*Ancylostoma, Strongyloides, Plasmodium, Leishmania*).

When the ms enter into the body, they search for a suitable environment and multiply and initiate the disease depending on the immune system of MS. It is, therefore, important to determine early enough whether symptoms may appear or not at this stage. Finally, ms exit out of the body via urino-genital (e.g., HIV), respiratory (*Mycobacterium*), and digestive system (e.g., GI parasites). As a result, the ms is transmitted into environment containing reservoirs or into another MS directly, or into arthropod, annelid, molluskan, and mammalian vectors. In these contexts, reservoir is a natural habitat of ms that includes MS (e.g., all pathogens), arthropod like insects (e.g., *Plasmodium, Leishmania*), arachnids (*Sarcoptes scabei*), and mollusks (e.g., *Schistosoma*, *Fasciola, Clonorchis*), plant (e.g., *Fasciola*), soil (Coccidia, *Ascaris, Clostridium tetani*), or substance, or a combination of them in which an ms

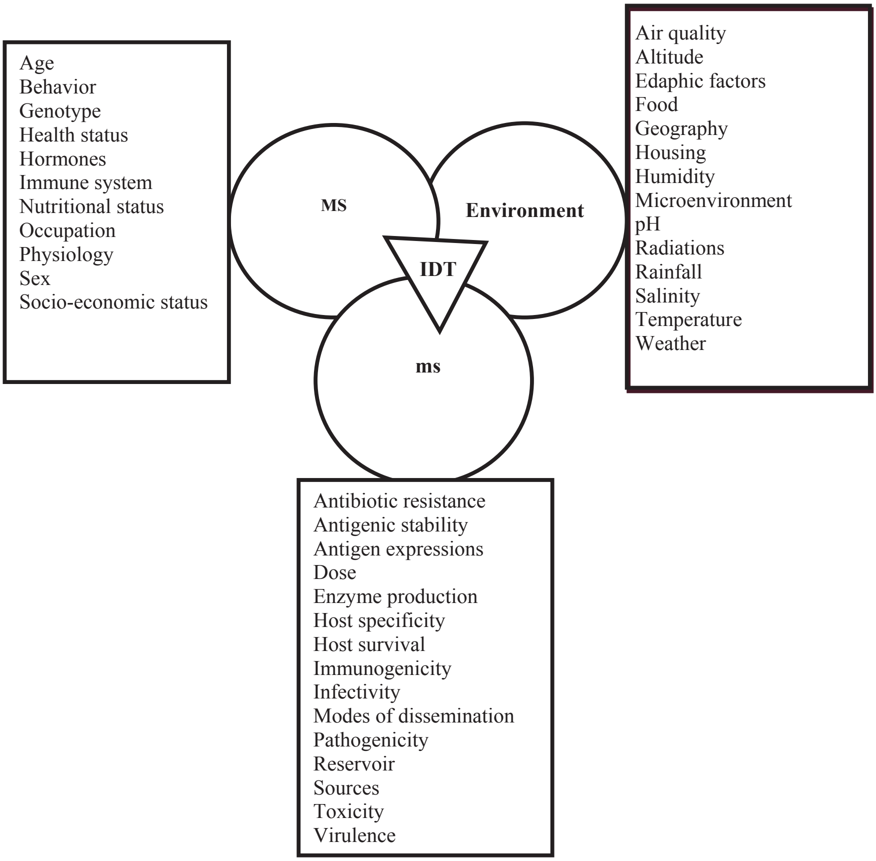

Fig. 40.1 Understanding of diseases based on the traditional 'Infectious Disease Triad Model'. To transmit, initiate, and establish disease, various factors of MS, ms, and environment play a critical role with reference to geography and time. The triad can be used to assess the role of pathogens in morbidity and mortality following outbreaks of diseases. Modified after (Keane 1997; Ghimire 2014; Snieszko 1974). *MS* macrospecies, *ms* microspecies, *IDT* Infectious Disease Triad

normally lives, grows, and adapts leading rapid multiplication in a fashion that it can be transmitted to a suitable host. This pattern of chain of infection involving a series of journey of ms from reservoirs to susceptible hosts through various modes of transmission produces the dynamics of disease transmission. In this context, the third member of epidemiologic triad or the environmental factors such as climate, temperature, humidity, micro-and macro-environment, topography, zoogeography, host specificity, light, salinity, pH (hydrogen ion concentration), percent gases, soil, water, food quality, and nutrients are important. These factors determine the successful invasion, establishment, and transmission of the ms leading outbreaks of the diseases and morbidity and mortality of the MS (Ghimire 2014; Yan et al. 2016; Si et al. 2010; Roberts and Wiedmann 2003; Keane 1997).

40.4 Contribution of Microspecies (ms) to Diseases in Macrospecies (MS) in Nepal

The public and veterinary health reports indicate that Nepal is vulnerable to increased rate of morbidity and mortality of MS by various underlying causes such as ms, natural calamities, climate change, plant and pesticide poisoning, non-communicable diseases, antibiotic resistivity, road accidents, and intra- and inter-specific competition (DoAH 2015, 2016a, b; DoHS 2012, 2016, 2017) (Fig. 40.2). Among these underlying factors, the role of ms is critical because they may induce immediate and rapid mass mortality of MS leading susceptibility to endangerment and extinction (Field et al. 2009; Fey et al. 2015; González-Suárez and Revilla 2014; Smith et al. 2006; Pedersen et al. 2007; Adams et al. 2017). For example, mass elimination of Mongolian saigas by Peste des Petits Virus (PPRV) (Chimeddorj and Buuveibaatar 2017), of amphibian populations by *Ranavirus*, *Batrachochytrium dendrobatidis*, and *Perkinsea* (Fey et al. 2015; Cheng et al. 2011; Duffus et al. 2015; Isidoro-Ayza et al. 2017; Kwon et al. 2017; Geng et al. 2011), and of humans and

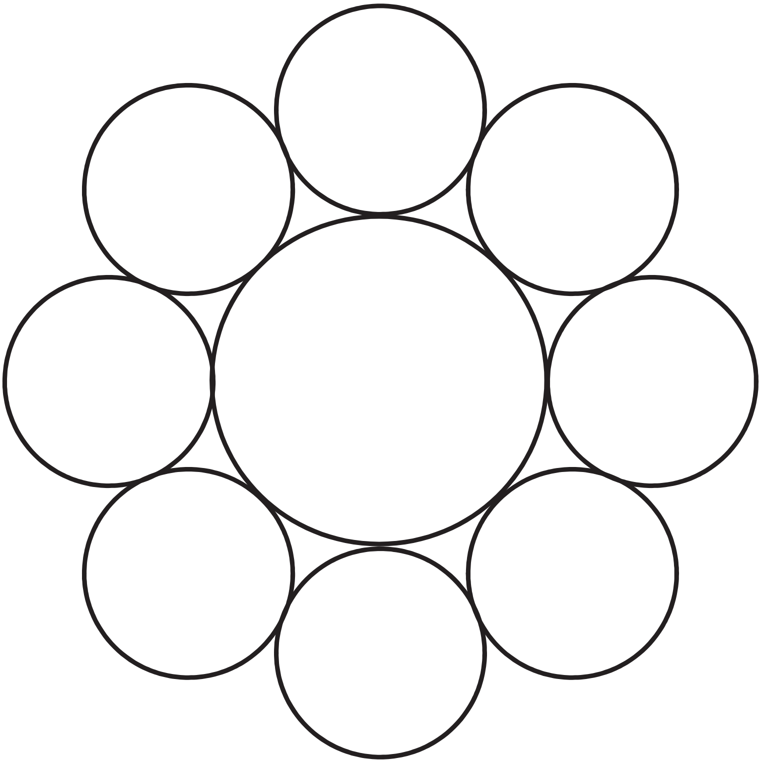

Fig. 40.2 Underlying causes of MS decline. Antibiotic resistivity, plant and pesticide poisoning, climate change, natural calamities, ms, road accidents, and intraspecific and interspecific competition variously decline the MS populations

animals by TB, influenza, acute respiratory, and diarrheal pathogens has been already reported around the world (NRC 1993; Gates 2014; DoAH 2016b; DoHS 2017). In these contexts, although several causes might exist, extreme virulence, toxicity, and the pathogenicity of the pathogens actually govern the disease appearance and outbreaks. Thus, understanding the role of ms in causing many food- and water-borne, vector-borne, and zoonotic diseases would make sense in veterinary and public health. In this review, the contribution of ms to disease susceptibility, morbidity, and case fatality rate (CFR) data of cattle, yak, buffalo, goat, sheep, pig, birds, dog, and horses have been expressed based on the reports published by of the Government of Nepal (GoN) (DoAH 2016b).

40.5 Viral Infections Leading to MS Decline

Although the reports of viral infections in wild fauna are scarce, several natural, sporadic, epidemic, endemic, epizootic, zooanthroponotic, and anthrozooponotic viral infections those in the livestock of the country are available. One serologic study confirmed the cercopithecine herpsevirus 1 (CHV-1), rhesus cytomegalovirus (RhCMV), *Cercopithecine herpesvirus* 1 (CHV-1), and simian foamy virus (SFV) in Rhesus macaque *Macaca mulatta* in Kathmandu valley indicating their critical role in zoonosis (Jones-Engel et al. 2006). Various fatal viral diseases including avian influenza, canine distemper, human corona, coronavirus disease 2019 (COVID-2019), rabies, and several others have been reported from the country.

40.5.1 Avian Infectious Bronchitis (AIB)

AIB is an acute and highly contagious disease of a wide range of birds including chicken caused by an enveloped, pleiomorphic, positive-sense, and non-segmented single-stranded (ss) RNA AIB virus called a coronavirus that falls in the genus *Gammacoronavirus* within family Coronaviridae (Cavanagh 2007; Zanaty et al. 2016; Liu et al. 2005; Boursnell et al. 1987). AIB not only causes a severe respiratory distress but also leads to renal and reproductive tract dysfunction resulting in the reduction of quality and quantity of the egg and meat production (Cavanagh 2007). The disease is predominant in many areas with large commercial poultry population including both layers and broilers of all ages with high mortality. Nepal is one of them in which several outbreaks have occurred resulting in a high morbidity and about 17.5% CFR (Cavanagh 2007; DoAH 2016b).

40.5.2 Avian Influenza

Avian (Bird) flu, caused by the avian flu virus, has an enveloped, segmented, and negative-sense ssRNA that falls in genus *Influenza A* and family Orthomyxoviridae. The virus contains surface proteins hemagglutinin (H) and neuraminidase (N) and produces 16 H subtypes (H1–H16) and 9 N subtypes (N1–N9) in avian hosts. This virus is classified into the low pathogenic (LPAIV) or highly pathogenic (HPAIV) strains based on their lethality (Alexander 2000b). Although both strains are transmissible via feces, saliva, nasal secretions, the HPAIV strain causes 100% mortality, even within 48 h (CDC 2017). On the other hand, the pathogenicity of LPAIV can be enhanced by other infections or environment conditions (Alexander 2000b). The *Influenza A* virus has been isolated from more than 100 different species of wild aquatic birds that can act as reservoirs maintaining the viruses in nature (CDC 2017), however, reports of detection of other genera like *Influenza B* are from humans and seals (Osterhaus et al. 2000; Kato et al. 2015) and those of *Influenza C* are from humans, pigs, and dogs (Matsuzaki et al. 2002; Youzbashi et al. 1996).

It should be important to note that migratory birds spread the *Influenza A* viruses to the geographically unrelated regions. In the eastern part of the country, outbreaks of an H5N1 avian flu occurred in January 2009. Since then, several outbreaks led mass mortality of commercial and household chickens and ducks (WHO 2012). In addition, the GoN killed several thousands of chicken and eggs to prevent the viral spread (CIDRAP 2017; Gautam 2012). The strain, H5N1 serotype, has been evidenced to kill chicken and ducks in the high altitude area (OIE 2017b), whereas both H5N1 and H5N8 have killed several chicken, Asian Openbill (*Anas tomus oscitans),* and the Whooper Swan (*Cygnus cygnus)* in the low altitude area (OIE 2017a) suggesting Nepal to be highly endemic region for HPAI despite Her geography. One study found H9N2 in the stool of a ruddy shelduck (*Tadorna ferruginea*) in seven wetland migratory bird roosting areas (Karmacharya et al. 2015). This suggested that this strain leads to endemicity in poultry and may evolve into H7N9 to facilitate transmission into human (Liu et al. 2014; Chen et al. 2014). Only one case of death of a 21-year-old male following the H5N1 infection was reported on March 29, 2019 in Nepal (Shrestha 2019) suggesting that the virus rarely spreads from birds to humans and there is no proof of the viral spread from human to human till date. However, pandemic *Influenza A* by the H1N1 strain has become a critical problem of public health (Adhikari et al. 2011; Anonymous 2018). Avian influenza is also critical in this country because of the full of various migratory birds in and around the Kathmandu Valley, major rivers like Karnali, Gandaki, and Koshi river, and wildlife reserves at the lowland regions in Nepal, and from China, Mongolia, Korea, Siberian region of Russia, and central Asia in the winter seasons. This is because one of the birds, wild waterfowl, have been shown to act as the natural reservoirs of LPAI and transmitters of LPAIV along migratory routes in Asia, Africa, and the Americas (Webster et al. 1992; Munster et al. 2007; Cappelle et al. 2012; Spackman et al. 2005).

40.5.3 Canine Distemper Disease (CDD)

CDD or hardpad disease, a highly contagious via inhalation, is caused by a negative-sense ssRNA virus of the genus *Morbillivirus* within the family Paramyxoviridae (Sykes 2014). It affects a wide members of families like canidae, mustelidae, cercopithecidae, procyonidae, ailuridae, ursidae, elephantidae, vivirridae, and felidae (Creevy 2018). The virus has been detected in 27% of domestic dogs in the buffer zone of a national park indicating a high risk factor for the wild fauna in Nepal (Dudley 2017) and Canine Distemper Viral antibodies in more than 70% of the examined dogs with 13% prevalence of P-gene in 13% in the 10 villages in Nepal's Annapurna Conservation Area at high altitude suggesting predominance of this virus in the national park areas and in this scenario, risk may exist during transmission of virus from feral dogs to wild carnivores in the nearby zones (Ng et al. 2019). The virus has been hypothesized to lead endangerment process of *Canis lupus, Cuon alpinus,* and *Canis aureus* in the country (Dudley 2017).

40.5.4 Classical Swine Fever (CSF)

CSF or Hog Cholera is an acute and chronic disease caused by the enveloped ssRNA virus that falls in the genus *Pestivirus* within the family Flaviviridae (Blome et al. 2017). The disease naturally occurs in domestic and wild pigs. Although genotypes similar to Indian regions have been identified in Nepal indicating the imported cases, other genotypes have been recorded proving Nepal to be endemic country for CSF (Postel et al. 2013). Few outbreaks in the Nepalese pig populations have led very high CFR, quantitatively about 60%. The GoN has not been able to issue certification process to ensure the quality and disease free status of pigs and as a result, exports of pigs and pork to China, India, Bhutan, Thailand, Vietnam, and Hong Kong have been very difficult indicating an existence of huge impact on Nepalese economy by the disease (PEAN 2016).

40.5.5 Contagious Pustular Dermatitis (CPD)

CPD, a rare zoonotic disease, is caused by the double-stranded (ds) DNA virus called CPD virus (CPDV) or Orf virus (ORFV) of the genus *Parapoxvirus* (Matthews 1979). In Nepal, CPD primarily infects sheep and is critically important in their orphan lambs (Scott 2009; Gameel et al. 1995; Abu Elzein and Housawi 1997).

40.5.6 Foot-and-Mouth Disease (FMD)

FMD is caused by a FMD virus that falls in the genus *Aphthovirus* of the family Picornaviridae and is characterized with the basic picornaviral structure that exists the various serotypes (Fry et al. 1999). Most importantly, the serotypes O (lineages O/ME-SA/PanAsia-2 and O/MESA/Ind-2001d), Asia 1, A, and C have been isolated from Nepal (FAO/EuFMD 2020; OIE 2017c; Chhetri et al. 2010; Ferris et al. 1992; VEC 2016). FMD represents an endemic infection since the time immemorial because it is found in almost all parts of the Himalayan nation during the year (DoAH 2016a). Its outbreak has been reported in blackbucks (*Antelope cervicapra*) in the Blackbuck Conservation Area in the Western part of the country indicating the possibility of FMD transmission to other endangered fauna (Anonymous 2009). It is principally found in elephants and cloven-footed domestic animals including cattle, buffalo, goats, sheep, and pigs and wild species, however, indigenous and improved breeds of these animals are highly susceptible (DoAH 2016a; Shrestha and Upadhyaya 2016). Its epidemiology in cattle, buffaloes, goats, and pigs is similar, whereas in sheep and yak, it is different. This pattern of MS-wise ms epidemiology is eco-zonal because cattle, buffaloes and goats are domesticated in terai and hilly areas and in contrast, sheep and yak are reared mostly in the mountain region. Interestingly, it has been reported that about 54% of elephants following migration on foot from the low altitude to the Kathmandu valley got infection probably from water buffaloes on the way (Kitching et al. 1988).

Although size of human and buffalo populations and the numbers of technicians were associated with the increased risks of FMD (Chhetri et al. 2010), its outbreaks are epidemiologically linked to a. the mass migration of animals livestock in the grazing sites, local markets, established trading routes b. movement of infected small ruminants around households, and c. seasonal migration of livestock and other animals from Tibetan plateau to Nepal and vice versa (Ferris et al. 1992). In the September and October in festive, goats are taken from Tibet to the larger cities of Nepal and in the December and January, bullocks and cattle are collected and purchased in the border areas of India enhancing the modes of transmission around the region. China did not allow Nepalese dairy product (butter) to enter into its country during 2001/2003 due to presence of FMD creating a major hurdle in international trade (VEC 2016). Due to the lack of certification and traceability of FMD and resulting its doubts in the pig farms, Chinese have stopped purchasing pigs via Rasuwagathi border at northern part of Nepal (PEAN 2016).

The reports of several FMD outbreaks per annum with high morbidity and mortality have been published in this country (VEC 2016; FAO/EuFMD 2020). The outbreaks seem to be seasonal. The first rise in the number of FMD outbreaks during pre-monsoon and monsoon periods might have been due to excessive movement of animals for summer agricultural operations that favor the spread of disease resulting in to more outbreaks (Thakuri 2012). Although numerous works have been undertaken for the research of FMD in livestock, concerned authorities have not opened their eyes toward opening the primary data on wild fauna in Nepal. The crucial role of FMD in declining the fauna includes lack of proper implementation of animal movement regulations, immunization, and the lack of research.

40.5.7 Fowlpox

Fowlpox is a disease of chicken, turkeys, quail, canaries, and pigeons caused by dsDNA virus of the genus *Avipoxvirus* of the family Poxviridae (Afonso et al. 2000). It is transmitted via the biting of mosquitoes and via inhalation. Fowlpox is the underlying cause of the several outbreaks with a high morbidity and about 8.3% CFR in the chicken in Nepal (DoAH 2016b).

40.5.8 Infectious Bursal Disease (IBD) or Gumboro Disease

Infectious bursal disease (IBD), popularly known as Gumboro disease in the Himalayan countries, is a highly contagious and immunosuppressive disease of young chicken caused by IBD virus (IBDV) that is a naked icosahedral virus with segmented dsRNA belonging to the genus *Avibirnavirus* of the family Birnaviridae (Dobos et al. 1979; Khatri and Sharma 2007). IBD is responsible for not only the direct losses via death of chickens but also the IBDV-induced immunodeficiency that is the underlying cause of secondary infection by viral, bacterial, and parasitic infections leading peaked morbidity, mortality, and disability and finally the huge loss in the poultry industry around the globe (Berg 2000; Zachar et al. 2016). The disease is responsible for a large numbers of outbreaks with high morbidity and about 5.8% CFR in chicken in Nepal (DoAH 2015, 2016a, b).

40.5.9 Marek's Disease (MD)

Marek's disease is a highly contagious neoplastic disease caused by dsDNA virus and its species is called Marek's disease virus (MDV) or *gallid alphaherpesvirus 2* (GaHV-2) of the genus *Mardivirus* within the Herpesviridae family (Nair and Dunn 2018) (Boodhoo et al. 2016). Although the disease may infect chicken with different syndromes like acute, neurolymphomatosis, cutaneous, ocular, atherosclerosis, and immunosuppression with few outbreaks and high morbidity, it has not been reported in other birds in the Nepal (Nair and Dunn 2018).

40.5.10 New Castle Disease (NCD)

New Castle Disease (NCD) is caused by a helical capsid containing non-segmented, negative-sense ssRNA virus. It is an avian paramyxovirus serotype-1 that falls in the genus *Avulavirus* within the family Paramyxoviridae (Dortmans et al. 2011; Alexander and Senne 2008; Miller et al. 2010). The disease is responsible for high morbidity and mortality including enhanced stress and decreased egg production and hatchability in chicken (DoAH 2016b; Alexander 2000a). It has been reported that about 600 outbreaks of endemic NCD killed more than 20,000 chickens in from 2002 to 2006 although vaccination prevented more than one million birds (Sharma 2010). Although NCD can infect its natural hosts comprising more than 236 species of birds such as chickens, pigeons, turkeys, guinea fowl, Japanese quail and many wild birds of all ages (Alexander 2000a; Kaleta and Baldauf 1988), the data show that it gives about 9.5% CFR in domestic chicken and its effects in Nepalese wild birds are lacking.

40.5.11 Peste des Petits Ruminants (PPR)

Peste des petits ruminants (PPR), 'goat plague', or 'Kata', or 'Ovine rinderpest', or 'syndrome of stomatitis-pneumoenteritis' is caused by a PPR virus (PPRV) which is an enveloped negative-sense ssRNA virus belonging to the genus *Morbillivirus* of the family Paramyxoviridae (Gibbs et al. 1979; Dhar et al. 2002; Parida et al. 2015). The disease is highly contagious and acute in domestic and wild small ruminants, and is characterized by high fever, conjunctivitis, oculo-nasal discharges, necrotizing, erosive stomatitis, and diarrhea. In Nepal, PPR was first diagnosed in 1995 and has already been reported from Her 63 districts with its concentration in mid-hills and low land with a high morbidity ranging from 50–90% and mortality ranging from 10–100%, with 17.2% CFR although it has not been dealt with wild animals in the country (DoAH 2016a, b; Shrestha 2015).

40.5.12 Rabies

Rabies is an infectious disease caused by the rabies virus, a cylindrical neurotropic polystrain, negative-sense ssRNA virus of the genus *Lyssavirus* within the family Rhabdoviridae. The disease is epizootic in nature and its sylvatic or enzootic cycle is maintained by wild carnivores such as the members of the canids, mustelids, viverrids, procyonids, and chiropterans living in forest zones, national parks, or wildlife reserves although each strain is maintained in these particular hosts (CFSPH 2009b). Besides, its nature is zoonotic because it can principally be transmitted to humans and animals by the bite of an infected animal that contains virus in saliva.

Several outbreaks of rabies have been reported in the canines and bovines in Nepal with its high morbidity and 100% mortality of the livestock (DoAH 2016a, b). Data show that rabies kills about 100 livestock and 10–100 men per annum being the highest risk in the southern terai plain particularly due to agricultural lands, wildlife areas, and the open border with India (Devleesschauwer et al. 2016). Rabies is gaining significance in travel medicine particularly because there are many reports of bites and scratches into both tourists and foreign residents by rhesus monkeys (*Macaca mulatta*) that live anthropogenically near temples in many parts including the Kathmandu Valley, one of the oldest cities of the Himalayan countries (Devleesschauwer et al. 2016; Pandey et al. 2002). Although around 50,000 people seek post-exposure rabies prophylaxis (DoHS 2019b), there is no proof of rabies transmission following monkey attacks to the local and foreign travelers in Nepal (Shlim et al. 1991; Gongal 1998).

