Mrittika Basu
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Preface

Indigenous and Local Knowledge (ILK) is a source of collective understanding (perceptions, beliefs, philosophies) and self-help measures (inherent skills, local ways of doing things, traditional practices) that has developed over history through dynamic interaction between communities and their natural surroundings. The potential role of ILK in addressing sustainable use of natural resources, adaptation to vulnerable conditions, and subsistence is well recognized. However, there exists a gap in understanding and translation of the wide knowledge systems of indigenous and local people into mainstream decision-making process. If the local and indigenous practices and actions are incorporated and promoted with modern scientific knowledge, optimum benefits can be derived for major environmental concerns.

Indigenous and local knowledge regarding water use, conservation, and treatment is existing for centuries. Though many of these knowledge, practices, or skills got lost over the span of time, indigenous people across the world still hold plenty of knowledge that makes them resilient to the changes around them and survive under difficult situations. ILK is well documented from some parts of the world and for most of the other parts, they are seldom studied and reported, and integrated into decision-making processes. Water resource management, including water harvesting structures, water quality monitoring, filtering, water use, and conservation, is an arena where ILK has been found to be particularly useful. For instance, traditional water harvesting structures like step wells in India had been an excellent source to hold water for use during drought periods. In recent times when India faced severe water shortage every year, step wells were a harbinger of hope due to the capacity to hold immense quantity of water as well as their ability to recharge the groundwater.

This book consists of 19 chapters, which aim to explore, assess, and report various indigenous and local knowledge and practices associated with water use, conservation, and water infrastructural facilities. The spiritual and religious values related to water are explored through four interesting chapters on how water is represented in Hinduism, Islam, and Shintoism. With no specific geographical boundary, the book includes examples of indigenous water knowledge and practices from various geographical regions including Africa, Middle East, South Asia, and

Southeast Asia. The book presents case studies from different indigenous communities and their water conservation practices. The book is divided into four sections. The first section conceptualizes the indigenous water knowledge and practice, and the rest of the chapters present various case studies.

This book is meant for students and researchers who are working on/studying indigenous water knowledge, values, and practices. The book will be also useful for policy planners as it puts a special emphasis on integrating indigenous knowledge and practices to the decision-making process. We are hopeful that the knowledge shared in this book will act as a catalyst to promote research on indigenous knowledge, their contribution to sustainable development, and mainstreaming the knowledge and practices into policy making.

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About the Editors

Mrittika Basu is an Assistant Professor in the Laboratory of Sustainable Rural Development, Graduate School of Global Environmental Studies (GSGES), Kyoto University, Japan. She received her PhD from Kyoto University and has extensive experience in field-based research on water resource management. She has published several scientific papers in peer-reviewed journals and edited volumes. Her research interests mainly include, but not limited to, water resource management, rural water security, human-nature connections, pro-environmental behavior, ecosystem services assessment, and human well-being.

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Chapter 1
Exploring Indigenous Water Knowledge, Values, and Practices: Insights and Examples

Mrittika Basu and Rajarshi Dasgupta

Abstract This book presents a detailed and insightful account of indigenous water knowledge, values, and practices with examples from across the Global South. The main objective of this volume is to explore and understand the diverse indigenous knowledge that exists in the Global South and document the local water use and conservation practices adopted by indigenous people and local communities. The book includes several examples of water values and conservation practices that are still functional and practiced. In addition, the book includes a section on the spiritual and/or religious and cultural values of water which opens a new arena of understanding water resources and valuing them. In the process of exploring and understanding the existing indigenous and local knowledge and practices, the book identified several commonalities, one of which is the lack of integration of indigenous and local knowledge into mainstream policy-making. This chapter introduces the key concepts and definition, objectives, and organization of this book.

Keywords Indigenous knowledge · Water values · Water resources · Cultural value · Indigenous people · Local practices · Traditional knowledge

1.1 Introduction

Science-policy arenas and agreements such as the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) and the Convention on Biological Diversity (CBD) acknowledge the importance of indigenous and local knowledge and explicitly support the diversity of knowledge systems in informing international biodiversity assessments and decision-making (Díaz et al., 2015). The IPBES Global Assessment (GA) is the first ecological assessment to systematically incorporate indigenous and local knowledge (ILK) at the global scale (Díaz et al.,

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2019; IPBES, 2019). Engaging with indigenous and local knowledge systems involves encounters of different worldviews, identities, practices, and ethics, in a context of asymmetries of power and rights.