40.5.13 Rinderpest Disease (Cattle Plague)

Rinderpest disease, caused by a negative sense ssRNA virus called *Morbillivirus* genus of the Paramyxoviridae family affecting ungulates including wild and domestic animals, has been associated with the movement of warriors with the large cattle herds to carry foods and baggage (Roeder et al. 2013). Although the terai plain was 'home' of the disease, the exports of buffaloes and cattle from terai and Bhutan resulted in the common problem in the hills in 1866 (Spinage 2003). It caused several annual losses so that the GoN had to establish a Government Veterinary Service in 1939 (Spinage 2003). Nepal was declared as Rinderpest disease and infection free country in 2002, which demonstrates the strength of effective national epidemiological system in Nepal (DoAH 2016a, b). Mass vaccination to all bovids along the southern belt in the Indian border has been credited for the freedom from rinderpest within the country (Spinage 2003). It has been reported that the population of wild buffaloes in the Tsavo National Parks of Kenya declined by over 60% and the lesser kudus, the forest antelope by 90% in 1994–1995 following rinderpest infection indicating a huge economic loss in the wildlife (Rossiter 1996).

40.5.14 Sheep Pox and Goat Pox

Sheep pox and goat pox are caused by the antigenetically and physiochemically related the respective Sheeppox virus (SPPV) and goat pox virus (GTPV), the dsDNA virus, that belongs to the genus *Capripoxvirus* in Poxviridae family (Tulman et al. 2002). Both are transmitted by the contact to aerosols, respiratory droplets or contact with oronasal secretions of infected animals and by the mechanical methods, for example, the arthropod vectors like *Stomoxys calcitrans* and tsetse flies suggesting a critical role of climates in the transmission of the diseases (Kitching and Taylor 1985). Both diseases are underlying causes of a high morbidity but with only 1.6% CFR in sheep and goats in Nepal.

40.6 Bacterial Species Leading MS Decline

The presence of several bacterial species have been detected in environmental, clinical and veterinary samples like water, meat (buff, chicken, fish, mutton), feces, milk, urine, tissues, water, nasal swabs, ear swabs, and skin scrapings provided by farmers, researchers, and medical, and veterinary professionals. These species include *Bacillus, Enterobacter, Escherichia, Haemophilus, Klebsiella, Micrococcus, Pasteurella multocida, Proteus, Salmonella of subgenus I or II group* including *S. agona, S. choleraesuis, S. enterica, S. enteritidis, S. gallinarum, S. pullorum, S. virchow, Shigella,* and *Staphylococcus* (Chhetri et al. 2008; Maharjan et al. 2006; DoAH 2015, 2016a). These bacteria may solitarily or collectively induce the initiation of the diseases which are discussed in the next section (Photos 40.1).

40.6.1 Actinomycosis

Actinomycosis, an infrequent invasive disease, is caused by a Gram-positive filamentous bacterium called *Actinomyces* (Wong et al. 2011). It is a minor problem by occurrence in the country because few outbreaks of actinomycosis with few morbid cases have been reported.

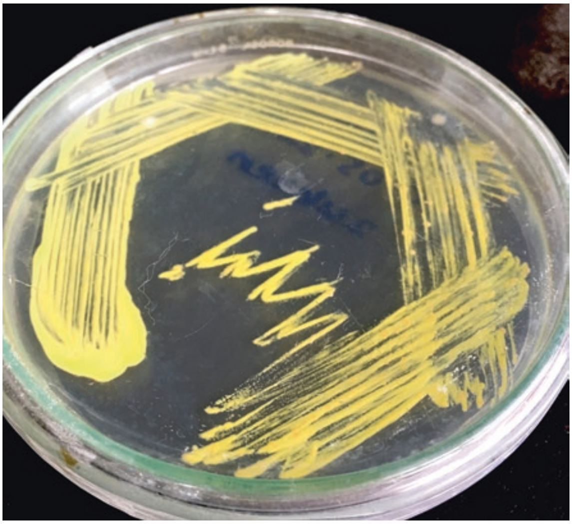

Photo 40.1 *Staphylococcus aureus* cultured on Mannitol Salt Agar (MSA) plate from the clinical samples. (Photo kindly provided by Sagar Aryal (PhD Scholar), Tribhuvan University, Nepal)

40.6.2 Anthrax

Anthrax is a zoonotic disease of humans and domestic and wild animals caused by *Bacillus anthracis*, a spore-bearing aerobic Gram-positive bacterium (Mwakapeje et al. 2018; Baillie and Read 2001). Based on the transmission routes and the clinical features, the disease has been classified into the cutaneous form, the gastrointestinal form, and the pulmonary form that may lead to immediate death (Mwakapeje et al. 2018). The disease has usually been sporadic and is responsible for several outbreaks in pigs, cattle, buffaloes, and horses with high morbidity leading up to 100% CFR in Nepal (DoAH 2016a, b; Aryal 2016). Postmortem examination of a dead pregnant rhino revealed the presence of anthrax bacteria indicating the etiology of death of other several rhinos died in nature in the country (Anonymous 2017). In addition to overhunting, habitat degradation, exposure of rinderpest, and FMD, infection of anthrax has been attributed to the reduction of the population of *Bos gaurus* (Duckworth et al. 2016).

40.6.3 Blackquarter

Blackquarter or blackleg disease, a highly fatal disease in cattle, sheep, and goats, is caused by *Clostridium chauvoei*, an anaerobic spore-forming and toxin-producing motile Gram-positive highly pathogenic bacterium (Frey and Falquet 2015; Hatheway 1990). The disease occurs around water holes, well, in grazing areas, paddocks, and pens, and wells outbreaks may occur after flood and after excavation of soil because it may activate latent spores (Sultana et al. 2010; Hatheway 1990). The disease has a huge impact on the cattle herders because of the tremendous loss on the economy (Ayele et al. 2016; Hatheway 1990). It is an underlying cause of several outbreaks with high morbidity and about 1.7% CFR in the livestock in Nepal.

40.6.4 Bovine Tuberculosis (BT)

BT, an endemic zoonotic disease of the cattle and buffaloes, is caused by *Mycobacterium bovis*, a slow-growing, aerobic bacterium called a bovine tubercle bacillus. The bacterium is highly virulent and its several strains have been recovered after milk, feces, and intradermal test of most of the areas of the country indicating a critical role of this pathogen in public health (Jha et al. 2007; Silwal et al. 2011; Joshi 2003; Pun et al. 2004). TB in Nepal has been reported in the half of the Nepalese population among which 5000–7000 deaths and 44,000 new cases occurs per annum (NTP 2016). Data show that new and old cases of low altitude people are highly infected compared to those in the mountainous region, however, *M. tuberculosis*-borne human TB confirmation has been the highest in mountains compared with other landscapes (NTP 2016). This indicates that the possibility of bovine TB exists in the public health in the low altitude which may synchronize with respect to the numbers of cattle and buffalo population. Zoonotic characteristics of TB indicate that it is critical to farmers, raw milk consumers, cattle exporters and businessmen, and butchers.

40.6.5 Brucellosis

Brucellosis is a highly contagious zoonotic disease caused by a Gram-negative bacterium of the genus *Brucella*. *B. melitensis* principally infects the reproductive tract of sheep and goats and causes ovine and caprine brucellosis characterized by abortion, retained placenta, and impaired fertility. *B. ovis* causes ovine epididymitis. *B. abortus* infects cattle and buffaloes and causes bovine brucellosis. *B. suis* causes swine brucellosis (Smith and Shorman 2019). All of these brucellosis are recorded in Nepal (Knox et al. 2000). The disease is transmitted vertically into the new babies via milk and reproductive tract discharges and blood transfusion and homo-and hetero-sexual activities (Burgess 1982). Interestingly, few cultural practices involving the handling of dung in the agricultural land and biogas plant, drinking of raw goat blood by the pregnant women, consumption of raw milk, liver, kidney, testis, and brain, and practicing of shepherding and animal husbandry in the closet space with high stock density and high stocking rate might be the underlying risk factors of endemicity of the brucellosis. Principally, the evidences of high prevalence rate (up to 32%) and morbidity in the livestock of Nepal comes from the seroprevalence study of the disease of several outbreaks in the *Bos grunniens*, and its breeds with local hill cattle (*Bos indicus*), cattle, pigs, goats, dogs, sheep, and domestic and wild buffaloes (Smith and Shorman 2019; DoAH 2016a; Shrestha 2008a). The low mortality might be associated with different factors like pathogenicity of the bacterium that depends on the species, size of inoculum, portal of entry, mode of transmission, and immune status of the MS. Brucellosis has been a massive global economic issue because of the loss of income due to abortion, milk and meat production, low fertility of the animal hosts, and huge cost on control and prevention programs including drug therapy and mass vaccination.

40.6.6 Chronic Respiratory Disease (CRD)

Chronic respiratory disease (CRD) in chicken, turkeys, game birds, pigeons, and wild birds is caused by *Mycoplasma gallisepticum* that is evolutionarily related to the low % Guanine and Cytosine Gram-positive Clostridiales (Weisburg et al. 1989; Ricketts et al. 2017). Serology examination shows about 9.5% prevalence in the chicken in the Nepal (DoAH 2015).

40.6.7 Colibacillosis (COB)

Colibacillosis (COB) is a disease caused by a Gram-negative, non-acid-fast, non-spore-forming bacterium called *Escherichia coli* with mainly serogroups O78, O1, O2, O15, O55 in animals including chicken (Chart et al. 2000; Dho-Moulin and Fairbrother 1999). COB causes pericarditis, airsacculitis, and perihepatitis in chronic form and may cause death following septicemia (Dho-Moulin and Fairbrother 1999). Several COB outbreaks have caused a high morbidity leading about 4.1% of CFR of the Nepalese livestock indicating a massive impact on the economy of the country.

40.6.8 Contagious Agalactia

Contagious agalactia principally infects sheep and goats in which the disease is caused by a bacterium called *Mycoplasma agalactiae* (Kumar et al. 2014). However, principally, other species like *M. capricolum*, *M. putrefaciens, M. mycoides capri*, and *M. mycoides* (large colony forms) can cause this infection in goats (CFSPH 2009a; Lambert 1987) and various signs of mastitis, arthritis, and keratitis have been reported in few morbid cases in Nepal.

40.6.9 Enterotoxemia or Pulpy Kidney

Enterotoxemia is a disease primary of sheep and goats caused by the toxin of *Clostridium perfringes* type C and D that are normally found in small numbers in healthy animals (McDonel 1980). The disease develops when the numbers of bacteria are increased and the microenvironments of the gut become favorable to toxin production (Nagahama et al. 2015; Uzal et al. 2010). Its outbreak is presumably associated with the lack of immunity, the heavy GI infestation, the periods of greatest pasture growth (Leite-Browning 2007). This is possible during summer months when mass grazing practice is culturally conducted during the availability of the new, better, and grainy diet. Although its outbreaks, susceptibility, and morbidity are very high, its CFR is only about 2.4% in Nepal.

40.6.10 Fowl Typhoid (FT)

FT is an acute or chronic septicemic disease that is caused by *S. pullorum*-related bacterium called *S. gallilnarum* (Shivaprasad 2000). It primarily affects adult birds, but, grouse, guinea fowl, ostriches, parrots, peafowl, pheasants, quail, ring-necked doves, sparrows, and turkeys of all ages are susceptible. FT has contributed several outbreaks resulting in a high morbidity and about 7.6% of CFR in chicken indicating a huge massive impact on the Nepalese economy.

40.6.11 Hemorrhagic Septicemia

Hemorrhagic septicemia, occurring primarily in cattle and buffaloes and secondarily in wild elephants, is caused by a Gram-negative nonmotile coccobacillus bacterium called *Pasteurella multocida* (Tankaew et al. 2017; Narasimham 1946). The disease manifests fever, depression, salivation, and submandibular edema, acute respiratory distress, and septicemia (de Alwis 1984). The GoN has indicated its several outbreaks leading a high morbidity and about 5.9% of CFR in livestock that suggested a national concern in the economy and veterinary health.

40.6.12 Infectious Coryza

Infectious coryza (ICR) is an acute respiratory disease of chicken caused by *Haemophilus paragallinarum*, a Gram-negative bacterium (Blackall et al. 2005; Blackall 1999). ICR induces nasal and lacrimal discharges, facial swelling, and diarrhea reducing the growth and egg production in chicken (Han et al. 2016; Soriano et al. 2004). Although ICR induces very high morbidity, it has about 1.6% CFR in chicken in Nepal.

40.6.13 Mastitis

Mastitis is a common persistent inflammatory disease of livestock, principally the cattle, that is caused by mechanical, thermal and chemical injury and most importantly, the toxins released by various coliform bacteria, *Staphylococcus albus,* and *S. epidermidis* (Subedi and Dhakal 2002; Dhakal et al. 2007). The occurrence of mastitis is related to rainy season when temperature and humidity is high, and during first calving, and first month of parturition (Dhakal et al. 2007). Since the replacement of local cows by many European breeds for increasing milk production, several thousands of mastitis cases with CFR less than 1% have been reported in the country (Knox et al. 2000; DoAH 2016b).

40.6.14 Pullorum

Pullorum disease or bacillary white diarrhea is caused by a Gram negative bacterium, *Salmonella pullorum* (Shivaprasad 2000). This disease highly affects the young birds, however, it has been recovered from many adult species like chicken, turkeys, quail, guinea fowl, pheasants, ducks, pigeons, sparrows, canaries, bullfinches, parrots, pigs, cattle, cats, dogs, foxes, mink, rabbits, guinea pigs, laboratory and wild rats, and chinchillas (Barrow and Freitas Neto 2011). In addition to transmission via transovarian cycle and cannibalism of infected carcasses, the bacterium is transmitted by bird-to-bird contact, wound contamination, and fecal contamination of feed, water, and litter (Berchieri et al. 2001). In Nepal, pullorum results in the high morbidity and about 11.0% CFR after several outbreaks in chicken indicating a huge impact on veterinary health and the consequent loss in economy.

40.7 Parasitic Species Leading to MS Decline

40.7.1 External Parasitosis and Warble Myiasis

The infestation with external parasites is quite important in Nepal because of their effects in the high morbidity and mortality (DoAH 2016a). For example, several species of *Amblyomma*, *Anomalohimalaya*, *Argas*, *Boophilus*, *Dermacentor*, *Haemaphysalis*, *Ixodes*, *Nosomma*, and *Rhipicephalus* in humans and domestic and wild vertebrates have been well recorded (Estrada-Pena and Jongejan 1999; Clifford et al. 1971a, b; Hoogstraal 1971; Daniel 1979; Apanaskevich et al. 2014; Mitchell 1979; Bohara and Shrestha 2016; Fegan and Glennon 1996; Pun et al. 2018; Ghimire et al. 2018).

The country is also rich in several species of mite, lice, flea, and mosquito faunal diversity in various hosts (Mitchell 1979). Mites cause skin disease called mange or acariasis that has resulted into high morbidity and <1% CFR (DoAH 2015, 2016b). Lice including Mallophaga (bird lice) and Anoplura like *Pediculus human capitis, P. h. corporis,* and *Pthirus pubis* are the predominant lice species (Mitchell 1979; Poudel and Barker 2004).

Importantly, a total of 44 species of *Anopheles* mosquitoes have been identified in the country, however, only seven of them (*Anopheles minimus, Anopheles fluviatilis, Anopheles annularis, Anopheles maculatus, Anopheles dravidicus, Anopheles pseudowillmori,* and *Anopheles willmori*) have been found to be malarial vectors (Ghimire 2016; Darsie and Pradhan 1990). In the same way, *Aedes aegypti, A. albopictus, Culex quenquifasciatus, Culex tritaeniorhynchus*, and several unidentified species have been recorded from low lands to upper lands of the country (Dhimal et al. 2014b). Other species at various landscapes are *Aedomyia*, *Armigeres, Heizmannia, Mansonia*, *Malaya, Mimoyia, Tripteroides,* and *Uranotaenia* are also reported (Dhimal et al. 2014b; Pradhan and Darsie 1989; Darsie et al. 1993) indicating the possibility of either existence or import of other several unreported vector-borne diseases in this country. Notably, the adults of the *Anopheles*, *Culex*, and *Aedes* mosquitoes were found in animal habitat, human habitat, mixed habitat, and natural outdoor habitat, where as their larval forms are predominant in stream, seepage, water tanks, discarded tire, paddy fields, tree holes, and plastic drums at different landscape within the country (Dhimal et al. 2014b).

Notably, warble infestation or myiasis has predominantly been reported to lead <1% death of livestock in the country (DoAH 2016b). Warble myiasis is caused by the infestation of a warble fly called *Hypoderma* species on the body of horses, goats, sheep, and humans. When the fly lays eggs on the legs, the hatching larva invades the connective tissues and migrates almost all body parts and produces a swelling called 'warble'.

40.7.2 Coccidiosis

Coccidiosis is a disease caused by spore forming protozoa called coccidia of the *Eimeria* genus traditionally, however, broadly, this term can be used for the infections led by various genera like *Isospora, Cyclospora, Cryptosporidium, Toxoplasma, Sarcocystis*, and *Microsporidia*. Various species of *Eimeria*, for example, *E. acervulina*, *E. maxima, E. necatrix, E. tenella* and *E. brunetti* have been reported in chicken that might get coccidiosis (Adhikari et al. 2008; Jayswal et al. 2014). Several outbreaks of coccidiosis with high morbidity and about 4% CFR have been reported in chicken in Nepal (DoAH 2015, 2016a, b). Interestingly, the presence of one or more species of *Eimeria, Isospora, Cyclospora, Cryptosporidium, Toxoplasma,* and *Sarcocystis* have been predominantly reported in the wild hosts like red panda, rabbit, Hodgson's Giant Flying Squirrel (*Petaurista magnificus*), deer, yak, and in the humans (DoAH 2015, 2016a; Lama et al. 2015; Bista et al. 2017; Koirala et al. 2016; Achhami et al. 2016; Byanju et al. 2011; Ghimire et al. 2005, 2007, 2010; Ghimire 2010, 2018; Ghimire and Mishra 2005). Among these coccidia, toxoplasmosis has been predominantly reported in humans and domestic animals like sheep and goats showing the possibility of infection with meat-eating habits and cat-rearing situations in the country (Subedi et al. 2018; Rai et al. 1996, 1999; Sah et al. 2017). Even, it was reported to be lower in the sheep of high altitude with arid climate compared to those of lower altitude with hot and humid climate suggesting the climate-guided infection of *T. gondii* (Subedi et al. 2018).

40.7.3 Helminthiasis

Several experiments revealed that the stools of one or more of the hosts like bats, pigs, cattle, buffaloes, sheep, goats, dogs, poultry, red panda, deer, rhesus and assamese macaques, elephants, rhinoceros, Hodgson's Giant Flying Squirrel (*Petaurista*

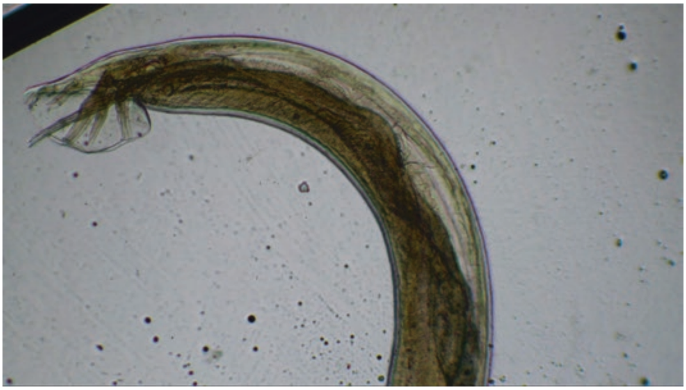

Photo 40.2 Microscopic image of *Oesophagostomum* species (X400 total magnification) extracted from the tissues of small intestine of goat and prepared from permanent slide. (Photo kindly provided by Anita Bhattarai, Department of Animal Breeding and Biotechnology, Agriculture and Forestry University, Rampur, Chitwan, Nepal)

magnificus), and yak contained *Ancylostoma, Angiostrongylus, Anisakis, Ascaris, Baylisascaris, Capillaria, Chabertia, Dicrocoelium, Dictyocaulus, Diphyllobothrium, Dipyllidium, Dirofilaria, Fasciola hepatica, Fasciolopsis buski, Gnathostoma, Haemonchus, Moniezia, Nematodirus, Oesophagostomum, Ostertagia, Oxyuris, Paragonimus, Paramphistomum*, *Schistosoma, Spirometra, Strongyloides, Syphacia, Taenia, Toxocara, Trichinella, Trichostrongylus,* and *Trichuris* (Devleesschauwer et al. 2014; DoAH 2015, 2016a, b; Achhami et al. 2016; Byanju et al. 2011; Ghimire 2010, 2018; Joshi et al. 1997; Ghimire 2018; Ghimire and Bhattarai 2019; Adhikari and Ghimire 2019; Ghimire and Adhikari 2019; Adhikari et al. 2018; Ghimire et al. 2019; Prajapati et al. 2018; Joship and Mahato 2013) (Photo 40.2). Several of these helminths cause echinococcosis or hydatidosis, cysticercosis, fasciolosis, schistosomiasis, trematodiasis, and soil-transmitted helminthiasis and all these induce about 1% CFR in Nepal. Among these infections, soil-transmitted helminths have been one of the major issues all over the country especially in the city areas particularly because of open defecation by domestic animals like dogs, cattle, and goats and seepage of sewage water in the soil.

40.8 Fungal Species Leading to MS Decline

40.8.1 Mycotoxicosis

Mycotoxicosis is the disease caused by the ingestion of cereal grains or foods containing toxic metabolites of certain fungi like *Aspergillus flavus, Aspergillus parasiticus* or *Penicillium puberulum*, *Claviceps purpurea*, *Fusarium moniliforme,* and

Fusarium graminearum (Zain 2011). Several outbreaks of mycotoxicosis with various signs and pathologies leading high morbidity and about 4.0% CFR have occurred in Nepal. Our primary observations indicated that mycotoxicosis is mainly associated with the use of hybrid seeds, lack of optimum post-harvesting duration, lack of proper storage, early harvesting, and carelessness in maintenance and management of environment during storage of grains, food, and animal fodders.

40.8.2 Ringworm

Ringworm or dermatophytosis characterized by red, itchy, scaly, and circular rash, and the loss of hair is caused by many fungi including *Trichophyton, Microsporum*, and *Epidermophyton*. The cases are very low, but critical in the veterinary health. In Nepalese people, ringworm has been critically experienced from many years in clinical settings (Paudel and Manandhar 2015; Reddy 2017; Mathur et al. 2012; Jha et al. 2019) resulting in the loss of economy, psychologic disorders, and high morbid cases especially in the immunocompromised, diabetic, and cancer patients.

40.9 Vector-Borne Viral Diseases

Nepalese veterinary and public health is highly affected by many vector-borne diseases that have massive impact on socio-economic status and socio-agricultural status. For example, bovine ephemeral fever (BEF) or Three Day Sickness is caused by bovine ephemeral fever virus (BEFV) that contains a negative ssRNA of the genus *Ephemerovirus*. As the virus has been isolated from various genera of Anophelines, Culicines, and Culicoides, they are implicated in the disease transmission (Walker 2020; Uren 1989). Disease is characterized by sudden onset of fever, stiffness, nasal and ocular discharges, depression, muscle tremors, and constipation (Wang et al. 2001; Burgess and Spradbrow 1977). The disease occurred with several outbreaks producing high morbidity and low mortality (CFR < 1%) in livestock of Nepal (DoAH 2016b).

The public health is highly affected by the Chikungynya, Dengue, JE, and West Nile Fever in the country (Rutvisuttinunt et al. 2014). Chikungunya is caused by an icosahedral positive-sense ssRNA virus called Chikungunya virus (CHIKV) that falls in *Alphavirus* genus within Togaviridae family. CHIKV has 3 genotypes. After Chikungunya febrile cases were firstly reported in the patients from March to June 2013 (Pun et al. 2014), it has been dominantly reported in the terai regions of the country (Pandey et al. 2015, 2017).

Similar virus called Dengue virus (DV) causes Dengue that occurs in the form of Dengue fever (DF), Dengue hemorrhagic fever (DHF), and Dengue shock syndrome (DSS) is also dominant in the country. DV is an icosahedral positive-sense ssRNA virus that falls in genus *Flavivirus* within the family Flaviviridae. DV has 5 serotypes and among them, only 4 serotypes (DEN-1, DEN-2, DEN-3 and DEN-4) have been reported in Nepal (Malla et al. 2008; DoHS 2017) indicating a serious threat to public health. Although the DV was firstly detected in a Japanese volunteer after his return to his country in 2004 (Takasaki et al. 2008), its sporadic cases and outbreaks were detected after 2006. The country had massive outbreaks in several districts in 2010 especially in Chitwan and Rupandehi districts. In a 4-year periods from 2006 to 2010, the DF cases increased from 5 districts to 24 districts indicating the rapid expansion of the disease in a wide geography of the country (Pun et al. 2014). Similar epidemics in 2013 and 2016 occurred infecting several people of middle hill districts suggesting the shifting of DV from subtropical areas to temperate zones (Gupta et al. 2018). More than 2000 DF cases as well as few deaths have been recently reported from 28 districts including Rupandehi, Jhapa, Mahottari, and Sarlahi at low altitude and Palpa, Arghakhachi, Rolpa, Pyuthan, and others at high altitude (DoHS 2019a). The shifting data are evidenced by the presence of CHIKV and DV vectors like *Aedes aegypti* and *A. albopitus* and the climatic variables like rainfall, temperature, and relative humidity are critical factors in the distribution of these vectors from the lowlands (80 masl) up to highlands such as Dhunche, Rasuwa districts (2100 masl) (Dhimal et al. 2015). The rapid expansion of the landscapes of these vectors and the associated viral diseases might be due to the increasing movement of viremic people, and means of transportation especially from the lowlands and endemic neighboring country like India, presence of vectors, and favorable environments via climate change (Narain 2008; Dhimal et al. 2014b). Thus, in addition to several socio-economic determinants like awareness, educational and social status, the role of climate change and the subsequent spread, acclimatization, establishment, and breeding of mosquitoes is critical to establish and transmit the diseases in a wide landscape. This principle also applies to the transmission of Zika virus (ZV) which is an enveloped and icosahedral positive-sense ssRNA virus belonging to the genus *Flavivirus* within Flaviviridae family. This is because since most cases of Zika virus are asymptomatic, it is not wrong to hypothesize the ZV existence in Nepal although a seroepidemiologic study could be used to prove this question (Wiwanitkit 2016). Nepal, as a member of HKH region, possesses few favorable environments of ZV transmission like shifting of *Aedes* vectors in highlands, public movement to the risk areas, lack of immunity in the people, climate change, and others (Dhimal et al. 2018).

Another vector-borne disease in Nepal is the West Nile Fever (WNF) caused by positive-sense ssRNA virus that belongs to the genus *Flavivirus* within the family Flaviviridae (Rutvisuttinunt et al. 2014). WNF possesses 8 different lineages with 2 main virulent lineages (Lineage 1 with clades 1a, 1b, and 1c and Lineage 2) responsible for outbreaks in humans, the clade 1b containing Kunjin virus has already been reported to infect 3% pigs in Nepal (Pant et al. 2006) suggesting existing risks of zoonosis in future.

40.10 Vector-Borne Bacterial Diseases

Various emerging vector-borne diseases like rickettsioses and anaplasmosis have been reported in the Himalayan nations including Nepal. Rickettsioses caused by *Rickettsia* species are endemically found (Murphy et al. 2011; Murdoch et al. 2004). Anaplasmosis, transmitted by tick and characterized by severe anemia, increased heart rate, and hemoglobinuria, is caused by a Gram- negative rickettsial agent called *Anaplasma*. It has been detected in ticks as well as cattle, buffaloes, and dogs in Nepal suggesting one of the crucial vector-borne pathogens (Bohara and Shrestha 2016; DoAH 2016a; Adhikari et al. 1997). Scrub typhus is an emerging disease caused by a Gram-negative obligate intracellular ricketts called *Orientia tsutsugamushi* and transmitted by the blood sucking larva (chigger) of mite. The disease possesses a zoonotic tetrad with chiggers, rodents, scrub forest, and mites which helps maintain a sylvatic cycle among the chiggers and rodents (Nayak 2016). Thus, agricultural workers, travelers in endemic areas, people who are usual contact with mice and mites in houses or camping, and any form of temporary shelter are the high risk groups. Postearthquake consequences like human migration, overcrowding, and unsanitary conditions could increase the linkage among vector, rickets, and human which might represent truths of Earthquake Nepal-2015 (Nayak 2016; Upadhyaya et al. 2016; Blacksell et al. 2007; Sedhain and Bhattarai 2017). Although a neglected disease, it has high morbidity and mortality in the Nepalese population. Another typhus called murine typhus is caused by *Rickettsia typhii* that is transmitted by the bite of fleas (*Xenopsylla cheopis*) of rats. It is an endemic disease of Nepal where thousands of people get infected indicating a huge public health issues in the country (Zimmerman et al. 2008; Walter et al. 2012; Pradhan et al. 2012; Thompson et al. 2015).

40.11 Vector-Borne Protozoan Diseases

Several babesiosis outbreaks with low morbidity and low mortality have been reported (DoAH 2016b). Cattle, buffaloes, dogs, and horses have been found to be positive with *Babesia* infection (DoAH 2016a; Bohara and Shrestha 2016) and their death has been resulted following red urine (DoAH 2016b). The prevalence recorded is about 10% and the lowland landscape, the transboundary area near India, and the hilly regions of the country are endemic areas for babesiosis (Adhikari et al. 1997; Shrestha and Singh 1999; Dhakal et al. 1996; Thakuri et al. 1992).

There are many reports of theileriosis, caused by a protozoan species called *Theileria parva*, that outbreaks with high morbidity and low mortality (DoAH 2016b). Tsetse-borne trypanosomiasis caused high morbidity and very low mortality of livestock following many outbreaks (DoAH 2016b). The disease is predominant in the transboundary region of Nepal and India, especially the lowlands areas (Shrestha and Singh 1999). Importantly, dogs, buffaloes, and horses are found to be positive for *Trypanosoma* (DoAH 2016a; Adhikari et al. 1997).

While vector-borne protozoa have low impact on health of livestock, their association to that of human is severe. For example, malaria, an endemic as well as imported disease primarily caused by *Plasmodium vivax* in general situation, *P. falciparum* in epidemic situation, and *P. ovale* in people with traveling history from Africa, has been recorded from many districts including mountainous areas (EDCD 2019). The trend of clinically suspected malaria case, slide positivity rate, and malaria caused by *P. falciparum, P. vivax* are decreasing year by year and is due to the increased health services and socio-economic status of the local people, and others (DoHS 2019a). The malariometric indicator analysis shows that although indigenous *P. falciparum* cases are rapidly decreasing, the indigenous *P. vivax* cases are slowly decreasing (Dhimal et al. 2014a). However, the trend of imported *P. falciparum* cases shows increasing (DoHS 2019a) indicating the critical role of human migration in the malaria transmission around the country.

It has also been suggested that the high risks and high risk zones of malaria includes foothills and river belts, forest fringe areas, forests of lowland area, inner valleys, and some terai districts (EDCD 2019; DoHS 2016, 2017). It is suggested that climate change and global warming have favored the breeding mechanisms of its vector, *Anopheles* spp., even in the high altitude leading to the probability of transmission of sporozoites. This has been evidenced by the fact that *Anopheles fluviatilis* was not detected above 1500 masl, has now been observed in Kashmir and Bhutan at heights of 2000 masl and more, indicating the role of climate change in vector spread in the Himalayas (Narain 2008).

In the same way, over the last decade, visceral leishmaniasis, caused by a protozoan hemoflagellate called *Leishmania donovani* and its vector sand fly, *Phlebotomus argentipes*, has spread towards the hill and mountain regions (Ostyn et al. 2015). Temperature, rainfall, and environment have been associated with the outbreaks. Notably, leishmaniasis has been reported from goats, buffaloes, and cattle indicating the possible role of domestic animals in the endemicity of the pathogen (Bhattarai et al. 2010; Khanal et al. 2010). The GoN has listed 18 districts as kala-azar endemic areas, however, new cases have been regularly reported in other districts (DoHS 2019a). Incidence of kala-azar (1 per 10,000 population) is at risk in the country leading to even more fatal in the presence of HIV/TB co-infection or in the lack of treatment on time (DoHS 2017).

40.12 Vector-Borne Helminth Diseases

Lymphatic filariasis (LF), caused by *Wuchereria bancrofti* and transmitted by *Culex quinquefasciatus*, is a neglected disease with <1% to 39% prevalence rates in 61 endemic districts of Nepal with about 25 million populations at its risks (DoHS 2016, 2017). It showed various ranges of landscapes in distribution, for example, ranging from 92 masl to 1768 masl including the hill and mountain areas, especially the valleys and river basin areas of hilly districts with high disease burden suggesting the role of topographical landscapes in governing the establishment and distribution of the vectors (DoHS 2012, 2016, 2017). This presence data was satisfied by the observation of its main vector *Culex quinquefasciatus* that had been found up to 2100 masl indicating the shifting of diseases following climate change (Dhimal et al. 2014c). Since 2003, more than 100 million doses of drugs against LF have been administered to at-risk population and the transmission assessment survey in 25 districts in 2017 (DoHS 2019a) observed a significantly reduced prevalence of this disease suggesting government's successful achievement toward prevention of LF.

40.13 Other Diseases Leading to MS Declines

The public health is devastated by many food and water-borne diseases like bacterial diarrhea, hepatitis A and E, and typhoid fever, sex-borne diseases like HIV/AIDS and syphilis, airborne diseases like TB and acute respiratory illness, urine-borne disease like leptospirosis, and vaccine-preventable diseases like diphtheria, influenza, measles, mumps, rubella, *Haemophilus influenza type b* infections, hepatitis B, polio, tetanus, and typhoid that have a very high morbidity and mortality (DoHS 2017; Murdoch et al. 2004; Karkey et al. 2008; Woods et al. 2006; Maskey et al. 2006; Blacksell et al. 2007). Illness and or death of livestock following one or more of pneumonia (CFR <1%), poisoning (CFR 2%), metritis (inflammation of the uterus), unclassified respiratory disease (CFR 3.7%), respiratory sign diseases (CFR 2.1%), milk fever (CFR <1%), wound (CFR <1%), dystocia (CFR <1%), and skin lesions, seems to be critical in veterinary health. Besides, several outbreaks of Khari disease have been reported in the buffaloes in the Far-western regions. This has been probably associated with the higher indoor radiations, malnutrition, and parasitic infestation (Khanal et al. 2008, 2013).

Leptospirosis is an emerging disease of humans caused by *Leptospira* spp., a spirochete bacterium transmitted by food, water, soil contaminated by urine of infected hosts like domestic and wild vertebrates. The disease occurs during rainy season probably because of the high temperature, increased flood, and transmission of bacteria through open defection. It is usually underdiagnosed and underreported disease in Nepal where many cases are being reported due to the increased interests of scientists and veterinarians.

40.14 Antibiotic Resistivity and Human and Wildlife Health

Antibiotic resistance has been one of the biggest threats for environmental, public, and veterinary health resulting in the failure of treatment, cost of treatment, and the increase in morbidity and mortality of the MS in Nepal (Thapa et al. 2016; Baral et al. 2013; Belbase et al. 2017). This issue is evidenced by identification of the resistivity of one or more antibiotic/s to *Acinetobacter*, *Citrobacter*, *Enterobacter*, *E. coli, Mycobacterium tuberculosis, Pseudomonas*, *Vibrio cholerae*, *Klebsiella* *pneumoniae, Proteus, Staphylococcus, Streptococcus pneumoniae, S. pyogenes, Shigella spp., S. typhi, S. paratyphi* A, *Salmonella* species, *Neisseria gonorrhoeae,* in clinical, subclinical, veterinary, and environmental samples (Lamichhane et al. 2014; Chaudhary et al. 2017; Rijal et al. 2017; Bansal et al. 2015; Dhakal et al. 2007). Regarding antibiotic resistivity, the role of a fungus, *Candida albicans* is important (Photo 40.3). It is critical to note that *Candida albicans* and non-albicans groups are associated with the infections and are primarily present during immunosuppression. In this context, antibiotic resistivity might be dangerous because few antibiotics have been proved to be resisting by both albicans and non-albicans groups (Khadka et al. 2017) and patients can experience with fatal and chronic infections. The search of reliable antimicrobial surveillance data in animal health is particularly demanding, and prioritized because of the emergence of multi-drug resistance of mastitis, pyometra, colibacilosis, and tuberculosis. It has been shown that antibiotic resistivity is associated with the environmental density of the antibiotics spreading from focal points of drug distribution and the close community environment of antibiotic over- or mis-use (Walson et al. 2001). In a close community, sharing water sources for drinking, bathing, laundry, and crop irrigation is common, and the practice of open defecation not only enhances the frequency of antibiotic resistant genes, but also speeds up the presence of biocenose that comprises bacteria, parasites, viruses, fungi, and others in the aquaculture, raw fruits, and fresh vegetables, fish, meat, and other agricultural products (Walson et al. 2001; Rolain 2013). In addition, ethnically used common herbal medicines in the country act as antiseptic or disinfectant that may contribute to the selection and multiplication of drug-resistant bacteria (Shrestha and Dhillion 2003; Bhattarai 1997). In these contexts, several MS like arthropods, annelids, mollusks, and vertebrates including human and animals may act both as carriers and transmitters of antibiotic-resistant

Photo 40.3 *Candida albicans* cultured on Sabouraud Dextrose Agar (SDA) plate from the clinical samples. (Photo kindly provided by Sagar Aryal (PhD Scholar), Tribhuvan University, Nepal)

genes or biocenose all over the environment. This also suggests the possibility of the generation of drug-resistant genes in biocenose following the continuous feeding of several herbal plants by wild populations.

40.15 The Generic Problem of Zoonoses

As already discussed, ms has possibility to induce 60 zoonotic diseases including avian influenza, brucellosis, cysticercosis/taeniosis, hydatidosis, leptospirosis, neurocysticercosis, and toxoplasmosis that have played critical role in public health (DoHS 2017, 2019b). Deaths following snake bites and dog bites are also reported. In these cases, 32 deaths followed by the bite of more than 35,000 dogs and other animals and 20 deaths followed by more than 5600 snake bite cases have recently been reported throughout the country (DoHS 2019b). Critically, a total of 21 poisonous snakes include pit viper, krait, cobra, coral, and Russel's viper that are predominant in 26 low altitude districts and their bite cases generate 10% mortality rates (DoHS 2019b). There are cases of cat and monkey bites although none of the deaths have been reported yet. Due to increase in people-wildlife conflicts, attacks by monkeys, jackals, bears, and other large mammals have been critical in the country and it is not included in this chapter here.

40.16 Conclusions

Since the beginning of agriculture civilization, the MS in Nepal has faced several ms infections leading their several morbidity and mortality. In addition, for several drivers of endangerment, the role of ms stands at the top. Although viral, bacterial, and parasitic diseases can lead to an endangerment process for a MS, the role of climate change and antibiotic resistivity and their consequences are critical. However, how these drivers play a role in the endangerment process have not been evaluated *in situ*. While lots of morbidity and mortality data are available for livestock, they are lacking in the context of wildlife. An integrated approach of research on human, wildlife, and livestock should be conducted so that we can collect many data related to the neglected diseases such as zoonotic diseases like brucellosis, reemerging diseases like many parasitic diseases, major killers like influenza, and vector-borne diseases like malaria, babesiasis, JE, and leishmaniasis. A coordinated control program including enhanced surveillance, isolation or rigorous precautions, early discharge, and alterations in antimicrobial usage can prevent the spread and emergence of drug resistance in the medical and veterinary offices (APUA 2008). In addition, search of effective, specific, and safe antigenic molecules to be used in vaccines and mass vaccination to prevent the future infections of ms into MS should be conducted.

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Chapter 41
Water in Mongolia: Sources, Uses and Issues, with Special Emphasis on Mining

Rajive Ganguli

Mongolia is a land locked country sandwiched between its two neighbors of global relevance, Russia (to the north) and China (to the south). In the late 2000s Mongolia caught the world's attention for its blistering economic growth. The growth was primarily fueled by mining and resulted in a nick name for the country, "Mine"golia. Currently, mining accounts for 18% of the GDP (International Finance Group - World Bank Group and International Council on Mining and Metals 2016). Major minerals mined in Mongolia include copper, gold, molybdenum, coal and fluorspar. Gold is also mined by artisanal miners. But mining needs, and thus affects, the water table. The work by Tao et al. showed dramatic lake shrinkage on the Mongolian Plateau.

41.1 Sources of Freshwater

Mongolia consist of three topographic regions: mountainous, basins and plateau (Lattimore et al. 2017). Three major mountain ranges define the northern and western regions. The Khentii mountains are to the north, the Khangai are in the middle and the Mongolian Altai range is to the west. Basins -where water accumulates - define the region between and around the mountains. A massive upland plateau spans the southern and eastern parts of Mongolia. The Mongolian Altai range is the only mountain range in Mongolia that actually has glaciers serving as a water storage for the wide region.

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R. Ganguli (✉)
Department of Mining Engineering, University of Utah, Salt Lake City, UT, USA
e-mail: rajive.ganguli@utah.edu

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Fig. 41.1 A view of the Selenge river in the summer. (Photo: Rajive Ganguli)

Water from the Khangai and Khentii mountains feed many lakes and rivers in basins (or watersheds) that eventually drain into the Arctic ocean (FAO 2011). A basin or watershed "*is an area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel*" (Survey 2016). Water has shaped vegetation and associated human civilization of Mongolia for millennia. The amount of water flowing out of the basin depends on precipitation, infiltration into the ground, evaporation, transpiration (water absorbed by plants and escaping through the leaves into the atmosphere), storage and use by humans (Survey 2016).

The Arctic Ocean basin for Mongolia includes the Tuul river basin, Selenge river basin and the Khovsgol lake basin. Those watersheds have a long human history. Figure 41.1 shows the Selenge river in pristine surroundings near the town of Selenge in the summer. More than half of the country's three million people resides in the Tuul river basin. Ulaanbaatar, the capital of Mongolia, is located on the Tuul river (also called Tula river, Fig. 41.2). The Tuul basin, which runs short of water already (Fig. 41.2), is also home still to thousands of industries and businesses,

Fig. 41.2 Down town Ulanbataar: Some rivers in Tuul River basin run dry already for many years. (Photo: Falk Huettmann)

farms and hundreds of thousands of livestock (Emerton et al. 2009). The Selenge river basin is home to major mining, industrial and agricultural activities, in an around the cities of Erdenet, in the Orkhon sub-basin, and Darkhan. Darkhan is in the Kharaa basin (Hofmann et al. 2013) which drains into the Orkhon basin. The 46 rivers and many lakes that drain into the Khovsgol lake forming the wider Khovsgol lake basin. Khovsgol lake, the second largest freshwater lake in the world, contains 74% of the freshwater resources in Mongolia (FAO 2011). About 51% of the total annual runoff flows through the Arctic Ocean basin.

River runoffs follow a certain pattern in Mongolia since it is situated on a continental divide (Lattimore et al. 2017). Rivers in the north flow to the Arctic Ocean, while rivers in the northeast flow to the Pacific Ocean (Pacific Ocean basin). Those in the south and west generally drain into salt lakes or trail off in the desert (Central Asia Internal Drainage). The Pacific Ocean basin (15% of the total runoff) spans the semi-arid regions of eastern Mongolian, with its rivers originating in the Khentii and the Khangai mountains (FAO 2011). The Central Asia Internal Drainage basin, in the southern and western parts of Mongolia, covers 68% of the country. Rivers and streams in this basin are intermittent and end up in salt lakes or seep into the desert. The basin contains large lakes, the Northern Gobi river basins and the Southern Gobi river basins. Approximately 78% of Mongolia's wetlands is located in this basin.

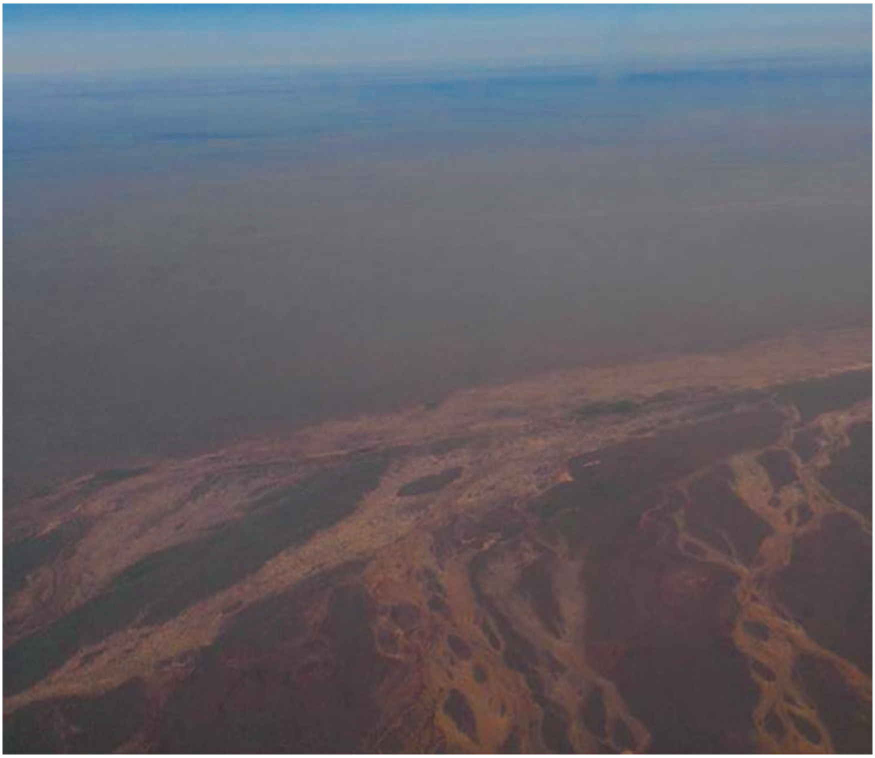

Fig. 41.3 Dry seasonal streams visible through the summer haze near Dalanzadgad in the Gobi desert. (Photo: Rajive Ganguli)

There are 4113 rivers in Mongolia (FAO 2011). The water sources for the rivers are rainfall, groundwater, snow and glacier melt. Groundwater is the source for the waterways of the Gobi Desert. Melting snow contributes up to 20% of the annual runoff of Mongolian rivers. Almost 40% of the total runoff ends up in the lakes of the Gobi Desert, with the rest draining into Russia and China. Figure 41.3 shows some seasonal streams in the Gobi. Figure 41.4 depicts the surface run-off in Mongolia.

The average internal renewable water resource of Mongolia is estimated at 34.7 km^3 (FAO 2011), with surface water contributing the most (32.7 km^3). The annual ground water resource is 6.1 km^3, though most of it (4 km^3/year) flows back into the rivers. Based on official information Table 41.1 lists some important water source and use data for Mongolia.