Mercer et al. (2010) assemble several literatures to define indigenous knowledge as "a body of knowledge existing within or acquired by local people over a period of time through the accumulation of experiences, society-nature relationships, community practices and institutions, and by passing it down through generations" (p. 217). Similarly, Cuaton and Su (2020) aggregated local and indigenous knowledge as "a body of different types of knowledge and practices of societies accumulated through a continuous interaction with their natural surroundings." Boven and Morohashi (2002, p. 6) treat indigenous knowledge as local knowledge and define the concept as "a complete body of knowledge, knowhow and practices maintained and developed by peoples, generally in rural areas, who have extended histories of interaction with the natural environment [. . .] these sets of understandings, interpretations and meanings are part of a cultural complex that encompasses language, naming and classification systems, practices for using resources, ritual, spirituality and worldview." Indigenous knowledge is local, empirical, and practical, develops independently, is transmitted orally or by imitation, mostly remains undocumented, and is usually shared (Lauer, 2012; Williams and Hardison, 2014).

The characterization that is gaining wider acceptance from scholars is perhaps best stated by UNESCO which defines ILK as "the understandings, skills, and philosophies developed by societies with long histories of interaction with their natural surroundings." Over an extensive succession of observations conveyed from one generation to another, indigenous people have a historical continuousness of practices on resource-use practices and often own a wide-ranging knowledge based on the intricate ecological structures in their own vicinities (Gadgil et al., 1993).

Such knowledge can be developed over many generations and handed down. Indigenous and local knowledge are acquired experientially, grounded in the sociocultural context of the need to address issues of everyday living (Bwambale et al., 2020). It arises from context-specific and outcome-based understanding of the natural realities (Bwambale et al., 2021). On the other hand, scientific knowledge is developed through a formal evidence-based technical systematization of information to carefully provide explanations of phenomena.

When taken independently, the term "local knowledge" is derived from a community's place-based relationship with the local environment, while "indigenous knowledge" is gained from long-term cultural ties or traditional ownership of a place (Agrawal, 1995). Similarly, the IPCC (2018) characterizes the former to be the understandings and skills specific to where people live, while the latter is developed out of long-standing interaction with the natural environment. Distinctions between the two exist in literature. However, in reality, the difference between local or indigenous and traditional knowledge is blurred since communities often use varied sources of knowledge concurrently.

Collaborative research initiatives based on Western science and indigenous knowledge for addressing issues such as climate change impacts have the potential to be advantageous to both the indigenous communities and the researchers.

Dichotomies between Western science and indigenous philosophy are often underpinned by long-standing prejudices and not so subtle better or worse views: Western knowledge as rigorous, scientific, evidence-based, systematic, and universal and indigenous knowledge as unempirical, cultural, intuitive, local, and non-generalizable. Indigenous ontologies, although incredibly diverse and dynamic, hold commonalities, one of which is an understanding of water as a relative (or something similar) to whom people are linked through an intricate web of extended kin-based relationships (Mistry & Berardi, 2016). The idea of water as a living more-than-human entity is widely articulated through indigenous oral traditions, laws, governance regimes, and management practices.

Water has been fundamental to the existence of humanity. All the civilizations formed along the banks of the rivers as rivers provided a steady supply of drinking water as well as water for growing crops and navigation. Indigenous and local knowledge on water has been a key ingredient of sustenance in the face of challenges and vulnerabilities for many indigenous and local communities across the world. The information sustained in the indigenous and local knowledge are already identified to be highly significant for the development of sustainable water management practices, and there has been an urgent call to mainstream them into formal water management planning for their wider acceptability at a local level. The existing literature on indigenous and local water knowledge has been mainly confined to case studies from countries like Australia, New Zealand, and Canada and from some parts of Africa and Asia. This book volume contains case studies from different countries across Global South and documents the knowledge and practices of not only the indigenous people but also local rural communities.

1.2 Cultural, Spiritual, and Religious Values of Water

Indigenous societies, in general, hold spiritual values about water that are not found in the mainstream of Western culture. Water, in Western cultural theory, is a resource. It is inert and not alive and is mainly defined in terms of its physical and chemical properties. It has no consciousness, and it has no life. It has no value but has great potential value in being applied to some productive purpose. There is no benefit from water's existence other than the extent to which humans can benefit, directly or indirectly, from the water itself, or the environments that water supports (e.g., stocks of food fish that depend on the viability of a lake ecosystem). Water is a resource much like coal or oil. It is not only culturally permitted but culturally preferred to make use of the resource by mining it or recovering it in whatever way is technologically feasible. The environment within which water is found is also a resource which can be utilized for productive benefit. Recent views about the water environment have changed to confer economic value to the environmental services of the ecosystems that water supports, for example, a riverine environment that includes fish, birds, wildlife, wetlands, and the associated plants and microorganisms. This recent appreciation of the ecological aspects of river systems, and the associated economic benefits of water ecosystems, has led to reconsiderations about the desirability of water diversions for irrigation and reanalysis of the costs and benefits of hydropower dams. But while the equations have changed with the new values accorded to biological and ecological factors, the cultural theory underlying the equations has stayed the same: the value of water is defined in economic terms.

In contrast to Western culture, the indigenous spiritual perspective of the environment is clearly articulated and directly experienced. It also provides a more dominant "voice" within the society, than is the case in the West. The introductory words of the Indigenous Peoples' Water Declaration (United Nations Educational, Scientific and Cultural Organization, 2003) very clearly demonstrated the identification that indigenous spirituality makes between people and nature:

1. We, the Indigenous Peoples from all parts of the world assembled here, reaffirm our relationship to Mother Earth and responsibility to future generations to raise our voices in solidarity to speak for the protection of water. We were placed in a sacred manner on this earth, each in our own sacred and traditional lands and territories to care for all of creation and to care for water.
2. We recognize, honor and respect water as sacred and sustains all life. Our traditional knowledge, laws and ways of life teach us to be responsible in caring for this sacred gift that connects all life.
3. Our relationship with our lands, territories and water is the fundamental physical cultural and spiritual basis for our existence. This relationship to our Mother Earth requires us to conserve our freshwaters and oceans for the survival of present and future generations.

Water is not only an aspect of indigenous spirituality but a very major component of that spiritual world. Water, whether as a substance or in the form of water bodies (rivers, lakes) and meteorological phenomena (rain, snow, fog, clouds), are seen through a spiritual, not an economic, lens.

1.3 Indigenous Water Governance

Water governance is defined as "[t]he range of political, organizational and administrative processes through which communities articulate their interests, their input is absorbed, decisions are made and implemented, and decision makers are held accountable in the development and management of water resources and delivery of water services" (Bakker, 2003, p. 3). Indigenous outlook of water governance differs from mainstream Western approaches (Boelens, 2003; Boelens et al., 2006), which consider water as a resource available for human exploitation (Bakker & Cook, 2011). Indigenous people often value water as a living entity that carries deep spiritual and cultural meaning (e.g., Barbera-Hernandez, 2005; Boelens et al., 2006; McGregor, 2012). Furthermore, indigenous peoples' worldviews influence their patterns of water use and management, and their relationships to water, as well as other elements of the environment, fundamentally contribute to their distinct identities (Barbera-Hernandez, 2005).

Indigenous governance refers to a vast field of study related to indigenous peoples and decision-making that is generally considered to include indigenous identity, sovereignty, self-determination, values, ways of knowing, and race, as well as historical and ongoing colonialism and the resulting consequences of marginalization (Coulthard, 2008; Ford & Rowse, 2012). In the Indigenous Peoples Kyoto Water Declaration, self-determination for indigenous peoples is defined as "the right to control [their] institutions, territories, resources, social orders, and cultures without external domination or interference" (United Nations Educational, Scientific and Cultural Organization, 2003). Indigenous water governance puts the need of the communities and their hydrosocial relations at the center of decision-making. For indigenous peoples, indigenous knowledge is crucial to understanding hydrosocial relations. These hydrosocial relations include distinct uses and values and are complexly connected, context-specific, dynamic, and adaptive.