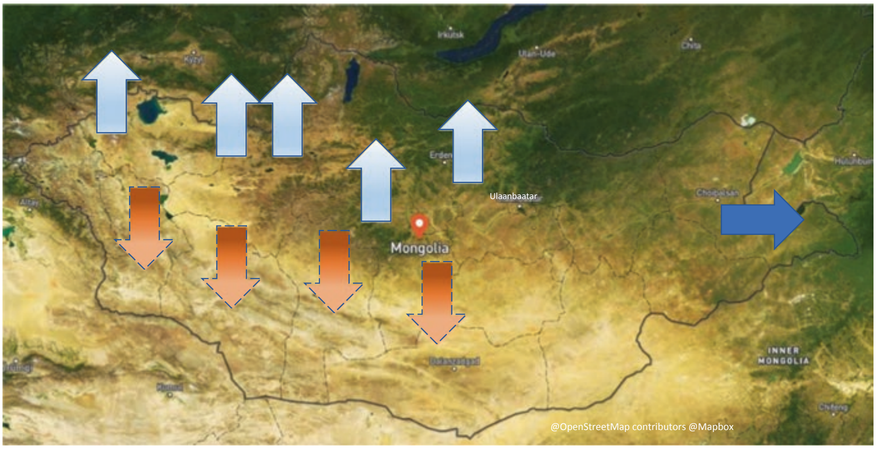

Fig. 41.4 Schematic depicting the water run offs from Mongolia. Approximately, 40% of total run off ends up in the Gobi desert, while about 10–15% heads east into the Pacific ocean basin. The rest ends up in the Arctic ocean basin. (FAO 2011)

Table 41.1 Use and sources of water in Mongolia. (Knoema n.d.; FAO 2011)

Water topic	2012	2014
Annual precipitation	241 mm	NA
Actual renewable water resources per inhabitant	12,393 m^3	11,761 m^3
Freshwater withdrawals	0.6 billion m^3	0.6 billion m^3
Water productivity[a]	\$17.2 per m^3	\$20.7 per m^3
Dependency ratio[b]	0	0

[a]GDP in 2010 prices divided by total water withdrawal
[b]Percentage of total renewable water resources sourced from a foreign country

41.2 Water Issues: Consumption, Availability, Mining and Pollution

The 2030 Water Resources Group inventoried water resources and uses in Mongolia, as part of a wider planning exercise (Banerjee et al. 2014). According to their report, the major uses for water are irrigation (30% of total use), livestock (23.5% of total use) and mining (12.7% of total use), with mining expected to draw more water in the future. The Tuul and the Orkhon basins draw the most water, at 27.6% and 13.5% of total use. The Tuul river basin has seven main wellfields, including Ulaanbaatar (Purevjav 2017). There are still sufficient groundwater resources in all 29 of the water basins in Mongolia to meet future demand, though in 22 basins (in central and eastern Mongolia), demand is expected to exceed 50% of the groundwater resources (Banerjee et al. 2014). Surface water is insufficient in 8 of the basins in an average year. As a nation, thus far, Mongolia has sufficient water resources.

But water is scarce in some regions. Water demand in Ulaanbaatar will exceed its supply by 2021. However, water scarcity is not the only problem for Mongolia.

Contamination of water resources from a lack of sufficient wastewater treatment facilities, and huge livestock numbers, are already a major problem in many parts of the country, including Ulaanbaatar (Theunissen 2014). Very high levels of uranium (from natural sources) was detected in wells in seven of the nine subdivisions in Ulaanbaatar (Nriagu et al. 2012). High levels of contaminants have also been detected in the waters of the Selenge basin (Kasimov et al. 2017), home to numerous artisanal placer gold mines in the Zaamar goldfield, numerous large mines (including Erdenet copper mine, Boroo gold mine, Gatsuurt gold mine, Baganuur coal mine), and the industries in Darkhan. The primitive mining technologies in use in much of Zaamar goldfields has been attributed to the negative impact on the surface waters in the region (Byambaa and Todo 2011). Heavy metal flows increased by an order of magnitude in that region since the advent of that type of mining (Thorslund et al. 2012). The mass flows have increased for Al, As, Cu, Fe, Mn, Pb and Zn. Alkaline conditions near Zaamar can further reduce the quantity of metals that are dissolved in the water, and therefore, the dissolved concentrations are much lower than the suspended concentrations. Suspended sediments carry almost 90% of the Bi, Cd, Mn, Pb, V and Co in the Selenge river (Chalov et al. 2013).

The tailings water from the Erdenet copper mine has been shown to impact both the Khangal river and the local groundwater (Battogtokh et al. 2014), with elevated levels of Ca, Mg, Mo and As measured in the streams and the soil. Though the Khangal river is not the source of drinking water for the Erdenet city, it is so for the herders. Additionally, the Khangal river flows into the Selenge river, that is the potable water source for Erdenet city. The tailings storage facility (TSF) at the mine contains 718 million tons of mine tailings, as well as 27 million m^3 of water (Dagva et al. 2016). The TSF at the Erdenet mine, which started in 1978 (LLC n.d.), is not lined at the bottom to prevent seepage of tailings into the groundwater. Modern TSF are constructed with a thick plastic liner at the bottom to prevent seepage of tailings into the ground. The mine also has an issue that is very typical of Mongolia: local herders take their animals to the TSF for grazing despite warnings from the mine. The author for instance saw horses grazing at the TSF (Fig. 41.5). The water visible in the picture is from the TSF. There are plans to close the existing TSF, and construct a modern one when the mine expands in the near future (Dagva et al. 2016). Figure 41.6 shows part of the TSF of the Boroo gold mine. The plastic liner that protects the groundwater from seepage is clearly visible. It is unclear if the liner spans the entire TSF, or just partially.

There are complaints of turbidity in water in the Orkhon basin, though high turbidity was also observed in the years prior to gold mining. The large sediment loads during storm events are attributed though to the collapse of stream banks, rather than mining (Chalov et al. 2013).

Shallow groundwater has been the source of water for herders and local communities in the Gobi desert (Sternberg and Paillou 2015). Gobi is home to significant mineral resources, including coal, copper, gold and uranium. Naturally occurring uranium and a large number of livestock has been attributed to groundwater contamination in the region (Sodov et al. 2016; Nakazawa et al. 2016). Arsenic

Fig. 41.5 Horses grazing at the tailings storage facility (TSF) of the Erdenet copper mine, Mongolia. (Photo: Rajive Ganguli)

Fig. 41.6 Tailings storage facility of Boroo gold. (Photo: Rajive Ganguli)

was also detected in several wells in South Gobi, with deeper wells (more than 300 m depth) having less arsenic than shallow (under 100 m depth) wells (Olkhanud 2012). Acknowledging that water is a precious resource, the mining industry in Mongolia adopted voluntary measures to minimize their impact on water resources (International Finance Group - World Bank Group and International Council on Mining and Metals 2016). One of the largest mines in the Gobi, the Oyu Tolgoi copper-gold mine, located near the Chinese border, taps a deep, unpotable, saline aquifer for its operational needs (Tinto 2018). Recycling 85% of its water, the mine has adopted additional measures to reduce its water consumption to 0.44 m^3 of water per tonne of ore processed (in 2015). This is less than half of 1.22 m^3 per tonne of water the industry consumed for comparable mines worldwide in 2013 (Tolgoi 2014).

Climate change is also impacting the water resources, and a topic that is likely on the rise for watersheds and landscapes of Mongolia. Changes in surface area of some lakes in the central Mongolia have already been linked to climate change (Szumińska 2016). Glaciers have been receding (Pan et al. 2017), while desert area has been increasing (Purevjav 2017). That seems to be a common trend by now and with wider repercussions to come.

41.3 Conclusions

Mongolia has adequate water resources. However, a shifting population has created significant shortfalls in some parts of the country, especially Ulaanbaatar. Insufficient wastewater treatment facilities, huge livestock numbers and legacy industries lead to contamination of available water resources. The mining industry is strongly expanding in the country in an environment that is sensitive to water use. Wary of conflicts, it has taken voluntary measures to minimize use of, and protect, water resources. Climate change is an added complication and could impact water resources further.

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Chapter 42
Good Citizen Science Experience Downstream of Everest Helps Monitor Status of Wetland Birds

Hem Sagar Baral and Laxman Prasad Poudyal

42.1 Introduction

Nepal has exceptional altitudinal variation at the shortest span of distance. Within less than 200 km, one can traverse from the tropical lowlands to life-less cold desert of the High Himalayas. In terms of altitude range, it starts from 60 m above sea-level that culminates with the height of Sagarmatha (better known as Everest outside Nepal) – the highest point on earth, a staggering 8848 m.

Arguably, only around 5% of Nepal's total area of 147,181 km^2 is covered with freshwater in the forms of streams, rivers, ponds and lakes. However, we often forget the huge ice sheet and snow that remains as the dominant cover of the high Himalayas round the year, and seasonal. Ice and snow are forms of 'water' but in its solid form due to the unique property of water solidifying at 0 degree Celsius under normal atmospheric pressure. The bulk of the water that flows through Nepal's rivers and also the high altitude lakes, they are all fed through snow-melt and ice.

Nepal has three major river systems that drain different parts of the country from east to west, and are all fed through snow and ice. These are Karnali in the west, Gandaki in the central and Koshi in the east.

H. S. Baral (✉)
Zoological Society of London Nepal Office, Kathmandu, Nepal

School of Environmental Sciences, Charles Sturt University, Albury-Wodonga, Australia
e-mail: hem.baral@zsl.org

L. P. Poudyal
Department of National Parks and Wildlife Conservation, Ministry of Forests and Environment, Government of Nepal, Kathmandu, Nepal

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Karnali is the longest large river in Nepal which flows in the western part of Nepal whereas the Gandaki (popularly known as Narayani) river flows through the central part of Nepal. When all of the Gandaki seven snow-fed tributaries join it becomes the largest river of Nepal – in terms of water volume discharge per second. It is also known as Sapta Gandaki, Sapta in Sanskrit meaning seven.

The Koshi river is unique; its fed by rivers that originate in the Tibet Autonomous Region (TAR) of China as well as Nepal. The Arun, Tamor and Bhote Koshi are three major tributaries of Koshi that also originate in Tibet. Another interesting fact is that these tributaries are fed through snow-melt of the highest peaks of the earth.... Sagarmatha (8848 m – world's highest) and various other 8000 m peaks around it: Lhotse (8511 m – world's 4th highest), Cho Oyu (8201 m – world's 6th highest), etc. as well as Kanchenjungha (8586 m – world's 3rd highest) and Makalu (8463 m – world's 5th highest). Essentially, if a Briton had to name it like was named for the highest peak, s/he would have probably given the name as Everest river! A total of seven major snow-fed tributaries joins to form the mighty river Koshi, which is often known to Nepali as Saptakoshi, the seven Koshi/s**.** Not surprisingly then the Koshi river makes the largest floodplains of all the rivers in Nepal, has the highest silt load and also considered as the most dynamic river not only in Nepal but the entire south Asia.

The Koshi river was once known as the 'sorrow of Bihar' due to the annual disasters it brought to the Indian state during monsoon time. To minimise the loss of human lives and properties, the Indian government in agreement with Nepal, built the famous Koshi barrage nearly six decades ago. Since the erection of this structure, wildlife in the area has suffered in spite of Nepal government's effort to declare lower floodplains of Koshi river in the name of Koshi Tappu Wildlife Reserve. How in the recent years, the populations especially those dependent on wetlands have plummeted in this Reserve is discussed below.

In this chapter we primarily discuss how Himalayas connect to the lowland rivers, the state of wetlands as shown by citizen science bird monitoring programme and various threats and challenges wetlands face in the country.

42.2 Birds as Indicator of Wetland Health

There are many taxa that inhabit the wetlands, from unicellular plants and animals to the uniquely evolved aquatic vertebrates. Of all the taxa, traditionally birds have been the most noticeable and studied ones. Because of their plumage, songs and ability to fly humans have always used birds as the source of inspiration and they feature prominently in traditions, culture, and religions. They represent food as well as God/Goddesses. Human perceptions on birds is largely an aspiring one. In recent years they have become popular indicator species, may that be for forests, open air, grasslands or cultivation and or wetlands. This is mainly because birds are easy to see, have great diversity, some are specialists enough and to monitor them usually very little resources and efforts are needed.

At the interface of the wetland habitat there exists a group of birds classified as river birds. These species are found mainly along rivers and are mostly passerines (except Kingfishers). They lack webbed feet but may be syndactyle (Kingfishers). The Nepal Himalaya actually boasts the most diverse river bird assemblages in the world (Buckton 1998; Buckton and Ormerod 2002, 2008). More than a dozen species of river birds are found along Himalayan rivers in Nepal (Buckton 1998; Table 42.1). It is important to recognise river birds especially when we talk about environmental and river flow matters as these species will be those impacted in a uniform way from upstream to downstream.

The river bird group is rather fascinating in many regards as its distribution runs along a north-south river gradient. Much of the knowledge derived from this group comes from studies carried out on river birds in the mid-1990s (Buckton 1998). The main Koshi River as well as its snow-fed and other smaller spring-originated tributaries provide the habitat for this collective group of species. Some species show distinct altitudinal migration (e.g. Grey Wagtail, *Motacilla cinerea*), whereas others show a very wide range of distribution from lowlands/foothills to highlands (Blue Whistling Thrush, *Myophonus caeruleus* and White-capped-Redstart, *Chaimarrornis leucocephalus*). Because of their confinement to river courses and rather contiguous distribution compared to other birds and wider altitudinal coverage, this group of birds may present us with rather interesting facets to monitor temporal changes in water regimes. Many of those changes we currently come to witness. These birds have been also suggested as useful indicator of river health (Buckton 1998).

Table 42.1 Some resident river birds in Nepal

English name	*Scientific name*	Range remarks
Little Forktail	*Enicurus scouleri*	Midhills to foothills
Slaty-backed Forktail	*Enicurus schistaceus*	Midhills to foothills
Black-backed Forktail	*Enicurus immaculatus*	Foothills to lowlands
Spotted Forktail	*Enicurus maculatus*	Midhills to foothills
White-capped -Redstart	*Chaimarrornis leucocephalus*	Highlands to lowlands
Plumbeous Water-Redstart	*Rhyacornis fuliginosa*	Midhills to lowlands
White-throated Dipper	*Cinclus cinclus*	Highlands only
Brown Dipper	*Cinclus pallasii*	Midhills to lowlands
Grey Wagtail	*Motacilla cinerea*	Highlands to lowlands
White-browed Wagtail	*Motacilla maderaspatensis*	Foothills to lowlands
Blue Whistling Thrush	*Myophonus caeruleus*	Highlands to lowlands
Crested Kingfisher	*Megaceryle lugubris*	Midhills to foothills
Common Kingfisher	*Alcedo atthis*	Midhills to lowlands
Blyth's Kingfisher	*Alcedo hercules*	Midhills to foothills
Blue-eared Kingfisher	*Alcedo meninting*	Lowlands
White-throated Kingfisher	*Halcyon smyrnensis*	Midhills to lowlands
Ruddy Kingfisher	*Halcyon coromanda*	Lowlands
Stork-billed Kingfisher	*Pelargopsis capensis*	Lowlands
Pied Kingfisher	*Ceryle rudis*	Lowlands

Modified table from Baral and Thapa (2016)

42.3 Water Birds

Water birds are primarily non-passerines and have special physical modifications suited for life in aquatic habitats. They are usually colonial nesters with a medium to high tendency to be completely aquatic in nature. These include wading birds (storks, ibises and spoonbills, sandpipers, stints, plovers) as well as waterfowls (moorhens, waterhen, rails and crakes, ducks and geese; Tables 42.2 and 42.3).

These birds depend entirely on water and riverine floodplains. Lesser Adjutant (*Leptoptilos javanicus*), Asian Woollyneck (*Ciconia episcopus*), Indian Skimmer (*Rhynchops albicollis)*, Black-bellied Tern (*Sterna acuticauda*) and Baer's Pochard (*Aythya baeri*) are examples of globally threatened species. There are several other nationally threatened species that occur in the same water areas (Inskipp et al. 2016). These species are sensitive to fluctuation in water level, and most are found in the lower Koshi basin (Baral and Thapa 2016). These birds are usually found in

Table 42.2 Some resident water birds in Nepal

English name	*Scientific name*	Range remarks
Lesser Adjutant	*Leptoptilos javanicus*	Lowlands
Black-necked Stork	*Ephippiorhynchus asiaticus*	Lowlands
Asian Woollyneck	*Ciconia episcopus*	Lowlands
Asian Openbill	*Anastomus oscitans*	Lowlands
Red-naped Ibis	*Pseudibis papillosa*	Lowlands
Black-headed Ibis	*Threskiornis melanocephalus*	Lowlands
Indian Skimmer	*Rhynchops albicollis*	Lowlands
Black-bellied Tern	*Sterna acuticauda*	Lowlands
River Tern	*Sterna aurantia*	Lowlands
Little Tern	*Sterna albifrons*	Lowlands
Ibisbill	*Ibidorhyncha struthersii*	High altitude to foothills
River Lapwing	*Vanellus duvaucelii*	Foothills to lowlands
Little Ringed Plover	*Charadrius dubius*	Lowlands
Black-tailed Crake	*Porzana bicolor*	Middle altitude
Brown Crake	*Amaurornis akool*	Lowlands
Purple Swamphen	*Porphyrio porphyrio*	Lowlands
Great Thick-knee	*Esacus recurvirostris*	Lowlands
Small Pratincole	*Glareola maldivarum*	Lowlands
Khob-billed Duck	*Sarkidiornis melanotus*	Lowlands
Lesser Whistling Duck	*Dendrocygna javanicus*	Lowlands
Ruddy Shelduck	*Tadorna ferruginea*	Highlands breeding
Cotton Pygmy Goose	*Nettapus coromandelianus*	Lowlands
Mallard	*Anas platyrhynchos*	Midhills breeding
Indian Spot-billed Duck	*Anas poecilorhyncha*	Lowlands

Table 42.3 Some wetland visitors to Nepal

English name	*Scientific name*	Range remarks
Great Cormorant	*Phalacrocorax carbo*	Lowlands, winter
Eurasian Spoonbill	*Platalea leucorodia*	Lowlands, winter
Pallas's Gull	*Ichthyaetus ichthyaetus*	Lowlands, winter
Indian Skimmer	*Rhynchops albicollis*	Lowlands
Caspian Tern	*Hydroprogne caspia*	Lowlands, winter
Little Tern	*Sterna albifrons*	Lowlands
Watercock	*Gallicrex cinereal*	Lowlands, summer
Bar-headed Goose	*Anser indicus*	Lowlands, winter
Baer's Pochard	*Aythya baeri*	Lowlands, winter
Goosander	*Mergus merganser*	Foothills to lowlands, winter

big numbers and are easy species for monitoring the changes in large wetlands, especially in the floodplains area.

Other than the true water birds, which get their feet wet in water, there are several fringe feeders. These include various species of birds of prey that feed on fish or take waterfowls such as White-tailed, (*Haliaeetus albicilla*), Pallas's (*H. leucoryphus*), Imperial Eagles (*Aquila heliaca*), and Lesser Fish Eagles (*Ichthyophaga humilis*) that occur in the Koshi area (Baral 2016) and are indirectly impacted by altered flow regimes. These species are known to occur in lower densities and numbers when compared to the waterbirds, but they are key for monitoring as these act as the apex predator in the lowland wetlands and respond very quickly to changes.

42.4 Citizen Science in Action

The annual midwinter water bird count is the longest running citizen science programme in Nepal. It started early in 1987 with a modest beginning but in 2018 it reached its 31st year. The midwinter waterbird count has become an event where more than 300 volunteers all over Nepal take part and celebrate on the spot such as festivals (a very Nepal-specific approach). The programme was started initially with the global coordination of Wetlands International (then known as International Waterfowl and Wetlands Research Bureau with its Asian wing known as Asian Wetland Bureau). Wetlands International is the self-proclaimed world authority on the status of water birds; it works to sustain and restore wetlands and their resources for people and biodiversity (Wetlands International 2017; Wikipedia 2018).

This regular waterbird monitoring data have enabled monitoring on how changes in wetland bird communities are taking place, how individual bird species or groups of birds are faring in their respective habitats. Through the longest running citizen science programme, we have been maintaining a large set of data for specific locality for the last 30 years. These data have been the main source of information for assessing the status of wetland birds in Nepal and has been repeatedly used in various publications. The status of Nepal's birds –a periodic assessment has used the information extensively to produce robust and authentic details on the status of birds of Nepal (Baral and Inskipp 2004; BCN and DNPWC 2011) and most recently the National Red List for Birds of Nepal (Inskipp et al. 2016). Similarly, information published in field guides about species' status, ecology and distribution are also based largely through the citizen science information (Baral and Shah 2008; Grimmett et al. 2016). One more example of citizen science data for species conservation can be witnessed in another publication on the red list of mammals of Nepal (Jnawali et al. 2011) (Fig. 42.1).

Although there is a general increase of waterbird populations overall in Nepal since the 2011, the increase is primarily associated with a couple of sites. According the count of 2018, Jagadishpur Reservoir holds 1/third of entire country's waterbird population. Other sites, for example, Koshi and Bardia show slight increase but these increases may indicate better coverage as well as changes in river courses and creation of new wetlands sites that were not counted previously.

For the last 3 years, Jagadishpur and Barju-Chimdi are accommodating increasing number of birds. Barju-Chimdi was added to the national coverage only for the last 3 years. Other important populations of wetland birds that lie in Chitwan National Park and Koshi Tappu Wildlife Reserve area (Fig. 42.2). Currently, Jagadishpur is the only wetland site of Nepal that qualifies as Ramsar Site or IBA under the waterbird congregation criterion. The 2018 midwinter waterbird count showed more than 23,000 waterbirds in the Reservoir in a single day count (Fig. 42.2). This count is the largest known count for the site as well as the largest

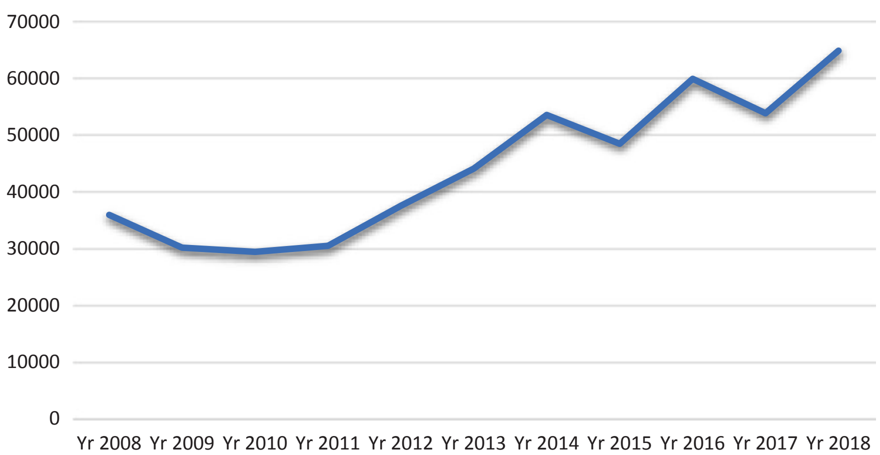

Fig. 42.1 Amount of national data from the mid-winter waterbird count. (Source: Midwinter Waterbird Count Archive: Wetlands international/Himalayan Nature)

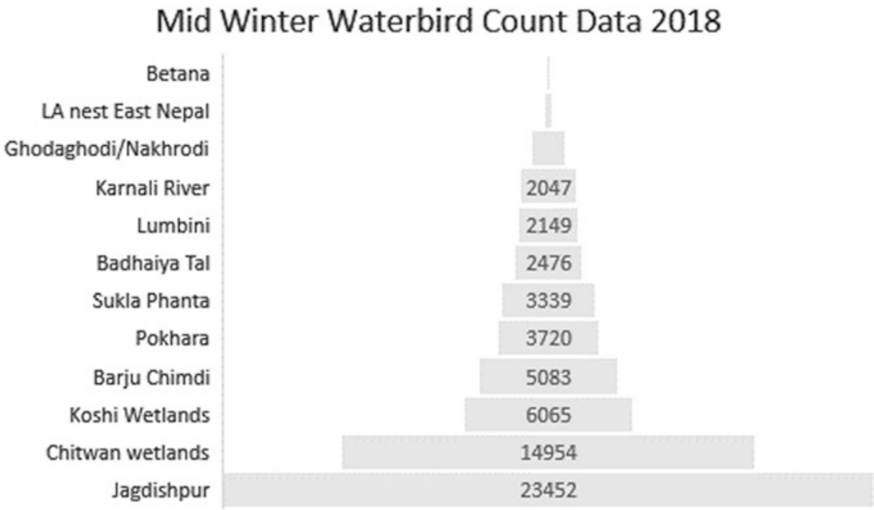

Fig. 42.2 Most important wetland sites of Nepal as per 2018 midwinter waterbird count in terms of the waterbird populations

one site count. Such numbers and more were counted only at Koshi before the mid-1990s (Himalayan Nature and Wetlands International 2018).