1.4 Objectives and Organization of the Book

This edited book volume consists of 19 chapters including this introductory chapter and the last concluding chapter. The rest of the 17 chapters are divided into two sections for easy reading and understanding. With both reviews and case studies, the book includes studies from various parts of the world like Africa, Middle East, Southeast Asia, South Asia, and East Asia. Hence, it can be claimed that the examples of indigenous water knowledge, values, and practices mentioned in this book predominantly represent the knowledge repository of the Global South. The existing literature on indigenous water knowledge, practices, and governance mainly consists of examples from Global North like from Australia, New Zealand, and Canada. This book can be considered as a first attempt to document and publish about indigenous water knowledge, values, and practices from the Global South.

Chapter 2 focuses on a critical debate of power dynamics, water resource management, technological interventions, and inability to include indigenous knowledge into mainstream natural resource management.

The first section of the book is on religious, cultural, and spiritual value of water and compiles examples from Hinduism, Islam, and Shintoism.

Chapter 3 provides a review on symbolization of river water, especially river Ganga in India. The chapter provides a critical insight into the purification property of river water and the different rituals that are practiced with river water, symbolizing the spiritual value of water to Hindus.

Chapter 4 elucidates the role of Islam in water management and water governance by carrying out extensive review of existing literature. The chapter highlights the use of water for different rituals showing its significance in ablution as well as provides a detailed insight on how Islam has directed its followers regarding the use, conservation, and distribution of water.

Chapter 5 highlights an interesting take on Shintoism and water, which is again a not so well-known arena. Similar to other religious beliefs, Shintoism is also found to consider water as the highest purifying form which can be used to purify ourselves from our impurities.

Chapter 6 by Ali and Chatti focuses on the philosophy of Islam and how it governs the use and distribution of water in the countries of Middle East. In spite of a rich traditional knowledge about water storage and use, this part of the world is facing severe water crisis which might be due to overreliance on technological intervention and Western theories of water management.

Chapter 7 by Sah is an interesting account of how spiritual values are intertwined with cultural approaches to use and conserve water in northern hilly terrains of India. This approach helps in developing ethics and moral codes among people that helps to create awareness.

Chapter 8 examines the current water status in New Delhi, the capital of India. Considering the chronic water stress situation in the megacity, sole reliance on technological interventions may lead to unsustainable water future. Hence, to have consistent supply of safe and sufficient amount, it is important to include indigenous knowledge in the water management planning.

Chapter 9 focuses on the drying up of Lake Urmia in Iran due to overexploitation of the lake water without considering its significance in supporting irrigation in the lake basin. Lessons from indigenous water management practices in Iran are drawn upon to assess the long-term social sustainability of common pool resource management in the region.

Chapter 10 explores the nature and internal dynamics of indigenous knowledge systems in contemporary rural Zimbabwe while noting how policy-makers can influence the strengthening of indigenous systems. It also explores opportunities of the integration of indigenous and formal water governance systems to enhance water access and equity. The chapter is based on a review of literature that highlights emerging debates related to how indigenous water governance systems are operating in post-colonial Zimbabwe.

Chapter 11 examines the role of indigenous water conservation structures like ponds, ditches, and dug wells in supplying water for farming in rural areas in India. Based on primary data analysis, these structures are identified to be highly beneficial to the farmers as they provided an alternative source of water, and with the surplus water, they could grow other crops that helped them to improve their livelihood as well as food security.

Chapter 12 investigates the local knowledge on water use and other natural benefits derived by the lowland, midland, and upland villages in the Libungan-Alamada Watershed in Mindanao, Philippines, from their water sources (i.e., river and spring) or water-related ecosystem services (WES).

Chapter 13 highlights the water use, filtering, and conservation practices adopted by the *Munda* community from Southwest Bangladesh. Due to increased salinity, the community faces increased water crises, not only for domestic use, but the agricultural lands are also damaged. The indigenous community adopts traditional practices to cope with the vulnerabilities.

Chapter 14 presents a case study on Basin School Network in Taiwan that involves grassroots communities to take part in monitoring and conservation of the river basin under study. The Basin School Network adopts a cultural approach to involve local communities like conducting musical concerts in the basin or bird watching events or stone stack competitions. The process not only creates awareness among the local community but also incurs a sense of responsibility among them to protect and conserve the basin.