Although the national count total gives a high figure as if gradually the waterbird population is increasing in Nepal since the 2011, correct and careful interpretation is therefore required on this matter. Delving into the data shows that although some common birds have been recorded in higher numbers, some species for example Baer's Pochard *Aythya baeri*, Black-bellied Tern *Sterna acuticauda*, Eurasian Spoonbill *Platalea leucorodia*, Eurasian Curlew *Numenius arquata*, Black-necked Stork *Ephippiorhynchus asiaticus*, and several others have seen gradual decline.

According to the recent status assessment of birds of Nepal, the wetland birds face the most critical threats compared to bird species found in other habitats of Nepal. Species declines have been most obvious from Koshi Tappu—a premier wetland site of Nepal. We can for instance present two powerful examples of waterbird decline at Koshi wetlands using citizen science data that date back to late 1970s. Black-bellied Tern is a resident breeding species whose population is augmented during early summer months and monsoon time (high number recorded in 1996 indicates data from August—the only monsoon population in the graph) due to the arrival of summer visitors from India (Fig. 42.3).

Eurasian Curlew is a winter visitor to Koshi wetlands, mainly recorded from September till April. A combination of these two species completes the full summer-winter cycle. Major decline has occurred post 2000 with more than 90% decline in 10 years (Fig. 42.4). Their decline indicates combined threats to birds—in their wintering ground like Nepal as well as perhaps also the breeding grounds. In totality these two species confirm that wetlands are facing grave risks and are losing their breeding and wintering wetland birds combined.

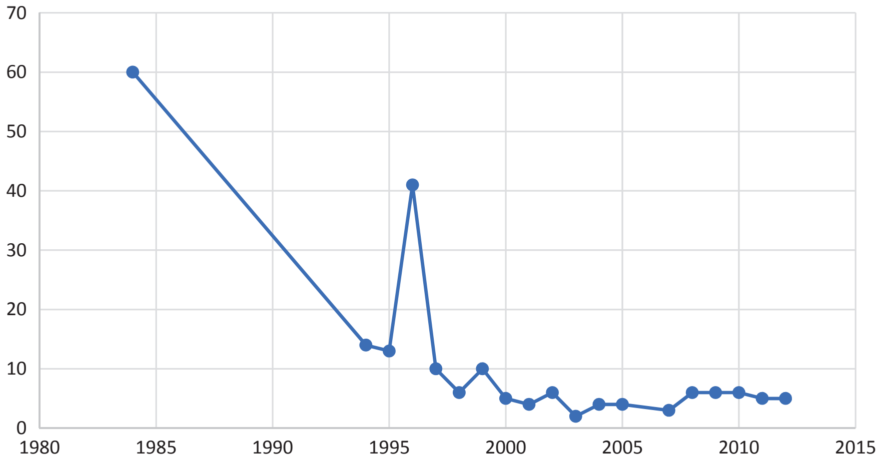

Fig. 42.3 Gradual decline of Black-bellied Tern at Koshi Tappu wetlands, data from citizen science used in Inskipp et al. (2016). X-axis Year of count and Y-axis population count

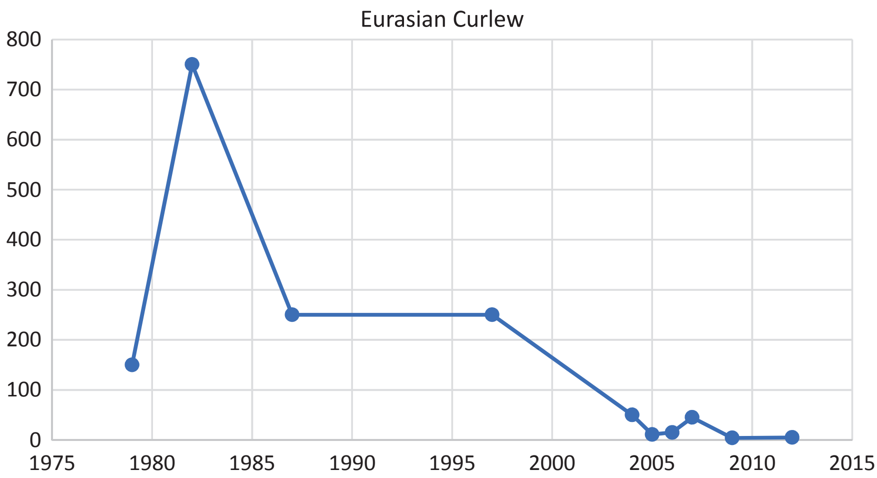

Fig. 42.4 Gradual decline of Eurasian Curlew at Koshi Tappu wetlands, data from citizen science used in Inskipp et al. (2016). X-axis Year of count and Y-axis population count

42.5 Discussion

Water and air are two main components that help sustain life forms on earth without which biodiversity will not exist. They require high attention and great management! We cannot see air and often it is difficult to gauge its status unless we take support of many scientific tools and gadgets. Water however is something we can easier see, feel, smell (if polluted!) and taste (if contaminated). Therefore it is very important to us as we can visually monitor its status in terms of its health. Water connection to other habitats and landscape is also greater than any other habitats. It travels greater distances, travels through underground, above ground and also in gaseous forms as vapour. As it rains and drains flowing through the surface, it becomes a life line for all living matters on earth. Space exploration and possibility of life on other planets and solar system are constantly looking for traces of water. But it's hard to find this commodity on other planets and our blue planet is the only one blessed with it.

Deposition of snow and the amount that melts in the Himalayas, affects the river flow downwards. How much of this water can be captured, and drained, how much to release is an important debate (Manandhar 2016). As water is needed for all live forms, including wildlife that are totally dependent on it as a habitat feature, as a conscious animal, we human beings have a greater role towards conservation, management and sustainable use of this precious gift of nature which will be needed for our future generations also. While we are discussing about all the problems our wetlands are facing, the government has come up with ambitious plan to divert the Sunkoshi river water (one of the seven important tributaries of Sapta Koshi river), to Kamala river. Sunkoshi's lower reaches is made up of five main rivers that feed the Sapta Koshi river, therefore, contributes bulk of the water discharge of the Sapta Koshi river. Further, now and then we still hear of Koshi high dams that may be built at the interest of government of India. The location of the dams somewhere in the lower foothills, north of the Koshi Tappu Wildlife Reserve is guaranteed to alter and destroy many forms of life. Dams, diversions and other uses have greater implications on hydrology of wetlands; their collateral damage should be properly understood and addressed before one can go to action. Ramifications of such mega structures that alter or stop the natural flow are far reaching both to people and wildlife (Thapa 2016); and one has to think of the distant future not only the immediate benefits. The altered flow lower down at Koshi floodplains may altogether wipe out the last remaining populations of Wild Buffalo, and important populations of Gangetic Dolphin as well as several other important fauna at national and global scale (Baral 2016; Baral and Thapa 2016; BCN and DNPWC in prep; Doody et al. 2016). This will mean ultimately losing the biodiversity significance of Nepal's premier and one of the most species rich Koshi Tappu Wildlife Reserve (Sah 1997).

Wetlands are free storehouses that provide us with 'goodies' for all times. These act as the hens that lay golden eggs. We should not over-extract wetlands so as to stop them from giving us the free resources we are getting for future years. That is why sustainable management guidelines have been prepared and there is a need to make them better and to follow these important documents (Buckton 2007; Buckton et al. 2009; Thapa and Dahal 2009).

Some seminal work has been conducted in the past especially led by IUCN and others with regard to wetland research and conservation (Bhandari 1998; IUCN Nepal 2004). Monitoring wetlands requires a huge amount of time and resources. Even wealthier countries are seeking ways for more cost-effective methods to inform the decision makers for appropriate actions to tackle with those changes. In this regard, Nepal's efforts on an individual basis (van Riessen 2017) or more organised long-term monitoring where work is completed on a volunteering basis like the mid-winter waterbird counting programme (Himalayan Nature and Wetlands International 2018). These important contributions are also reflected in the national conservation strategy documents for their plan of actions (GoN/MFSC 2014).

42.6 Threats and Challenges

Threats and challenges to wetlands have been discussed in detail in the past (e.g. IUCN Nepal 2004; Inskipp et al. 2013). Here some important points reiterated.

1. Habitat loss and shrinkage due to anthropogenic activities, natural succession including eutrophication, drying up of the landscapes primarily due to climate changes are the main threats to climate change. While climate change is affecting wetlands birds globally and studies have been made as yet we are unknown about its measured effect on national context. Habitats that supplement and support wetland birds eg other habitats in the protected area but more so the rural farmscapes outside the protected areas are changing rapidly which are also of grave concern for the future of wetland life especially the birds.
2. Trapping, poaching and other associated disturbances including recreational activities that are carried out without any checks and management are other threats.
3. Agrochemicals and pollution threaten the very existence of wetlands in Nepal. Industrial discharge, domestic sewage, unsustainable ways of fishing – including poisoning and blasting – have contaminated much of the wetlands outside the protected area. As rivers travel long distances and often through settlements, what can be put into it has no checks and monitor. Virtually all rivers and wetlands are polluted therefore.
4. Wetlands have been chosen as the boundary of protected areas for the sake of easier management. But this has also had greater consequences to the habitat and wildlife as it becomes the main interface for people (who use and dispose 'bad things' there) as well as wildlife (who may use the disposed 'bad things' and succumb the disturbance). For example, a stretch of over 16 km of Koshi river is protected within Koshi Tappu Wildlife Reserve –but it faces the dilemma from the unprotected top and bottom.
5. Dams and diversions are rampant. Almost all rivers in Nepal have been given licence to developers for generating electricity which will build dams in the future. Some rivers will have multiple dams and barrages. There is no monitoring on the minimum river flow. There is also no vision for keeping some rivers without dams and checks for the sake of biodiversity.

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Chapter 43
A Citizen Science Experience: Green Youth of Lumbini (GYL) Promoting Globally Threatened Bird Species (Cranes/Storks) and Holistic Landscape Conservation in the Lumbini Region of Nepal, on the Ground as well as with Social Media

Dikpal Krishna Karmacharya, Rabita Duwal, Santosh Kumar Yadav, and Arjun Kurmi

43.1 Introduction

Citizen science is the scientific research conducted in whole, or in part, by amateur non professional scientists which is sometimes described as "public participation in scientific research" (Hand 2010). It is the scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions. In citizen science the general public contributes to science either with their intellectual effort or surrounding knowledge or with their tools and resources. Citizen science may be performed by individuals, teams, or networks of volunteers to collect and compile data, often done in new shapes and forms for new insights. Citizen scientists generally partner with professional scientists to achieve common

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D. K. Karmacharya (✉)
Bhaktapur Multiple Campus, Tribhuvan University, Bhaktapur, Nepal

Third Pole Conservancy, Kathmandu, Nepal
e-mail: dikpal.karmacharya@gmail.com

R. Duwal
Third Pole Conservancy, Kathmandu, Nepal

S. K. Yadav · A. Kurmi
Green Youth of Lumbini, Rupandehi, Nepal

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goals. Large volunteer networks allow scientists to accomplish tasks that would be too expensive or too time-consuming to accomplish through other means (Silvertown 2009).

So far, there is very little citizen science carried out in the wider Hindu-Kush Himalayas and it remains a new undertaking. However, its relevance and its contribution is well recognized and many projects are coming up, including ones that involve wider high schools and village communities.

Citizen science has evolved over the past four decades. In recent projects more emphasis are given on scientifically sound practices and measurable goals for public education (Bonney et al. 2009). Modern citizen science differs from its historical forms primarily in the access for, and subsequent scale of, public participation (Silvertown 2009). There are long histories of citizen participation in science. However, the process of studying and understanding the best and most suitable ways to develop, implement and evaluate Citizen Science is just beginning. Either way it remains rather powerful tool for the generation of scientific knowledge to a level that often would not be possible for the scientific community alone (Garcia-Soto et al. 2017). Citizens allow for information to be gathered that is otherwise not possible due to the sheer abundance of citizens involved, their skill sets and high work and survey efforts in the field almost 24 hours a day. Compared to single researcher, or a small network, citizens can easily outperform 'experts' alone on those grounds. Other advantages come with the actual analysis methods employed for such data also allowing for more powerful inference and insights (e.g. Hochachka et al. 2007).

The combination of historical data and the gathering opportunities due to a large, dispersed team of observers on the ground all year round creates opportunities for ecological research at unprecedented spatial and temporal scales. Many ecologically based citizen-science projects collect important baseline data of the environment and wildlife for their further research and management (Sullivan et al. 2010). The primary impacts of citizen science are seen in biological studies of global climate change for instance, including the analyses of phenology, landscape ecology, and macro-ecology, as well as in sub-disciplines focused on species (rare and invasive), disease, populations, communities, and ecosystems (Dickinson et al. 2012). The benefits of those approaches are just showing now and more can be expected.

Several striking examples have recently been published that show the power of utilizing modern-day citizen science to provide meaningful contributions to scientific progress. Citizen-science projects have a large potential for making positive impacts when it comes to attitudes toward science that can provide a mechanism for participants to become invested in science research (Garbarino and Mason 2016). Utilizing citizen science, scientists are gaining myriad research team members in the landscape, and even internationally, who collectively survey large geographical areas, analyze large datasets and study large sample numbers on issues of relevance for mankind (Crain et al. 2014). Citizen science plays an important role in delivering environmental data at local and national scales, and it can form the basis of scientific research, as well as evidence for policy and management. It is also an important way of connecting people with nature conservation (Geoghegan et al. 2016).

Here a citizen science project for Sarus crane (*Antigone antigone*) conservation in Lumbini region is presented that shows how to improve the relation and acceptance of Sarus cranes, associated species and environmental issues for farmers and other people in the region resulting into wider sustainability in modern times.

43.2 Lumbini and Its 'Holy' Landscape Culture

Lumbini in Nepal is a unique study site. It is a world-famous Buddhist pilgrimage site in the Rupandehi District of Nepal near the Indian border. It is the place where, according to Buddhist traditional information, Lord Buddha was born as Prince Siddhartha Gautama of the Shakya Kingdom in 623 BC (UNDP/UNESCO 2013). It was declared as a World Heritage site by UNESCO in 1997 based on its historic, cultural and religious significance. In addition to the imperative pilgrimage site, Lumbini also supports a rich and diverse natural ecosystem. Similar to holy groves and other examples (see Li et al. 2014 for snow leopards benefitting from monastries) makes for a great showcase how religion contributes to conservation and promoting holistic and peaceful views. It also is an important carbon sink in the region, and further it allows for building greater adaptive capacity on the effects of climate change in Nepal. Lumbini houses a large garden with a dense grove of trees and shrubs of numerous local species. Its wetlands harbor a growing population of Sarus cranes and Lesser Adjutant storks (*Leptoptilos javanicus*) as well as many other birds. The blue bull (*Boselaphus tragocamelus*) is Asia's largest antelope species commonly seen in Lumbini (WWF 2011). It enjoys a certain protection there. The wider Lumbini landscape is of significant global cultural value and has a number of ancient temples, including the Mayadevi Temple (Fig. 43.1) and the World Peace Pagoda. Many monuments, monasteries, museum and the Lumbini International

Fig. 43.1 The famous Mayadevi Temple, birth place of lord Buddha

Research Institute are also within the holy site. Further there is the Puskarini, or Holy Pond, where -according to the historic holy reports – Buddha's mother took the ritual dip prior to his birth and where he had his first bath.

The temples around Lumbini are featuring international Buddhism and it represents a global microcosm of global buddhism, representing peace and holistic views about nature, with the Sarus crane at its ultimate.

The wider farmlands in Lumbini region are covering 141,367 ha areas of Rupandehi and Kapilvastu districts. They lie within the famous Terai Arc Landscape, which has already been identified as an Important Bird and Biodiversity Area (IBA) by BirdLife International giving priority for conservation. In the south there are wider plains reaching to India, and the north has dry bhabar and the Churia Hills. Perennial and seasonal rivers and streams including the Telar, Tinau, Sundi and Dano river systems flow through the region making it one of the most ancient landscapes with human civilization for thousands of years. The forest, scrub, wetlands and grasslands adjoining Lumbini region are an especially important refuge for wildlife. It habours 210 documented bird species including eight globally threatened birds. It also contains globally threatened mammals like blue bull (*Boselaphus tragocamelus*), Smooth-coated Otter (*Lutrogale perspicallata*) and Striped Hyena (*Hyaena hyaena*) (Birdlife International 2018).

In the Kapilvastu district there is a reservoir called Jagdishpur – the largest reservoir in the country and an important wetland site (Bhandari 1996) with the 225 ha surface area. It has been listed on the Ramsar Sites- the Wetlands of International Importance. Based on river confluences and wetlands, it was constructed through irrigations and a dam in the early 1970s over the Jakhira lake and agricultural lands for human irrigation purposes to improve farming gains. The water is fed from the Banganga river in the Churia hills catchment. It is surrounded by cultivated land and a few smaller lakes serving as a buffer zone for bird movements which are the important habitat for resident, wintering and migrating wetland birds, comprising there of 45 different bird species (Bhuju et al. 2007). The current use of the reservoir by local population includes fishing, grazing, fuel wood and fodder collection, domestic use and supply of water for irrigation in 6,200 ha of surrounding cultivated land (RSIS 2003). The site is providing shelter for an assemblage of some rare and endangered species of conservation importance, which include plants such as endangered Serpentine (*Rauvolfia serpentina*), rare Pondweed (*Potamogeton lucens*), threatened Lotus (*Nelumbo nucifera*), and the globally threatened bird species Indian Sarus Crane (*A. antigone antigone*).

The Sarus crane is the world’s tallest flying bird (Archibald et al. 2003). It is the only resident breeding, non-migratory crane (Sundar and Choudhury 2003, Baral 2009) which measures up to 176 cm in height, weighs about 6.35 kg and has a wingspan of 240 cm (Ali and Ripley 1987). It is a monogamous (Baral 2009), social and omnivorous bird that feeds on aquatic plants, seeds, roots, tubers, invertebrates, crustaceans, butterflies, insects pests, molluscan pests, fishes, frogs and reptiles (Verma et al. 2016). It is believed that a plot of land where a Sarus crane builds a nest produces higher crops. But due to lack of awareness people destroys their nests and eggs on the cropland to extend the paddy area. These birds are facing several threats hence, they are listed as vulnerable in the IUCN Red list (IUCN 2017).

According to environmentally engaged Buddhists, the Buddhism has always been close to nature. The Buddha was born in a garden, attained Enlightenment in and passed away from this world under trees, and always taught outdoors, preaching ahimsa (non-violence). So, there is a strong connection between Buddhism and conservation. According to legend, there is also a close connection between Buddha and Sarus cranes which states that, when the young prince Siddhartha was growing up he encountered a wounded crane, injured by a hunter's arrow. He removed the arrow and nursed the bird back to life. But Siddhartha's jealous cousin – Devadatta – eventually shot and claimed it as his own. These two boys argued, but the merciful Prince Siddhartha did not relinquish the bird. Finally, the case was adjudicated by a royal court judge who ruled that custody belongs to the one who saved the bird's life, not the hunter, which reflects the animal rights since those days

43.3 The Green Youth of Lumbini (GYL)

The Green Youth of Lumbini (GYL) is the nonprofit, non government, pioneer local conservation organization in the Lumbini. It was established in 2013 and consists of local youth members dedicated to the conservation of Sarus crane in relation to the communities. They enhanced their capacities through diverse and annually-held trainings and workshops from various national and international organizations including WWF Nepal's 'The Generation Green' programme and Global Primate Network- Nepal's 'Sarus Crane conservation' programme (Fig. 43.2) making them

Fig. 43.2 Local youth in capacity building workshop

'real' citizen scientists. They are conducting 'Ban Dasak' (our decade devoted to the forest) programme. It carries the main theme '*One Youth, Five Plants*' for the restoration of forests in low land Nepal. They are also taking part in the regular annual wetland bird count organized by Birdlife Nepal (http://www.birdlifenepal.org/).

These citizen scientists are maintaining cleanliness in the Lumbini region through the 'Waste Management and Sanitation' programme. On one hand they are regularly monitoring the Sarus crane in the Lumbini region compiling the population and nest status since their establishment. On the other hand they are spreading the conservation awareness (Fig. 43.3) among farmers and locals for the long term protection of species. So far, they have also rescued several injured birds and release them back in their natural habitat in co-ordination with District Forest Offices. They are regularly monitoring the birds for the long term conservation of the species. For instance, with the technical support from Global Primate Network-Nepal, financial support from Rufford Foundation, UK and equipment support from IDEAWILD, USA the team has counted 201 Sarus cranes in 2014 (Huettmann et al. 2015) and 295 in 2015 from the Rupandehi and Kapilvastu districts. In 2015, the team has also recorded 35 eggs and 10 chickens in 26 nests (DKK pers. com). The team is monitoring storks, their nests and other water birds since 2015.

These citizen scientists work closely with local farmers changing their negative attitudes and improving the generic relation of Sarus crane, environment and farmers. The farmers who used to destroy the crane's nests in the past for the extension of paddy plantation areas are now accepting them in their farmlands recognizing cranes as an agricultural pest controller. The cranes are showing no fear with locals

Fig. 43.3 Citizen scientists on a Sarus Crane count with conservation education material

Fig. 43.4 A young and motivated citizen scientist monitoring Sarus Crane at Lumbini

even when they reach closer (Fig. 43.4) and these animals tend to escape only with unknown foreigners.

The use of social network like facebook (https://www.facebook.com/Green-youth-of-Lumbini-1424458341143257/) but also twitter, messenger, whatsapp and vibers are also playing significant roles in gathering citizen scientists and disseminating their conservation efforts in mass which has also attracting the local people in conservation. The online portals and local daily papers are also highlighting the conservation works of the team which are being shared in the social networks to drag the attention of local people, youths, academicians, politicians and the policy makers as well. Their works were recognized by many conservation organizations and in return honored by many prestigious awards.

The continuous efforts of this youth group made the good numbers of Sarus Crane and storks in Lumbini region resulting into sustainability in the modern times.

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Appendix

Survey Data for the Lumbini Area, as Presented Online by Huettmann et al. (2015)

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Chapter 44
When Governments Cannot Do It Anymore and When Capitalism, Neoliberal Policies and Globalization Get Imposed Without Democracy: Self-Organization in the HKH Region Beyond E. Ostrom and Facebook

Falk Huettmann

All of the western nations have been caught in a lie, the lie of their pretended humanism; this means that their history has no moral justification, and that the west has no moral authority.
(James Baldwin 1963)

There can be no keener revelation of a society's soul than the way in which it treats its children.
(Carla J. Berrett in Bisman 2013)

The institution is not just a building, it's a method
(Source unknown)

"Instead of transforming the structure," said a former superior general of a Roman Catholic religious order, "the structure transforms you."
In: Daft (2015) Organization Theory and Design (textbook)

The most terrifying words in the English language are: I'm from the government and I'm here to help.
Ronald Reagan, August 12 1986

F. Huettmann (✉)
-EWHALE Lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

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The celebrities of western globalization also became its first victims: Modernization and human dignity, and certainly Mt. Everest, rainforests, tigers, snow leopards, red and great pandas, elephants, the Bajii as well as Brad and Angelina, Jonny Depp, or America and western ethics themselves (e.g. Elvin 2004; Kodas 2009; Altvater 2011; Cockburn 2013; Huettmann 2015a, b, c; Panthi et al. 2017; Herlihy-Mera 2018; for Asian people see Gelner 2013). Global aspects of the environment receive by now wide attention and are 'a big deal' indeed (Crawford et al. 2003; Collier et al. 2017 and publications within; Gelner 2013 for boundary lands, and see Buckley 2014 and Rai et al. 2018 for ecological services in watersheds,). But as shown in Mace et al. (2010) the pristine environment, including the earth processes and the wider atmosphere, are not in a good shape! Beyond water and climate problems, another typical example can be seen in the state of forests (Ali and Benjaminsen 2004). The initial and noble goals, aims, and dreams of the western model simply got missed (Altvater 2011, Alexander 2013; Gelner 2013 for Asia)! Because the governance does not really add up, more of those aims will be missed, and trusted governance becomes less trusted, widely ignored.

However, a recent study of the top 100 global corporations that have made a commitment to sustainability – which means to weave environmental and social efforts to preserve natural resources into all their decisions – actually had significantly higher sales growth, return on assets, profits, and cash flow from operations in at least some areas of the business (cited in Daft 2015). Sounds all wonderful, not? Well, considering the resources needed and that money does have an ecological foot print (Daly and Farley 2010), this looks more like a classic capitalistic trap and global dilemma just adding to the downfall even further (Czech 2002 for a running train wreck)! Selling more eco-friendly products is not the solution nor a green or any consumptive economy as such when acting on an earth with finite resources (Thompson 2017; Galaz et al. 2018).

So how about adding good ethics to the global operations to achieve sustainability through good governance (Bandura 2007; Huettmann 2015a)? For instance, a widely used textbook in business and leadership (Daft 2015, p. 407) clearly states:

> *Values-based leaders accept others' mistakes and failures and are never condescending. They hold themselves to high ethical standards and continuously strive to be honest, humble, and trustworthy and to be consistently ethical in both their public and private lives. However, they are open about and accept responsibility for their own ethical failings.*

Also from a military leadership perspective, U.S. General Norman Schwarzkopf once said "*Leadership is a combination of strategy and character. If you must be without one, be without the strategy.*" (Daft 2015, p. 407). Arguably, formal ethics programs are worthless if managers do not live up to high standards of ethical conduct. It's recommended policy to act as a leader for the internal culture and ethical values that are important to the organization. To treat people fairly, to hold oneself and others to high ethical standards, and to communicate a vision for putting ethics before short-term interests. Actions speak louder than words (Daft 2015, p. 405). Those things are widely promoted by some leaders, see for instance XIV Dalai Lama (in Hellstrom 2016):

There is no shop that sells kindness , you must build it within. You can transplant hearts, but you cannot transplant a warm heart. Just be a nice warm person, that's enough.

China, as a major global player in the climate field, is quoted as having achieved in the recent decade app. a 48% drop in 'carbon intensity', but arguably it's not even enough. It needs a 'strenuous' effort still (Liqiang 2019). In the HKH region, the glacier melt just doubled since 2000 (https://www.theguardian.com/environment/2019/jun/19/himalayan-glacier-melting-doubled-since-2000-scientists-reveal). So how can betterment be achieved with the global community in mind?

Clearly, globally, The World Bank is a self-declared leader in running the world, its people and towards eradicating poverty (https://www.worldbank.org/ and see mission statement within). But instead, a recently conducted survey of employees in The World Bank revealed a "terrible" environment for collaboration at the huge economic development institution that works in more than 100 countries (Lowrey 2013). Such a leadership trickles down, globally, and any citizen experiences it. Many problems can be named, and as taken from standard business textbooks even, bribery is one of the most frequent types of illegitimate activity in such type of governance, particularly in companies operating globally (Daft 2015, p. 166). It comes with the global framework that currently is favored (Gaffney and Harrison 1994). Closely related, political activity is now so important that "informal lobbyist" is an unwritten part of almost any CEO's job description (Yoffie 1988; Birnbaum 1999).

There is another wider failure becoming apparent in this western model, and that is the widely promoted science-based approach they carry out and promote (Wester et al. 2019 for the HKH region via NGOs but missing key issues and actions, see Lackey 2019 for lack of science in management and policy). Many more examples can be listed and named, e.g. Alexander (2013) or Huettmann (2012) for Polar Protection. And just by browsing the recent top100 publications in Ecology (for 2018: https://www.nature.com/articles/s41559-017-0370-9; for recommended ones: https://www.nature.com/collections/rpytmmpcnt) one will find much to ponder regarding scientific ignorance (compare with Bandura 2007) and fair vision, and relevant gaps not addressed for an effective governance (see similar scheme missing wider views and governance for Asia with Yao 2019; Zhang et al. 2019; compare with Buckley 2014). Instead, in ecology, all is connected, now dominated by 'man' in the Anthropocene (Hulina et al. 2017 for telecoupling). And where are any considerations of indigenous people, e.g. Buckley (2014), Dhongdue et al. (2019)? Arguably, (western, 'modern') science, and certainly the traditional ecology, is way too narrow, looks at the wrong scale, has the wrong oversight and review models, employs unfairness and is widely biased in the first place (Conner 2005; Spinrad 2017; see Obeyesekere 1992 for enlightenment; see Wester et al. 2019 for details and for the HKH region).

Arguably, while appealing and attractive to many, in times of globalization the classic top-down reductionist approach and framework for natural resource conservation management (Burnham and Anderson 2002; Wester et al. 2019; compare with Bandura 2007; Belgrano and Fowler 2011) and for its people who rely on it (Rosales 2008 for suggestions) fails us in the HKH region (e.g. Groisman et al. 2017), as well as globally. And this is not new (e.g. Kurt 1982). The simple western approach to modernity and its practices pursued for many decades did not achieve (Alexander 2013; see Rich 2013 for The World Bank as its main funder). One classic example of this 'traditional' approach and ongoing for decades is seen in conservation research like presented with the use of geolocators on raptors to indicate how and where birds of prey really migrate (as presented here http://timesofoman.com/article/128064). There is virtually no management policy or agency in charge that truly cares or implements those findings for betterment of the conservation status on a relevant wider scale (Czech 2002; Tankha et al. 2018). Nor has there ever been a decision that really takes such raptors into account or which benefits the HKH region or its people. So are the facts (see textbox at bottom on this issue with more details). So whom does such work really serve and why carried out and funded?

In the meantime, many birds of prey and their habitats and environments are 'fully crashing', e.g. Green et al. (2006) for Asia, songbirds are also widely declining (Jiao et al. 2016), species are vastly poached and traded illegally all over Asia and much beyond (see for instance https://www.theguardian.com/artanddesign/gallery/2018/feb/09/ the-bird-market-kabul-ka-faroshi-in-pictures). Clearly, even the most basic conservation management topics remain widely uncontrollable in modern times for the HKH region (see Wester et al. 2019 for various governance calls)! So how then can wider issues really be managed and governed in good terms?

This consistent ignorance of environmental issues and needed actions in the public policy arena is even more obvious when taking the atmosphere and water into account (see for an example Pandit and Paudel 2016; Marsden 2017), which is globally marginalized now by the governance and its underlying theories employed (Czech 2002; Daly and Farley 2010; The Guardian 2017; see Koengkan et al. 2018 for a mountain area example)! In the HKH region, many signs show us just that. For instance, modern Pakistan – a nation that runs for long time hundreds of hydro dams – is now confronted with serious floods. And contamination events are now the daily 'bread and butter' in the HKH region. Some of its estuaries and associated oceans are literally exploding (see for instance https://www.theatlantic.com/technology/archive/2018/01/the-oil-spill-that-wasnt/550820/ and http://www.hindustantimes.com/world-news/burning-iranian-tanker-leaves-10-mile-oil-slick-in-east-china-sea-chinese-state-tv/story-vTn5lnkdkb3QB9BngYGxjK. html for an event when in the East Asian sea (an estuary of the HKH) a massive Iranian tanker, the Sanchi, collided with a Chinese freighter carrying grain. The aforementioned sources report: 'Damaged and adrift, the tanker caught on fire, burned for more than a week, and sank. All 32 crew members were presumed dead. Meanwhile, Chinese authorities and environmental groups have been trying to understand the environmental threat posed by the million barrels of hydrocarbons that the tanker was carrying. That's because the Sanchi was not carrying crude oil, but rather condensate, a liquid by-product of natural gas and some kinds of oil products. According to Alex Hunt, a technical manager at the London-based International Tanker Owners Pollution Federation, which assists with oil spills across the world, there has never been a condensate spill like this and it's all new territory for agencies in charge on what to do.'

In a cleaned-out homogenous industrial landscape, without wilderness and relevant topography, ecological or water processes, such a model of governance provides for a self-fulfilling prophecy (=a value system that creates its own environment, with a subsequent state that sets its own type of administration, aims, narratives and policies. It's a suicidal spiral though that works towards eliminating nature, wilderness and human life. We find it as a typical western-dominated role model and template (Huettmann 2011, 2017); but the Earth -live itself- strikes back; Lovelock 2007). Thus far, the HKH landscape remains much bigger than that and can break out from the industrial (western) model! It should, and so it sets us a global model; one of the last. Already the religion and spirituality of HKH that does not fit into western forms of administration, and a 9AM–5PM work scheme of the usual industrial society with some social narratives added to it. But there is more in the HKH region that makes it a role model of sorts (see opening chapters of this book). Still, globalization is currently dominated by the western approach to life (e.g. The World Bank and its institutions) as well as the earth (Rich 2013) but which instead is only one of many approaches and in globalization. Already the Mongolian empire set a good role model how another type of globalization can look like, with religious freedom and effective administration Allsen (2004). Considering the global crisis we are all in (e.g. http://nymag.com/daily/intelligencer/2017/07/climate-change-earth-too-hot-for-humans-annotated.html and citations within), we are in urgent need of a new governance model regardless (see Cockburn 2013 and Alexander 2013 for details)! While Aldo Leopold (1948) is widely outdated but still hailed as a western role model, so far, Ostrom and Hess (2007) and Daly and Farley (2010) are among the few candidates with a valid sustainable governance model to consider by the west, and scaling up globally. But many other options exist beyond that and in good combination, e.g. Naess (1989), Duraiappah et al. (2012), Li et al. (2014).

For the ongoing governance, widely dominated by western institutions, there are almost endless examples to show how poor the western mindset, economic growth, marginalization of environmental issues, and 'fix the problems after the fact' concepts, actually work (e.g. Diamond 1997; Czech 2002; Alexander 2013 and Cockburn 2013 for overview; see Resendiz-Infante and Huettmann 2015 and Estrada et al. 2019 for real-world examples). Already the colonial problems created for Pakistan, Bangladesh and Myanmar speak to that effect fine (e.g. Mint-U 2007). A classic example for the watershed status of the HKH region might be found in Buckley (2014) or with the Yangtze River and its damns: by now it has five reserves set up 1992 onwards for the vanished Bajii (freshwater dolphin; *Lipotes vexillifer*). But obviously this concept failed all together. The Bajii is now virtually extinct (as the first marine mammal in the world, its extinction was caused directly by humans last decades and was witnessed as it happened without relevant actions). The reserves are lacking the Banjii and the mighty Yangtze River clearly is 'injured' if not even destroyed, while an ancient human lifestyle, culture and society along the river, as it has evolved for thousands of years (Elvin 2004; Lama 2012), got wiped out again through industrialization; harm done.

The western administrative mindset was already criticized for decades as not being feasible, hardly realistic, not making real money and just managing down the ecosystems (e.g. https:// www.clubofrome.org/, Czech 2002; Altvater 2011; Loewy 2009). The nation state, most of its institutions, and the wholesale lack of wider perspectives in such governance models are wide failures; none are so obvious than in transboundary management items like migratory species, water, air and pollution (Lkhagvasuren 2012; ICIMOD 2017; Marsden 2017; Rai et al. 2018). Human trafficking brings it up as well. And there are many other examples how poor such essential items are managed and where relevant governance and expertise is widely lacking on a more global scale as the source problem, e.g. the actual bird flyway in Asia, specifically the Australian section, is run for its shorebirds by amateurs (Gosbell and Clemens 2006; Moores et al. 2008; Clemens et al. 2016 for shorebird declines). It's easy to show that many Asian nations and their stakeholders are simply not in harmony with nature, or even with their people and landscapes (Miller and Spoolman 2011; see Lowe 2003 and Miller 2003 for Chinese management approach). Birds just show that, so do many other metrics along the gradient (see chapters within this book).

Alternative models of governance were suggested instead and are available from long time (e.g. from monastries over dictatorship and socialism, marxism and laissez-faire to ecological and peaceful ones; e.g. Marx 2010; Karmay and Watt 2007; Duraiappah et al. 2012 for Japan). Self-organization (as expressed in GAIA by Lovelock 2016 and in resilience concepts through Chapin et al. 2009) are also part of these considerations because it could potentially overcome individual problems in real-life and with a wider context trying by itself to keep life ongoing. These are hardly revolutions but they still bring massive change in how to run business. Those put solutions back to the individual and to earth itself, and thus can have a good outlook for humans (Lovelock 2007). Instead, the HKH region presents some good examples and applications for such dilemmas and how to move forward in a good way with such complex situations, e.g. when thinking about the Buddhist paradigm of '*life is struggle*', re-incarnation, or the Chinese concept of '*ying and yang*' (=something always has to give) and Daoism for instance (Miller 2003). Shamanism is there then as valid as the western and Christian concept but actually has a better environmental long-term track record (Davies 2011; Lama 2012).

There is a modern argument presented on this topic by Harari (2015) who argues that humans are social, and thus they organize themselves in groups - often with peers and certain taboos-, which is also the case professionally (the place where humans make a living). Thus, the existing global structure consisting of international corporations and shareholders should not be so surprising as such, but under a certain *laissez-faire* framework of neoliberal capitalism (Ostrom and Hess 2007; The Guardian 2017; see for Mackey and Sisodia 2014 calling it 'heroic') it can be equaled to a somewhat natural form of a massaged self-organization to manage the world and its resources for income of human society. It's rather powerful and an economic form of governance that does overrule national governments. However, it's now fabricated and thus operates currently without a good framework or promotion. Such a current globalization enforces here the 'tragedy of the commons'. And just because it's legal it does not mean it's ethical or any good, sustainable or healthy even. The validity of such an old economic theory remains to be seen, (climate change, species extinction and habitat loss easily invalidates those theories by now). But arguably, people organized themselves in wider global operations for hundreds of years, with colonial enterprises being one of the richest and earliest of those companies spanning the globe (usually based on the navy. The Dutch East India Company or the Hudson Bay Company are classic examples of western endavours; both ended in wider bancrupties). Similar business networks and structures are found with the Mongolian empires for instance on land using horses (Allsen 2004)! If the view by Harari (2015) is correct then it's a proof of Wilson (2000) that humans strive in socio-economic systems, and it's not just survival of the fittest as the dominating scheme (Altvater 2011). With that, the theory and achievements of capitalism come finally to an end (Collander 2000; Czech 2002; Barcellos 2012)!

The so-called classic governance model of federalism and its nation state just represents an artefact of the west; it's biased and often widely dysfunct (Acemoglu and Robinson 2013; Cockburn 2013 for the U.S). It's not a long-term success model really but just a resource-eating machinery filled with inconsistencies and human deaths (compare with Czech 2002), regardless of which position along the political gradient (see Jachnow 2013 for 'The Greens' in the EU becoming widely neoliberal; see textbox on bird conservation management and bad governance and compare with Hulina et al. 2017 for the Anthropocene). In its modern globally applied form it only is ~400 years old, a time when natural resources were still widely abundant. And the link with Ancient Greece fails already on the argument of the vanished ancient Greece state 2,000 years ago, lack of technology/industry and its current poor nation status with the EU (=virtually bankrupt on many accounts, financial, social and environmental). Such systems are not really 'home grown', but mostly technology-driven, printing fiat money, inflated with out-of-bounds stock markets (e.g. high-speed trading, hedge funds), artificially designed spiced up with nice-sounding arguments to cater a power elite and essentially they are just a certain top-down model with an assumed good smell of ancient noble Greece democracy bottom up (but which is not applicable and transferable in industrial times and globalization, or across all of the world). It was meant to be a good regional replacement concept of royal governance in Europe as pushed through by the French revolution. But for instance in the HKH nations it still has not established itself (see for instance the widely entrenched cast system in Indian cultures and various cultural clashes throughout Asia with western modernity). The modern form of the western state governance then was simply created by world capitalism after WW2 and further re-enforced when the iron curtain crashed in the absences of deeper reflection and valid future visions. The dominance of the U.S. value system including the Chicago School of Economics (Gaffney and Harrison 1994), in the absence of other strong alternatives, took it all over and drove the negotiations of Bretton Woods and with the U.S. $ as its ultimate expression (Daly and Farley 2010; Kennedy 2016). The winner takes it all, and some of its biggest biases in the 'new world order' are obvious in the setup of the world laws (schools of law, ivy leagues, no world court of justice, U.N. and The World Bank based in New York) and its finance system (The World Bank; see Rich 2013; Kennedy 2016). But despite the selling slogan of 'freedom' and 'eradication of poverty' it caused major deaths, inequities, diseases, revolutions and wars, many ongoing til this very day and implemented through drones, remote sensing and the internet even (Benjamin 2013). It links directly with human suffering and destruction for the actual hope of the arrival of a better world. Instead, indifference and loss of hope has taken over the world by now (Alexander 2013; Cockburn 2013). And even worse, the contribution of other solutions dealing with a better wealth distribution and the 'poor' (=the majority of people) got simply swiped away. Buddhism, environmentalism, liberation theology, communism, marxism and leninism were never really given their full credit, all just taken over, wrongly though, by the assumed automatic benefits of capitalism! Instead, the poor rely on any straw man and assumed support they can get, and those alternatives made a good job, at least better than what neoliberalism and capitalism achieved for them (Marx 2010; The Guardian 2017).

With capitalism still on the promoted rise by our institutions, globally (see for instance Khulan 2017 for Mongolia), it must come as a big surprise to see that in Nepal for instance, communism became a major decider for the modern governance in that nation and culture (Vanaik 2008). Similar examples are found in other nations of HKH. In the case of Nepal, it remains a certain mystery how a small communistic movement, educated actually in India, could come to rise again. But it happened…based on a few motivated individuals achieving a wider buy-in (Vanaik 2015).

So taken from those overview tables and metrics, what are the governance options for HKH? The nations of HKH are not extremely poor but certainly are of low income (Tables 44.1 and 44.2). They wrestle with many problems (Table 44.3) and those are of global relevance and influence, e.g. Tibet or water issues downhill from Nepal, and

Table 44.1 Governance style, human population density, poverty and state of the environment and wilderness in selected HKH nations

Nation	Governance style	Human population density per km2, rounded (United Nations 2015)	World Poverty Rank (GDP-based in US$ per capita)	Status of the environment and wilderness (Estimate by author)
Nepal	Federal Democratic Republic	193	28 (2480)	Poor
Bhutan	Kingdom (transitioning into democracy)	16	72 (8.129)	Good
China	Leninist and Marxist Government	146 (maximum of up to 22,477)	109 (15,423)	Poor
Tibet (China)	Autonomous region in China	~1	NA	Decent to poor
India	Republic of India	390	64 (6.658)	Usually poor
Afghanistan	Islamic Republic	49	23 (1957)	Pretty poor but not industrial; war-torn
Pakistan	Islamic Republic	236	53 (5120)	Quite poor, not so industrial
Mongolia	People's Republic	~1	95 (12,161)	Pretty poor and by now, highly commercial

Source: https://www.gfmag.com/global-data/economic-data/the-poorest-countries-in-the-world?page=12

Table 44.2 A selection of national metrics for selected HKH nations

Nation	Army personnel per 1000[a]	Electricity[b] (billions of kWh; rounded)	Internet users (Millions)
Nepal	4.83	5	0.5
Bhutan	10.74	2	0.05
China	2.88	4.69 (trillion)	389
Tibet (China)	NA	NA	NA
India	2.78	698	61
Afghanistan	0.92	2	1
Pakistan	5.91	70	20
Mongolia	6.26	4	NA

Source: http://www.nationmaster.com/country-info/stats/
[a]Active duty military personnel, including paramilitary forces
[b]Total electricity consumed annually plus imports and minus exports

Table 44.3 Selected topics that are not really under good control by the HKH nations

Topic	Location	Relevance	Justification for listing as a topic
Population rise	India, China, Bangladesh	Chokes human well-being and life-quality	Need of resources
Air pollution	India, China	Climate change	Cooking and energy production + cars
Water pollution	All HKH nations	Drinking water	No proper management and budget in place
Endangered species	Most HKH nations	Sustainability	Not well managed
Biodiversity	Most HKH nations	Sustainability	Lack of awareness
Wilderness	Most HKH nations	Sustainability	Not well managed, lack of space and natural resources
Poaching	Most HKH nations	Sustainability	Poor control and enforcement
Climate change	China, India	Global survival	The major scheme of our time; relevant global agreements not met
Urbanization	All HKH nations	Major landscape designer	Most urban areas are growing dramatically
Poverty	Most HKH nations	Landgrab and squatters	Not addressed at all

provisioning of (cheap) labor abroad. The HKH nations feature a lot of poverty governance but now are showing strong policies of economic growth at all costs (see for a blunt example with United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) and SINGG Secretariat 2012). Socialist and religious views are on the forefront in many of the HKH nations. Noteworthy is that Christian aspects are pretty low in HKH, when compared to other continents and nations, e.g. Latin

America, Africa, Southeast Asia or eastern China. It should not be forgotten that NGOs play a big role in HKH, namely the International Center for Integrated Mountain Development (ICIMOD.org; see mission and publications within) as a unifying platform; often those NGOs are potentially more powerful than individual governments and can achieve more. Most are funded by outside money and deliver outside-nation development aid goals, or at least align with them. It's pretty clear that the problems of the HKH governance will not go away any time soon, but certain scenarios can be developed, none of them realistic but some of them somewhat likely.

Scenario 1: Climate Change bringing everybody down
Scenario 2: Climate Change with a Paris-type agreement fully implemented
Scenario 3: Human Consumption and Population eats up most resources
Scenario 4: A Nice Shiny New World develops in Harmony and Happiness
Scenario 5: Dooms Day (all bad scenarios coincide in their worst outlooks[1])
Scenario 6: Friendly Wreck (all bad scenarios coincide but with a happy ending, as much as that is possible)

Perhaps some readers do not see the relevance of such planning and thinking, and why global governance is a great problem to be resolved with a relevant vision? But the figure on monthly wheat prices, or more explicit global food prices, shows the baseline, and what is at stake. Adding any more problems will bring globalization, and its loose ends, to a halt and result into massive roadblocks, conflicts and subsequent wholesale crash. The history of earth and human is full of such sudden crashes; see Diamond 1997 for some details (Figs. 44.1 and 44.2).

As stated in Cochrane and Kroeger (2017)'s elaboration: The Millennium Development Goals tried improvements, and the Sustainable Development Goals have set forth bold, shiny and new objectives of leaving no one behind. But this failed rhetoric shows continued geographic prioritization and exclusions within those aims. The global roll-out and status quo leaves us with an entrenched exclusion. A transformation of applied research, and the research community, is required to ensure that no one is left behind (instead see assessments by Rosales 2008, or profiles with National Academies of Sciences, Engineering and Medicine 2018). Providing the evidence to support a decision-making that is equitable and inclusive necessitates critical reflection of the exclusions that currently exist (see for instance bowlingalone.com for an assessment).

A typical answer to those problems by the western nations is 'education', and then to roll out an entire funding and worldview on what to do, and why and how (Kruss et al. 2015). This might make sense to the uncritical citizen, and it is widely practiced for centuries and in many scholastic efforts and within religions even (e.g. Chopel 2014). In times of the digital online age though it has taken a new spin (Huettmann 2007, see Khan Academy https://www.khanacademy.org/ and Coursera

[1] This scenario likely means we all get burned by the increasing global warming. While this sounds somewhat extreme to some people, reality is, many planets and stars in the universe get burned, specifically when the atmosphere is absent or gets fully sacrificed. It's just logical that life then can get burned too; deserts show us no others.