Chapter 15 explores the various indigenous water conservation and storage practices adopted by the indigenous communities from the red lateritic belts of Southwest Bengal in India. The indigenous communities like *Sabor*, *Kol*, *Santhal*, *Hor*, etc., predominantly living in this region, face chronic water scarcity which has compelled them to develop different indigenous techniques of storing and using water at both household and agricultural levels. The chapter provides a detailed account of the different practices for a clear understanding.

Chapter 16 explores the perception of elderly rural women regarding the significance of water and their indigenous water knowledge in Aranayake, Sabaragamuwa Province, Sri Lanka. The primary data for the study is collected through interviews in the study area, and the elderly agreed to the fact that piped water supply across the area has made water easily available at home and hence the local people do not need to practice any indigenous technique to filter or store water or to keep them cool. The indigenous water knowledge is now mostly lost in the study area.

Chapter 17 looks into the water harvesting methods used by local communities in Indian Sundarbans and their utility in augmenting livelihood. Ponds are an indigenous water harvesting structure that not only provide water for household and agricultural use but can be also used for fish farming which can be an alternative livelihood for the local communities.

Chapter 18 highlights the cultural discourses and indigenous conservation tactics adopted in India in response to continued water stress.

Chapter 19 consolidates Chapters 2–18 to summarize the main findings and identify the key learnings that will contribute to sustainable water management and governance in the future.

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Chapter 2
A Political-Economic Analysis of Water, Indigeneity, and Capitalism in the Face of Climate Change

Phoebe Holmes

Abstract Technocratic dominance in the water sector imposes a substantial threat to the possibility of participation of indigenous communities in decision-making. Current decision-making is heavily dependent on expert engineers, who present technical language and knowledge as rational, stable, and objective. Indigenous claims to water are dynamic and context-specific but generally adopt a holistic, intuitive, and harmonious perspective, and communities' interaction with water is often central to their identity and wellbeing. Neoliberal solutions to climate-water crises largely fail to benefit indigenous communities, having been evidenced to exacerbate social, political, and economic vulnerabilities of marginalised populations. The knowledge held in indigenous communities is currently underappreciated and underutilised. Learning from indigenous communities will be an essential part for the successful transition in the postcolonial socialist world. An expansion of institutional capacity is needed to meaningfully acknowledge indigenous water cultures and enable the political autonomy of marginalised groups. Knowledge sharing between indigenous and currently dominant institutions must be encouraged to formulate climate strategies with efforts to transform the hierarchy of the institutional structure.

Keywords Indigenous people · Water politics · Water rights · Climate crisis · Political economy

2.1 Introduction

The extent to which indigenous groups have been accounted for in global water policy is inextricably linked to colonial histories of exclusion, power asymmetries, and social oppression that have served centuries of elitist capital accumulation. Several authors have articulated that indigenous water struggles are colonially rooted, since water allocation systems during this era privileged the demands of

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white settlers and other non-indigenous groups over the needs of native communities (Franco et al., 2013; Phare, 2009; Strang, 2014; Tarlock, 2010; Jackson, 2018a, 2018b; Grajales, 2011). Such marginalisation entailed destroying indigenous institutions, silencing their political voice, and the invisibilisation and illegitimisation of indigenous traditions surrounding water management and use (Aho, 2009; Berry, 2000; Weir, 2009; Matsui, 2009; Jackson, 2018a). It placed water knowledge within a wider modernisation project, in which context and history are ignored (Zwarteveen, 2010).

Capitalism rests upon a series of social dichotomies (the most relevant to the current topic being nature/society and coloniser/colonised) that promote a simplified and disassociated view of reality. These were advanced by philosophers of the Enlightenment, who sculpted justifications for colonial intervention by introducing a linear vision of development (McEwan, 2018). At one end of this path existed inferior, savage beings, whilst at the other was the rational, civilised Western male (Strang, 2018). Said's (1978) *Orientalism* is an influential discussion on the origins of systemic "othering", a notion that discursively promotes those in poor countries as lacking autonomy or voice (McEwan, 2018). These perspectives set the precedent for global water policy of the late modern era; today, it remains common that water laws are imposed by foreign actors. Policy is legitimised by Westernised understandings that see water not for its social uses but as one of the many inputs into efficient agricultural production, ultimately leading to private economic benefit (Gelles, 2010; Roth et al., 2015). This dominance has undermined native knowledge surrounding community-managed, small-scale, or subsistence irrigation (Harrison & Mdee, 2017). This is demonstrative of ongoing social oppression and territorial dispossession, in which indigenous groups are marginalised through elitist attempts to modernise their ways of being (Boelens et al., 2010; Vélez Torres, 2012). In parallel with colonial times, liberalist ideology and rhetoric are used in the water sector to justify this coercion.