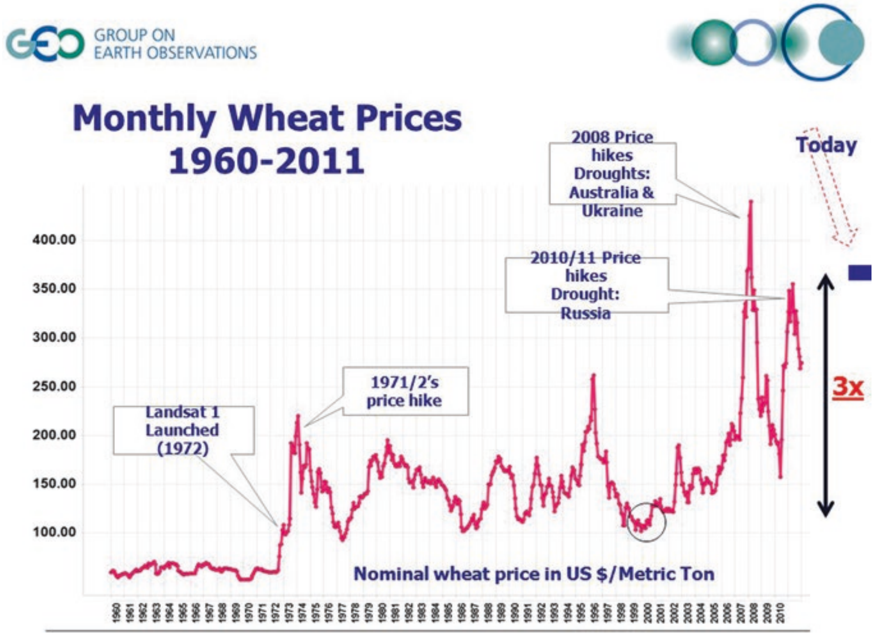

Fig. 44.1 Global wheat prize. (As taken from http://images.slideplayer.com/32/10090379/slides/slide_12.jpg) (Source: World Bank)

Fig. 44.2 Global food price index. (As taken from http://www.earth-policy.org/images/uploads/graphs_tables/highlights32_FoodPrices.PNG) (Source: FAO)

https://www.coursera.org/). Reality is that it must fail when the aim is just 'a job', or to cater neoliberalism (Van Heertum and Torres 2011) and underlying industrialization (as primarily done with STEM for instance https://www.ed.gov/stem. But even the wealthiest and powerful nations perform rather poorly in its public school systems with such concepts, e.g. HeavyRunner and DeCelles 2002; see global performance ratings with Kastberg et al. 2016). Education is a wider public good and allows for personal growth to be applied to the global community; it can be great and important, as long as it comes in a balanced package, does not enforce cliques, increases the wealth gap, and focuses on wider global sustainability and ethics skills (Huettmann 2007, 2015d, e).

So what to conclude? Hedging all bets, to diversify and being balanced, is probably among the best options, and being prepared and pro-active. A well-balanced world governance without science is not possible. As a matter of fact, all governments use surveillance and information, best available information and research to make best decisions, either way. In 2019 that means digital information, the internet and computers with machine learning and artificial intelligence in a holistic way (see Breiman 2001 for non-parsimonious methods). But along the same lines, spirituality needs to be considered also, as it's a major driver for actions and behaviors. This is eventually an ancient scheme, and the HKH shows us a good way on that aspect. And there are already examples of such changes, for instance Dyhrenfurth (2018) changed his entire life-outlook towards the Everest way and what he experienced in the HKH region (see also Messner 1999; Baumgartner 2015). Lessons learned from the HKH carry wider wisdom and applicability (Karmay and Watt 2007; Lama 2009, 2012; Ueda 2013)! And then, there are already self-evident and self-realizing conclusions that leave us with no other way, e.g. Green et al. (2006), Power and Chapin et al. (2009), Sun et al. (2016).

But the western drivers of governance and its policy still seem not to get it. They bounce around in their regimes and ideologies: in the last 60 years for instance, we first pursued a conservation without people, then a conservation for the people, then a conservation with the local people and now a conservation by the local people. How many more paradigm changes do we need to endure til we get it right, if ever? While the overall framework of power and self-enrichment almost does not change eventually we are now out of resources, however friendly we try to pitch it. And within all that friendliness and so-called human rights, we actually run a leadership that really is not friendly but just keeps making rich people richer, increasing the gap between rich and poor employing much unapproved terror (Mihai 2013; Benjamin 2013). Alone the politics of grain and related food indeces are showing it clearly (Figs. 44.1 and 44.2) A healthy society, a well-to-do and balanced middle-class, cannot form and actually gets dismantled that way.

In the year 2018, the IUCN is celebrating its 70th anniversary. As taken from its website (https://www.iucn.org/celebrating-70-years) it states something like this:

> *With growing momentum to meet ambitious global goals, the wind toward sustainable development is finally at our backs. It's time critical, as species are going extinct at alarming rates. Climate change is threatening communities, economies and the ecosystems on which they depend. No one government or organisation can correct humanity's course alone. With 70 years of experience, vision and impact, the world needs IUCN's diverse and powerful Union more than ever.*

But who still believes it? Arguably, beyond global change, unresolved poverty issues, a fair distribution of wealth and access to natural resources still sit at the forefront of any meaningful discussions for HKH and its environment, as well as globally (Denemark et al. 2000; Rosales 2008). Even worse, a relevant '*cryosphere and freezing temperature protection*' is not on the agenda at all (Huettmann 2012; Mukherji et al. 2019). So far, those kind of topics are widely ignored in wildlife conservation management in HKH and by IUCN, UNEP and its allies (see Wallrapp et al. 2017 for an example of caterpillar mushrooms), but sometimes at least it gets discussed in the politics in HKH nations and beyond (National Academies of Sciences, Engineering and Medicine 2018). This detail can be detected in debates about national constitutions or human rights (none of those can truly by achieved anymore for everybody in HKH in its original meaning while resources are running out). As stated at many other places (e.g. Naess 1989; Bandura 2007; Power and Chapin 2009; Huettmann 2012; Shonil 2018,), it is essential to resolve those issues for a good world order and that the governance addresses those details in a holistic way keeping all relevant actors and features intact. When it comes to those holistic issues, the HKH remains one of the global leaders and has much to share with the industrial world for their humble and respectful learning and actions.

Textbox 1: A Sustainable Environment Gone Awful Through Outside 'Help': The Economic Mongolia Example and Its Nomadic People

Mongolia is known to feature deserts, steppe and mountains. It's likely a cradle of mankind, hosting empires for millennia and it shaped global history. But by now, it has lost much of its fertile top soil, the primary productivity is vastly reduced, wetlands are drying out, soil degradation is a common site, desertification, air pollution as well as over-commercialization and climate change are the overarching issues for Mongolia; rural people moved to the capitol, Ulan Bataar.

Mongolia was in the hands of emperors, of China and Russia. And these days it features close ties with the U.S., Canada as well as the EU – Germany specifically. Like with many HKH nations, Mongolia is globally well connected and it's the lovechild of the international development AID agencies. But none of those powers really know what to do with nomadic people, the infamous herdsmen of Mongolia. Such a lifestyle just does not match western minds, or hardly any other administration. Being a nomad can mean to be virtually unconstrained, free of taxes and lack of control. Governments do not really like nomads. However, the nomadic tribes run one of THE best sustainable lifestyles in the world. It is just that most governments cannot govern and handle it well, specifically last 100 years during industrialization and its administrative (tax) schemes. The nearby Tibet nomads show the same dilemmas as most border-crossing people do, e.g. 'gypsies' (those are found also throughout Asia and EU and face similar problems resulting into their

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almost-elimination). This type of governance problem was shown by all regimes, from Chinese over Russian, white and red communists, the tsar and other ones later, including the so-called modern nation states. Using 'science', Russia for instance created new anthropological units in central Asia to justify their policies and settlements to achieved tax incomes (One will find similar concepts applied in North America in the prairies).

Governments favor easy to administer citizens, and thus forced residency and such lifestyles. Industrial Mining is one of those devastating income schemes. Due to the lack of resources elsewhere, the pressure on geologically diverse areas, and with mountains increased. Tibet shows that clearly too And so, 'bad mining', e.g. extracting resources with substandard methods and techniques, is wide-spread in Mongolia, as well as in China. By coincidence, one of the highest hepatitis and liver cancer rates is found there worldwide. Many other aspects of unsustainable mining, often run by international businesses, can be found in Mongolia too.

Whereas, the nomadic life-style is widely free of such problems. It distributes its impact widely, and it engages in spiritual practices that leave little trace in the landscape. It tends not to result into contamination, radioactive contamination, climate change or remotely run world wars with a cruel collateral.

Arguably, being nomadic is not everybody's lifestyle, nor is it realistic the world turns fully nomadic. However, staying open-minded on that issue can help to find new insights, and even might overcome genocide-type conflicts and to remain sustainable. So why not making good use of it?

Textbox 2: How Many Animals Need to Be Stressed and Die for Bird Banding/Ringing and Geolocators Done by Amateurs and Scientists for a Non-achieving Conservation Management? A Quick Assessment 100 years Later Exemplifying Bad Governance on a Local, National and Global scale

Most birds are essentially on the steep decline, worldwide, and have been now for decades without any halt in sight (for instance Edenius et al. 2016 for Rustic and Yellow-breasted buntings; see Jiao et al. 2016 for the wider China-Russia flyway on the Asian continent and in the wider Hindu-Kush Himalaya HKH watershed region). It's part of the Anthropocene. In parallel to this situation, birds are still trapped and handled in very high numbers for a so-called conservation and research by self-declared and so-called professional 'ornithologists' for over a century now. The conservation laws would take good care of it. The narrative always has been that this type of avian science is done "*for the sake of research*", approved by 'institutional animal care' and which

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would benefit birds, their conservation and society, eventually. But like done in economy as a justification that making rich people richer would quickly resolve poverty, it's just the classic trickle-down research conservation argument made by academies for centuries and which fails. It's a non-scientific, egoistic and mindless-repeated narrative that lacks good evidence while destruction continues full steam. The poor outcome of this argument and of the underlying model clearly speaks for itself though.

Considering that such science-based institutional obedience arguments (="*it's for science, must automatically be good*") were already put to rest by the Milgram Experiment in the 1960s (now public knowledge and presented by Singer (1975) and included in IACUC rules of animal care in most advanced institutions; see references within https://en.wikipedia.org/wiki/Milgram_experiment), if not even before that (see NAZI research https://encyclopedia.ushmm.org/content/en/article/nazi-medical-experiments or Syphilis experiments in the U.S. in the 1950s https://en.wikipedia.org/wiki/Tuskegee_syphilis_experiment; Canada has done human experiments also on their indigenous populations), and knowing that birds and their habitats are tanking and without any good outlooks (https://www.birdlife.org/sowb2018), how valid then is that 'science' argument now fueled with satellite-based tagging methods, high tech, and game'ified methods? Take into account that citizen science now produces impressive data too; so why not use them and eliminate intrusive bird science that has to catch and risk birds and attach devices even for their death?

Already for over a century, bird banding (ringing, as it is called in Europe) has been done by many stations and projects all over the world (e.g. Helgoland Hueppop and Hueppop 2011; Gaetke 2015; Fiedler et al. 2014, Rybachy-Russia http://www.zin.ru/rybachy/index_e.html, see https://www.environment.gov.au/science/bird-and-bat-banding for Australia; http://www.sevin.ru/menues1/index_eng. html?../laboratories_eng/litvin_lab.html for Russia; see EURING.org for Bird Banding Centers worldwide). From their summary reports – if ever available- it's easy to show and enumerate the annual bird numbers caught, handled, touched, and killed, all done for the sake of 'science' each day (Last decades, those numbers are easily in the millions). And there is a constant push to catch more, for science, and towards handling the true number of migratory birds, or more nesting ones and even their chicks (MAPS Monitoring Avian Productivity and Survivorship https://www.birdpop.org/pages/maps.php). The pursuit of birds by man knows no limits, certainly not for science ('greenwashing' the same pursuit). And while bird populations are in a global decline and habitats get increasingly lost worldwide the quest to catch more birds is even on the rise: "*more science would benefit the birds*"; so goes the institutionalized gospel well promoted by the media too! But that's just demagogy, and mostly done on the cost of birds. What was really learned and applied? Arguably, bird banding was widely

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done in the Pacific, and probably elsewhere in the world, to cater biological and germ warfare threats (Rauzon 2016 for The Smithsonian and for the wider 'Pacific Theatre'. In almost all bird migration bottlenecks of the world, mysteriously, after WW2 bird banding projects popped up out of nowhere; e.g. Thailand McClure 1974; Rauzon 2018 for seabirds in the Pacific). In the meantime, in the EU – a civilization that prides its leading global role – many raptors and over 20 million songbirds reportedly still get poached every year entirely illegally in Malta, Cyprus, Italy etc. (those impacts even get much higher in North Africa and for the African continent overall; similar for Asia (Barter et al. 2016) and in Central America, e.g. https://www.birdlife.org/europe-and-central-asia/news/shooting-whimbrels-sparks-calls-regulation-shorebird-hunting-caribbean). Many raptors also get caught on the EU mainland even. Clearly, the EU cannot get it under control. Now, those details are not new at all (McCullough et al. 1992) and known for decades while conservation progress is still lacking today for many decades. Still, science argues for bird catching, banding and geo-locator studies even further.

So the initial idea is that only tagged birds can provide missing conservation information on where they move, fly and can be re-sighted. It's needed for their conservation management, science-based (see McKinnon and Love 2018 and for lack of a conservation model even). Therefore, we first would need to catch and tag the birds, many of them, with a very faint hope of a recapture for our informed decisions. In reality though, bird banding recoveries are proportionally very few and typically just come from a few dead birds (and if those corpses are ever found and then reported to the investigator; the recovery rates in songbird, pelagic seabirds and shorebirds are usually less than one in a thousand; Bailley 1992. In Sweden for instance, 12 million birds were banded since 1911 but just 158,000 were recovered: https://www.nrm.se/en/forskningochsamlingar/miljoforskningochovervakning/ringmarkningscentralen.214.html). Recovery rates are primarily a large function of the public post/mail-in service and of cultural values by the recovery location and its nation. And even worse, most of those reported mortality records are human-caused, namely hunting/ poaching (McCulloch et al. 1992) and various bird collisions in the south, e.g. with housing, skyscrapers (see movie by The Audubon Society https://www.wcaudubon.org/story-blog/the-messenger-a-documentary-on-the-decline-of-songbirds), windparks or power lines (Bevanger 1999). Arguably, hunting (legal and illegal) and man-made industrial reasons remain the main drivers of bird deaths and subsequent bird band recoveries (e.g. Baillie 1995). And bird banding has not stopped those stressors at all (see poaching of Sarus cranes/Brolga's even in Australia: https://www.abc.net.au/news/2017-03-24/poached-brolga/8385302). In other words, research does not really stop illegal killing of birds, and even worse, bird individuals once caught and banded/ringed are essentially doomed, certainly stressed and put at risk in very high numbers due to 'bird enthusiasts'

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themselves. These bird people just want to catch, handle and look at birds, and take their photos and selfies; whereas the scientific contributions are tiny. Most bird banders do not carry out science really, at best become co-authors in research publications they hardly write themselves (usually done by PhD students or a few paid scientists; e.g. Nebel 2007 and Prins 2016, and then applying obscure and widely ambiguous statistics trying to convince; see Ramos et al. 2019 for sample size of 1, and also compare with Humphries et al. 2019). Such a science is then to be used for governance, whereas the findings are biased and poorly-based, and the governance ignores most of the science (see climate change management for an example, or see Czech et al. 2000; Huettmann et al. 2011; Beiring 2013; Resendiz-Infante and Huettmann 2015).

And the disease aspects of applying bird bands are not well understood yet, nor addressed for impacts. Is it possible that bird banders spread diseases themselves into wild populations (see Rauzon 2018 for the Pacific and Biological warfare)? But certainly bird catching and handling, on a mass continental scale, can result into stress, infections and even death of birds (see here for a de-banding project of Royal Albatrosses on Toroa, New Zealand Moore et al. 2016; for penguins see https://www.sciencemag.org/news/2011/01/flipper-bands-harm-penguins and citations within). Bird bands can carry bacteria that birds cannot get off those devices. And if even large and robust birds cannot handle a bird band/ring, why should small ones? Needless to say that decay of the actual bird band and ring contributes to biases and serious analysis problems with this ‘scientific method’ (e.g. Breton et al. 2006). Further, McCullough et al. (1992) state “*…changes are thought to be at least partly attributable to a real decline in the taking of birds but they may also reflect changed attitudes to reporting the hunting of species which are now protected*” which is elaborating on relevant attachment and reporting biases in marked birds (a common problem in bird band recoveries in China, for instance, where bird band recoveries are extremely rarely reported due to fear of prosecution making the entire approach quite pointless for a continent, despite millions of birds and banded in the wider area).

Despite massive bird handlings for over a century, and many associated deaths, even the bird banding/ringing researchers themselves state openly that their data are still insufficient to tackle relevant questions, e.g. (Baillie 1992; McCullough et al. 1992; Bevanger 1999; Fielder et al. 2004; Prins 2017) usually leaving inconclusive inference just asking for more science and more bird catching (a western scheme and set of pointless arguments pursued by now for over 100 years and applied worldwide). Arguably, bird banding/ringing remains a poor method, and simply banking on a techno-fix (telemetry, geolocators) and such mindsets (“*change for no change*”) cannot help much for bird conservation. Satellite telemetry and geo-locators suffer from similar or worse problems (Brlik et al. 2019). Publications with a sample size of 1 (bird)

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have been made and get interpreted (Ramos et al. 2019). Even worse, publically-available data are lacking for any of those activities (see EURING.org, Icarus https://www.mpg.de/13684039/icarus-test-phase and Movebank.org for lacking publically shared data and locked behind passwords, and compare with GBIF.org , specifically where citizen-science data now dominate the inference). Nations like U.S. and China -where millions of birds have been pursuit and banded – do not even have a bird banding recovery atlas after 100 years. So how can such a governance ever be effective, or help birds?

The governance failure here comes from seven angles: not implementing transparent and repeatable science, not asking for high-quality sustainable and effective research on birds, not certifying practitioners, and then, actually still providing permits to handle a public trust resource, and not being able to control illegal bird hunting. Often, journal editors come from governmental sources too (=tax-paid). And finally, this all happens essentially on a global scale. So what ethics are this (Huettmann 2015)?

What is widely lacking – for over 100 years but while bird banding and tagging still is pushed more – is an open discussion on ethics (Singer 1975; Bandura 2007) and performance assessment (e.g. Carlson 2011; Huettmann et al. 2011), a subsequent good and efficient management action as well as a legal management follow-up to minimize or to get rid of those mortality factors along flyways, globally. The notion of economic growth not being in harmony with the environment is still widely left untouched (Daly and Farley 2010; but see Resendiz-Infante and Huettmann 2012 for an exception in the avian literature). Secondly, an honest assessment of bird handling impacts and the underlying science-model and achieved conservation management is needed, too. Science simply done to cater more neocapitalism cannot work because it does not resolve the underlying contradiction: economic growth and technology do harm nature and Mother Earth on a finite-resource earth and atmosphere (Czech et al. 2000; Carlson 2002), Resendiz-Infante and Huettmann 2012). While many zoos and captive breeders – that includes bird keepers and the avian pet market – try to argue otherwise, birds can actually not live without habitat and wilderness. So there can be 100% no doubt that habitat needs to be maintained for those birds, and that also includes to address issues in the wintering grounds for migrants such as in Africa, Latin America or SE Asia (or the oceans, fisheries). All of those regions receive vast international development aid and subsidies but still, the bird habitat and mortality issues are almost not addressed there, e.g. Infante-Resenddiz-Huettmann (2012) and Zoeckler et al. (2016).

On the other side of the equation, for such a science to work many birds need to be trapped to attach bands, rings/bands, plastic flags, transmitters and geo-locators with a meaningful research design. None of those efforts, nor the devices are known to be benign though (Bub 1996). For instance the infamous Helgoland trap (https://en.wikipedia.org/wiki/Heligoland_trap) is essentially

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just a point sampling device that can easily injure birds by design (a wood-panel funnel with an angle board is typically used and birds run against those, if not caught up in the chicken wire. Bird trapping involves metal rings (bands) to be attached by pliers which can strangle the foot, or bend it during the process (amputations can happen, corrections are difficult to do). There is not even good agreement where to attach a bird tag and which one to use (neck bands in swans, wing markers, or for instance, whether to attach metal rings above or below leg joints; see LeMayo et al. 2011 for penguin flipper band impacts and ethics). These best advice for 'good and acceptable' attachment locations on birds, wings and legs differ, vary by nation, vets, animal care progress, and it evolves. Other investigators use dye's to color-mark birds but which can either expose birds to predators, make the feathers clumped up and handicap birds, or it even is plain cancerogenous (=birds might peck it off with the beak and it ends up in the digestive tracts for contamination). Bird handling and processing is often done by amateurs; it appeals to the male hunting instinct. Compromising shock moults do occur when handling birds (fault lines in growing feathers are suggested to occur), and it is observed that metal bands cannot only squeeze legs, but even worse, handicap the bird and/or attract predators to kill the marked individuals (e.g. Glue and Morgan 1977). Metal bands are also known to provide flawed estimates as they decay, e.g. in coastal and marine environments (Breton et al. 2006). There are other impacts, be it social (some birds travel in groups and those get disturbed by catching and banding events) or impacts through 'ecology of fear'. Modern mist-nets, as a method of choice, suffer from catching location bias and bycatch, e.g. insects and bats; but even worse, long-term mist-nets get frequented by predators, such as martens, cats, snakes and even birds of prey (other birds are known to fly just over those nets, e.g. for nocturnal migrants see Bolshakov et al. 2002; Mukhin et al. 2004). Thus, the initial purpose '*objective data and such a science for conservation*' clearly gets all knowingly compromised and are flawed – science goals not well reached – while avian and conservation management is not really implemented effectively in governance to maintain bird populations in a good state anyways. The latter was the initial intent of bird handling and marking, legally mandated, and is the official argument still for working on this public trust-resource. This discussion of impacts and mortality now got more intense when wind farms are to be discussed, or light pollution, and when knowing that many 'terrestrial' migrants use the coastal waters or oceans even (Huettmann et al. 2011, 2015). And how does hunting contribute to stressed populations, like it inherently occurs in many RAMSAR sites meant to 'conserve' birds?

Considering that evolution has shaped, designed and optimized those birds, one cannot simply add man-made (heavy) devices to birds and assume "*it's fine*" (or "*must be fine, it's for our science*"; see Milgram experiment mentioned above). Ornithologists -scientists- really should know better, but

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those are often just driven by careerism, self-interest, self-income, all-ignoring curiosity, a generic lack of conservation-focus and carelessness. Needless to say that there is virtually no university degree in Ornithology (narrow PhDs at best, with M.Sc. degrees in associated fields); it's hardly an accepted profession (most environmental contractors are hardly certified on how to draw inference in a modern and robust way; Humphries et al. 2019). And handling birds is widely done by enthusiasts, but often not by veterinarians or wildlife technicians with a solid education and how to handle euthanasia for instance. Hands-on bird work is still widely driven by those enthusiasts, e.g. Australian shorebirds are widely in the hands (literally) of 'amateurs' (http://awsg.org.au/) and those then provide 'training' to the entire flyway even, including Asia and the Americas. That's the shorebird culture, as initially set up by 'The Wash/UK' (https://wwrg.org.uk/) – a group of shorebird fanatics – in the 1950s, all approved and supported by the governance of UK, the EU and others.

At minimum, one would assume all data derived from those invasive methods are easily and readily publicly available so that one can use and apply them effectively (see EURING.org as an example; but the EU does not share its bird banding attribute data, usually collected by NGOs, tax-exempt, e.g. see for missing data with BirdLife International Hungary and https://www.birdlife.org/news/tag/birdlife-europe; see for missing data in the State of Alaska: https://aksongbird.org/bird-banding-protocols/). Arguably, bird banding is simply not serving the birds; it just serves the enthusiasts and financial interests handling a public resource and greenwashing current governance failures even tax-excempt.

To put more facts to those details:

With the help of the Swedish aid money China for instance has banded millions birds for over a decade, but the data are not publically available, likely not even collected to good animal welfare and science standards even (https://openaid.se/activity/SE-0-SE-6-5504005501-CHN-41030/)? This follows similar policies by the British Trust for Ornithology (BTO, https://www.bto.org/ our-science/projects/ringing), as well as the EU, which do not share their data online in a good and useable format and raw data collected with ISO-compliant metadata to actually understand them (Endless bird banding data from Africa collected by EU researchers provide other good examples. And just now, in 2019, the BTO-supported journal (IBIS) asks for a data policy; but what about the last 100 years of data collection?) And how many birds were handled for device attachments but with no data outcome? Whereas, there is no doubt that British birds are on a massive decline already for decades (McLean 2010). So how well has bird banding then really worked for conservation management? That's the real-world outcome of an outdated elite bird research concept carried out in, and lead by, Oxford and Cambridge – some of the traditional so-called leaders of avian research.

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And it's not ending there as technology gets pushed ahead, mini-transmitters emerge, e.g. as used for tracking cars, products, humans, supermarket clients or soldiers in warfare and in (secret) battles. We are supposed to live in the "golden age of tracking" (https://www.birdwatchingdaily.com/news/science/golden-age-of-tracking/). Geolocators are among those science data sources, but often they just come with a heavy burden for birds (stress, death), and such devices are known to bias research findings (Brlik et al. 2019).

It gets even more intriguing when considering birds carrying out non-stop migrations internationally around the globe (e.g. Battley et al. 2012). So those devices would not affect birds and their performance, or their well-being and psyche on such extreme trips; the birds happily carry extra weight, metal, plastic flags, or a harness with gear, aka 'there is no evidence'? Lot of evidence actually exists to the contrary.

Australia, as a former UK colony, lacks much science-based university- and government-cared shorebird research. Amateurs, pensioners, and NGOs supported by mining money etc. have happily taken on the fun, the governmental mandate and seeking public research fame, but all done on the cost of the animals. Their publications are primarily done in journals that lack a peer-review and which have no relevant impact factor (e.g. less than 3. For journals The Tattler and The Stilt see http://awsg.org.au/publications/tattler/), and data are not well shared, e.g. in GBIF.org (as requested by Rio Convention nations and Australia as a signatory nation). Such a presumed research lacks meaningful sustainable research design, reflection, transparency and repeatability and a peer-review, as the standard ingredients of 'valid research' (see Krausman and Cain 2013 and Humphries et al. 2019 for textbook definitions).

The underlying idea here would still be that those activities with a public trust resource (=birds) are 'fun' and it benefits birds and their flyways alike. Well, except, birds do get killed in cannon-netting, with devices, and that the flyway is in the worse shape ever; namely Asia and the Yellow Sea (Studds et al. 2017), the Arctic (Thomas et al. 2006), the EU-Africa flyways and birds in Australia itself (Clemens et al. 2016). There is no science-based management or legislation worth to speak of (Just like Canada and U.S., Australia essentially denies climate change or at least stall on progress of conservation, certainly when it comes to carbon emission reduction, sea level rise or ocean acidification; see Grech et al. 2016. Those nations still promote economic growth without relevant considerations for birds). To show at least some progress to the public, eco laws and policies get signed that are virtually worthless, have no teeth and lack expertise, enforcement and budget (just see Bonn Convention on Migratory Birds or RAMSAR Huettmann et al. 2011, 2013). Relevant politicians hardly know them! In the meantime, many more birds get caught, transmitters get attached to shorebirds to track their whereabouts and to show 'progress' to the public that all achieves little, if anything. All done

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on the cost of the birds, and eventually their habitats (where birds life) and the atmosphere.

As part of the Australian example, the real focus on the EEA flyway still sits with China, and also with S. Korea and Japan, as well as Taiwan and Singapore, Indonesia, Malaysia, Phillipines and certainly Mongolia. Almost all those nations and cultures are part of HKH watersheds and now heavily are vested by economic growth policies but which are known to be very destructive to birds and their habitats (Czech et al. 2000). The EEA flyway shows us no other, just like most other flyways do in the world.

The bird banding argument, or the use of geolocators etc., will not help it much, and such a mindset never really has last 100 years. Rather vice versa, it keeps a few people going, imposes a bad science concept and '*business as usual*' (=bad governance) gets enforced and further institutionalized, now widely done by NGOs acting under contract and permit of the state agencies with major industrial funders put in charge of the public trust-resource: 'birds'. Instead, migratory birds are not to be privatized and are not owned by anybody; they are a public international good and are to be treated that way! So is the law of the regime (Krausman et al. 2013).

This science-based model handling birds for self-enrichment, so-called non-profit and tax-excempt thus subsidized, is known to fail and has not much to show. The 90% crash of buntings shows no other (Edenius et al. 2006), nor do the declines of over 60% of all shorebirds (Thomas et al. 2006), and massive declines in the Asian flyways connecting with Australia, Alaska, or the Russian Arctic (Jiao et al. 2016; Beiring 2013 for lack of protection). UK bird declines, as indicative for the EU crisis, shows us the similar realities. Many of those species use the related watersheds of the HKH, or they suffer equally elsewhere.

Considering publically funded ornithologists still indulge into ineffective ivory-tower questions in times of a global conservation crisis (e.g. navigational research for over 100 years with little conservation results to show: Mouritsen and Ritz 2005; Wiltschko et al. 2006) how much of those negative trends was contributed by 'modern' ornithologists themselves and them leaving opportunities unused but focusing on ivory-towers, careerism, self-funding, convenience and 'fun' remains unstudied. But thus far, it has not helped birds nor their habitats or the atmosphere. Clearly, such ornithologists have already helped off species like the Great Auk or the Ivory-billed Woodpecker to their extinction by 'collecting them off the earth (Elphick et al. 2010; http://www.birds.cornell.edu/ivory/aboutibwo/slide_extinction_html). Until this paradoxon gets resolved, and all data get worked up for a good public conservation outcome, no birds should be caught, touched, banded, ringed, transmitters or geolocators etc. be attached. In the meantime, all data are to be made available (Huettmann 2011), like achieved with many museum specimen data (Huettmann and Ickert-Bond 2017), in modern forms and according to

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environmental conventions that most nations pride themselves of: Rio Convention, Access Data Policies, Repeatable and Transparent Science, High Impact Research. GBIF.org is the platform for it, free of passwords and harvestable with metadata for the global public to enjoy (Huettmann 2016; this is an aim that was achieved for over 20 years already (Carlson 2011) and is currently widely ignored and declining, certainly for geo-locator data). This is where governance still fails but can easily improve, globally. Eventually, it's how humans relate to birds, animals, the environment, and the world.

And needless to say that there exist for a long time research alternatives for such studies, such as non-invasive study methods, stable isotopes, indirect counts, and citizen-science as well as the use and inference of open access data already collected last 100 years and with citizen science (e.g. Huettmann et al. 2011; Zoeckler et al. 2016). So why not using those things for betterment?

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Chapter 45
Quo Vadis HKH? 'Sustainable Development' as a Horror Scenario while Climate Change, Human Population Increase and Global Conservation Decay are on the Rise Further

Falk Huettmann and Ganga Ram Regmi

> *Not all consumers are created equal.*
> Marketing textbook (www.mbaprepworks.com)
>
> *If men were angels, no government would be necessary.*
> James Madison, father of the U.S. constitution
>
> *Our mission is 'to be within arm's reach of desire' around the world.*
> Robert W. Woodruff, chief executive of Coca Cola

The future climate models show dramatic decay of the status quo (see Xenarios et al. 2019 for Central Asia and its mountain regions). This is not only true in all relevant weather metrics (e.g. http://worldclim.org/CMIP5v1) but also in terms of glacier loss (https://www.theguardian.com/environment/2019/jun/19/himalayan-glacier-melting-doubled-since-2000-scientists-reveal), habitat transition and wilderness loss (Huettmann 2017), as well as water problems (Karar 2017; Singh et al. 2018; World Water Council 2018; Craymer 2019) which reach far outside of localized problems promoting wars elsewhere. And it links directly with many human-related statistics such as population rise, consumption and loss of language, society

F. Huettmann (✉)
-EWHALE Lab- Institute of Arctic Biology, Biology & Wildlife Department, University of Alaska Fairbanks, Fairbanks, AK, USA
e-mail: fhuettmann@alaska.edu

G. R. Regmi
Third Pole Conservancy, Kathmandu, Nepal

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and culture (Xu et al. 2018 for the Hindu-Kush Himalaya region; see Hinze 2019 for remote monastries shutting down, lack of young people and missing lifestyle).

China acknowledges that a '*strenuous effort*' is still needed on the climate change issue; it still has an uphill battle on climate (Liqiang 2019). Beyond the International Panel on Climate Change (IPPC.ch) as the U.N. climate change entity, even the World Meteorological Organization (WMO) itself promotes reforms (https://public.wmo.int/en/media/press-release/world-meteorological-congress-drives-more-integrated-earth-systems-strategy).

The current poor status of environmental justice is exposed in the Environmental Atlas for everybody to see online (https://ejatlas.org/). And the outlook for a bad future, as we know it, can hardly be topped for the near and the far future alike (Alexander 2013; World Economic Forum Global Risks Report 2018 http://reports.weforum.org/global-risks-2018/) and while climate models continue to underestimate the real impacts (e.g. www.ipcc.ch). Many nations hardly acknowledge or see the problem even! Considering the vast political inaction by the trusted governance currently in charge, who knows whether we are not 'to burn' in 100 years from now? Major fire occurrences and desert extensions show us hardly any other. And any climate model forecast that wants to limit its predictions to 'just' 2.5 °C as a global baseline must be perceived as being ignorant and biased by conservatism, which by now, equals naivety and actually kills people 'down the road' and rivers, apart from many other impacts. Such passive ideologies are truly harmful (Czech 2002). This book and its chapters showed many of those details, and many more can be named and exist, globally. It's the direct outcome of the 'empires of extraction' (e.g. Belanger 2017) and its associated lifestyle and culture that lacks respect and taboos to put natural resources back where they belong to: from being marginalized by textbook economy (Daly and Farley 2010 for alternatives) to the governing power of mankind: Mother Earth rules.

Westerners have been invading Asian countries with power, force, ideology and money for hundreds of years and changing local culture/religion by force (Diamond 1999; Elvin 2006) or by alluring with money particularly to the poor families (Rosales 2008; for details why and how some high mountain areas were left alone see for instance https://www.recordnepal.com/wire/features/why-did-the-british-not-colonize-nepal/). Besides other things, these destructive trends ultimately trigger the loss of culture and religion of local landscapes in the HKH region and beyond, now up to the atmosphere (Huettmann 2011, 2017). It's global change in full steam. Arguably, virtually any sustainable development review shows increased (cheap) materialism promoted at all costs worldwide but eventually done for just a few people, while the environment is not benefitting, nor society overall and certainly not the global economy even itself (Daly and Farley 2010; Alexander 2013). Cheap materials are just possible here when low labor costs are paid, logistics subsidized and when plastic products are used on the cost of the environment; so who truly wins when Mother Earth loses? More than 60% of the world's population earn less than c. 3$ a day; that's not much different in Asia, and implications are obvious! The chapters of this book though present some basic but pretty clear synthesis and development paths that can be expected to occur in the future, based on official global institutional forecasts.

While those paths differ in detail, none of them show global cooling, or a reduction of conflict, less migrants, less people on earth, better watersheds or less risk and conflict.

And thus, it is pretty clear where we are heading on earth. Most spectacular global governance and sustainability aims get missed again, and repeatedly (see Mace et al. 2010). So new development plans get set but which are known to be unrealistic and which cannot get reached neither, e.g. the sustainability development goals by the U.N. (see for 17 SDGs at https://www.un.org/sustainabledevelopment/sustainable-development-goals/). So where does that really leave us?

In all the various discussions about climate change and its associated poverty and industrialization questions -in the media and on social media-, in all the endless and very expensive conventions of the parties (COPs) not much is covered on how to actually deal with the future in real terms. Are we all to die soon? What attitudes are we to have, how to live and with what goals and aims? What to believe? And what really is left to focus on? Just consider all that tremendous focus on education – a true social engineering – but where remains the progress for a good and sustainable world? What was really taught in those institutions and why (Van Heertum and Torres 2011; see also Bazzul and Tolbert 2019 for options)?

Apart from Czech (2002) and Daly and Farley (2010) there is virtually little or no effective textbook, professional university degree or institution that truly show us a globally sustainable guidance, and for a good answer. The conventional answer provided is simply 'life it' and 'keep shopping', and then people get lost in minute details around that. And so it will be lived then by most people; perhaps it is all just a survival game ('life is struggle' according to Buddhism; Keown 2009; Lama 2012) or as stated in western schools: 'survival of the fittest'? But that does not make for a good message, or for a good life really. The nation state can do better, as per mandate.

Reality will probably be more involved, namely, poverty, warfare and struggle for a good live while many options were knowingly destroyed for decades (e.g. Tsing 2015). And that means turmoil. The easy life is over; many in 'the west' know it but do nothing about it, nor did they act when it became obvious. They all saw it coming for over a decade, after the Club of Rome published its influencing work decades ago (https://www.clubofrome.org/).

But where is the Club of Rome now, and what does it say for the Hindu Kush Himalaya (HKH) region, for the watersheds we are so concerned with, or for Asia and the atmosphere overall? Earlier achievements apart, the Club of Rome remains an elusive and elite club which impresses in its absence now doing 'nothing' (effectively).

The only message one can still hear from western institutions is the one of economic growth and other neoliberal myths (e.g. sustainable development; Clark et al. 2015) that were proven wrong already decades ago in the western world itself (Mauerhofer 2013; Rich 2018). A triple-down economy – one that makes rich people richer first and which then would share their wealth with the poor later so that their live improves later, all where the environment is in good balance too- has not worked anywhere; neither in the U.S. itself nor globally; certainly not in Asia (see Li et al. 2018 for water crisis, see ICIMOD (http://www.icimod.org/?q=16929) for wetlands in the HKH region, Inskipp et al. 2016 for birds of Nepal; Czech 2002 and Alexander 2013 for global assessments). So why repeating it here all over again?

The answers might be more complex, but surprisingly, some of them can already be found in some classic economic textbooks. Ecological Economics work by Herman Daly with a 'Steady State Economics' focus shows a good outlook and first step (Daly and Farley 2010). Classic works by Karl Marx on the fact that capital tends to accumulate itself describes fairly well the fate of capital and human labor and society last 100 years (Marx 2010). Even the richer nations cannot get their poverty standards lifted up in the traditional capitalistic mindset they pursue. That is certainly true for the U.S., and for Canada, as well as for Germany (a nation with record profits in the EU), and for France, the U.K. or Japan (a nation with a huge debt load). It's a major topic in the HKH region too! Such models and development outlooks fail by themselves, certainly when exported to other nations. The African and similar colonial hand-over experiences show us that pretty well.

After decades of study and funding, here we stand (see Regmi et al. 2018 for an example of knowledge): Gaps and the unknown still drive our policy agenda but without a valid governance model and template – or theory for that matter (Marsden 2017) – in sight to fix things.

So what really to do in HKH and its nations?

Arguably, Asia is again in turm-oil; conflicts with North Korea or Afghanistan show that clearly. Water management issues remain widely ignored (e.g. Karar 2017) hardly governed even (for details see Marsden 2017; ICIMOD 2018 and http://lib.icimod.org/record/33755 (sewage problems)). That's not so new really, as Asia came from a feudal system that was taken over by colonial powers and then caught up in the cold war between western and eastern forces. China went entirely communistic, so did most of Mongolia, Vietnam, Laos, Uzbekistan, Kirgistan, Tajikistan, and parts of India and later Nepal following alternative western-northern ideologies (mainly Karl Marx, Friedrich Engels and Vladimir Lenin; Vanaik 2008). Others remained locked up in an isolated feudal state (Bhutan, Sikkim in India, partly Nepal and Tibet in China) while others went widely 'western' but merged with their own deep styles, e.g. most of India, Pakistan, partly Bangladesh. All this makes for a rather odd starting point and setting to be in for a continent. Nepal presents us here with a good example because this royal kingdom varied a lot in size and over time (Whelpton 2005). Now it's all driven by modern Mao'ists. Arguably, current Nepal is not the ancient state, and it's now a rather new and compromised construct designed by outside nations and neighbours overall. It's truly shaped by globalization. And India and China as major global powers are key players in the region and for the watersheds and conservation. Nowadays, it's the textile, hydrodam and the mining industries of China that are among the main contributors for the water crisis (Li et al. 2018; see Buckley 2014 for Western China). The environmental track records of those economic giants are far from benign, sustainable, harmonious or friendly throughout (Elvin 2006; Beech 2007; Harris 2007).

Still, the HKH region offer us wilderness and spirituality, and those are powers that is not really fully accepted by the western governance for their good impacts, yet (see here for a branding idea of holy Kailash: https://www.youtube.com/watch?v=joLni WY9LwU).

In the new world of 2019 onwards, where should the HKH nations go, and how? That's a crucial question while not even the borders or administrative units are that clear, culturally? Consider HKH as a diverse language group, a culture of its own, but that now is losing its culture and many workers of the rural workforce of the valleys are now working in …Qatar or North Korea, let's say, and in many other gulf/middle east countries. Urbanization is widely on the rise (e.g. Fitzpatrick 2011 for Eastern Nepal, Baumgartner 2015 for Sherpas).

Was there ever one single unified nation, culture and society in the HKH region? Not really, but there is the culture of Bhutia (Whelpton 2005; Karmay and Watt 2007; Lama 2012); essentially a mountain culture without a nation. And being nomadic was the wide-spread life-style (see Baumgartner 2015 for Sherpas and transhumance, Lama 2012 for Mustang and Humla, Byers 2017 for Khumbu, Prins and Namgali 2017 for Laddakh). This was pretty relevant because it allowed to adjust and respond to the environment. Secondly, and even more important, it allowed for avoiding unsustainable practices. An overuse, in the modern sense, was virtually avoided. Taboos and related policies resulted into a more respectful way to deal with nature and the environment. Like elsewhere (e.g. for Mongolia and for the Arctic and interior Alaska), by being 'forced to settle' (e.g. Buckley 2014) it turned into an environmental and social disaster.

Due to the movements and dispersal across valleys and downhill the HKH region has vast connections, and remains widely networked throughout the entire world (Baumgartner 2015; see for instance 'Yak and Yeti' in Vienna/Austria featuring Himalaya culture events in Central Europe; http://yakundyeti.at/). That's nothing new really. The HKH region was always politically well connected (see the expedition hiking by U.S. president Jimmy Carter; https://www.upi.com/Archives/1985/10/30/Carter-climbs-Nepalese-mountain/3889499496400/). In those connections might lie some parts of a good future. Those who have good friends elsewhere will always survive. The modern science-based approach to this might well be 'telecoupling in the Anthropocene' (Hulina et al. 2017); it awaits its implementation!

Good governance, transparency, political stability and sustainable development do matter (Diamond 1999; Acemoglu and Robinson 2013). These factors are also very important in determining Asian people, their livelihood, wildlife (Takehiko et al. 2018), sustainability and life standard (Elvin 2006, see Kandel et al. 2015 and Regmi et al. 2018 for good examples of a science-based open access conservation role model towards a sustainable landscape management; see Voss 2019 for constitutional questions)!

But as any economy, organizational and planning textbook will state, formal ethics programs are worthless if managers do not live up to high standards of ethical conduct (Daft 2016), e.g. in the global governance provided by the rich 'west' and with the United Nations and The World Bank itself; the latter ones are major drivers for the HKH region and its watersheds. Companies and leaderships that put ethics on the back burner in favor of fast growth and short-term profits ultimately suffer (Daft 2016).

Another true'ism sits in the fact that HKH is an elevated area. Earthquakes apart, this region is a relatively safe place that is protected from sea level rise or most of such floodings (Glacial Lake Outburst Floods GLOFs are a very recent climate change feature)! When compared to Bangladesh or Vietnam, nations like Nepal and Bhutan will not be flooded by the oceans any time soon.

Fact is also that right now likely the biggest threat to Asia's water supply is not climate change as such (see Gao et al. 2019 for a reversed, but incorrect rationale). Instead it is the massive threat that comes from China's megadams blocking the flow of sediment and water in many rivers sourced in Tibet (Buckley 2014; Karar 2017); Drying will be on the rise. A myriad other impacts can be expected from that (Wester et al. 2019 and citations within).

And of course it's also true that nations with glaciers are losing those precious fields of ice and snow, but relatively speaking, these areas will remain pretty cold for a long time to come. In that respect, 0 °C is better than +30 °C heat. Still, the status and future for species and habitat will follow concepts and realities outlined by Shresta and Bawa (2013), Chhetri and Badola (2017), Haider et al. (2018) and Han et al. (2018); see also news and updates such as https://www.theguardian.com/world/2018/jun/21/shimla-india-water-crisis-life-on-frontline. With a vast overgrazing, the good soil components that feed it all are getting lost (Eldridge and Delgado-Baquerizo 2018). Consequently, food security represents the core conflict of the century (Lauria et al. 2018 for deltas off the Hindu-Kush Himalaya region and its rivers).

There are still all these widely heralded projects (Miehe et al. 2015), so-called policy break-throughs (Regmi and Shrestha 2018), water and mountain awards[1] and so-called solutions (Komiyama and Yamada 2018); now those are more 'green', holistic-sounding and/or even more techno-centric (e.g. ICIMOD 2018; ICIMOD/HI-AWARE Working Paper 2018; Schoolenberg et al. 2018; Gurung et al. 2019; see Senthil et al. 2018 for remote sensing). But beyond words and paper we are not achieving real progress (e.g. see The Guardian 2017 for a visualization) and most of those reports are still plain neoliberal and 'business as usual' just benefitting a few and their funders. Relevant modern issues and solutions hardly get addressed (e.g. World Economics Forum 2018 for global risk increase, see Tisdall 2018 for geo-political aspects with China; Ishimatsu et al. 2016 for landscape planning using rain gardens in urban planning; Anslan et al. 2019 for taxonomy of species to be conserved) nor resolved (e.g. Pandey et al. 2018 for wider and deeper water problems virtually not solvable). Already the waste problem makes for a major, complex but unresolved problem (https://www.change.org/p/say-no-to-waste-burning-dumping-in-nepal-stop-waste-burning-dumping-in-nepal). And thus, what really is at stake here is the world's wilderness (e.g. Watson et al. 2018), and wilderness means freedom. When the wilderness goes, so goes freedom, sustainability and health for mankind, anywhere in the universe! Clearly, philanthropies won't be able to save it (https://www.theguardian.com/news/2018/may/24/the-trouble-with-charitable-billionaires-philanthrocapitalism), nor technology and its 'smart' water management (http://lib.icimod.org/record/33733/files/Hi-AWARE_WP14.pdf). And while there has been a good history of some supreme court judges

[1] For instance, the 'ICT for Mountain Development Award' has been awarded annually since 2013. It recognizes innovations in information and communications technology for development (ICTD), which can promote mountain development and environmental conservation but are utterly neoliberal and provide little support for wilderness and to reduce poverty.

taking on environmental water and wilderness issues (e.g. U.S. supreme court judge W.O. Douglas for the Arctic wilderness and with regards to a stand on development; see also the late Polly Higgins https://www.theguardian.com/environment/2019/apr/22/polly-higgins-environmentalist-eradicating-ecocide-dies), it looks like those times are over though and good governance remains at large (see Watson et al. 2018 for a reality situation)! There is really no big need to run specific climate scenarios, and worst-case assumptions anymore (see Wester et al. 2019 for such attempts, conservative ones as they are). Due to the inaction and ignored cumulative synergy effects, reality tends always to be worse and different than what narrow-sided managers and their 'conservative-minded scientists can imagine (Wester et al. 2019. Science should be precise, not conservative). Simply going with agreed worst-case scenarios remains these days a good bet when precision, efficiency and a reality assessment is to be achieved: Conservation is time-critical if good outcomes are to achieved! Some aspects of that are at least recognized in the HKH region (ICIMOD 2019 for a wider protected area network involving the Silk Road too).

Finally, it's true that live in the mountains is somewhat stubborn, pretty hard and not so easy to endure for most people (Baumgartner 2015; Byers 2017 for examples), but at least it's a life, and it can be a good and humble life after all, even if disturbed from the outside. Societies and cultures in high mountains existed for millennia and perhaps their drive to succeed can sustain there at least for a little longer with dignity when left untouched and self-sustained?

Don't let them fool you, not even school you

Bob Marley, Reggae musician (Exodus)

(The late Bob Marley visited the Himalaya region and is still very popular there to this very day)

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Index

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