Throughout the twentieth century, there have been distinctive shifts in international water governance. The colonial and early postcolonial era (circa 1960s) saw a preference for mono-juridical, state-led water allocation, imposed by a white-elite minority that aimed to eradicate local systems in favour of imported Westernised models (Mdee & Harrison, 2019; Boelens, 2009). This period preceded the re-emergence of neoliberal thought in the 1970s, in which water became subject to laissez-faire logic, essentially viewed as a tradable and profitable private resource (Gupta, 2013). The earlier days of the twentieth-century neoliberalism coincided with surfacing concerns for climate outcomes, which ultimately furthered the project of water privatisation, through the propagation of a "façade of free-market environmentalism" (McMichael, 2009; Garrick & Svensson, 2018; Mirosa & Harris, 2012). The 1980s was somewhat of a turning point in the proliferation of neoliberal ideology, largely led by the Thatcher and Reagan administrations of the UK and the USA, respectively. This corresponded with the United Nation's (UN) declaration of the "International Decade for Drinking Water Supply and Sanitation", which saw an unprecedented advance in water infrastructure investment. Following this, the

Dublin Principles of 1992 came to be a definitive declaration in which water was infamously labelled an economic good.

Since the 1990s, the Integrated Water Resources Management (IWRM) as a framework has remained prominent. IWRM encourages the diversification of stakeholders, promotes transboundary relationships, and is perceived to be a holistic pursuit of water management, encompassing economic, social, and environmental concerns (Conca, 2006; Klaver, 2012; Mdee, 2017). Today, IWRM remains hegemonic and institutionalised – it is advocated by a majority of national governments, international organisations (IOs), and donors and is written into the UN's Sustainable Development Goals (SDGs) (Mdee & Harrison, 2019). There are, however, many critics of IWRM. Whilst touted as a holistic model, it is heavily influenced by the neoliberal environment of its time, remaining within the confines of the dominant paradigm and thus unable to meaningfully recognise symbolic and spiritual uses (Wilder & Ingram, 2018; Mdee, 2017). Further to this, IWRM leaves intact asymmetrical power structures, and the framework's vagueness allows it to be easily co-opted by groups to legitimise privatisation agendas (Klaver, 2012; Franco et al., 2013). Conca (2006) concurs with this stance, providing substantial insights into the workings of IWRM, exposing its neoliberal underpinnings and technocratic assumptions vis-à-vis participation and knowledge.

2.2 Rights to Water and Power Struggles

2.2.1 The Rise of Privatisation

Hegemonic Western governments, the Washington consensus, the International Monetary Fund, and the World Bank have all played forceful and integral roles in embedding the monetisation of water globally (Conca, 2006). This process was one component in a wider project to consolidate neoliberal ideals into the international political economic landscape, generally understood as a mission to shrink state power in favour of an omnipotent market system (Franco et al., 2013). The consolidation of neoliberal ideas has been theorised as indicative of a systemic avoidance of answerability, causing states to be labelled complicit (Bakker, 2018; Lynch, 2012; Vélez Torres, 2012). As the notion of economically valued water became dominant, it closed the opportunity for debate on alternative governance ideas). This privileging of the neoliberal approach to water thus directly impeded the possibility of indigenous collective management systems to be considered at decision-making levels (Boelens et al., 2012). Conca (2006) provides an overview of specific global policies that institutionalised water as a marketable commodity, including the liberalisation of investment regulation and the decentralisation of essential water supplies, amongst others.

Orthodox neoliberal approaches gained legitimacy by pushing a narrative that played down state ability to effectively handle water markets, presenting the private sector as the only viable solution. States and aid agencies were framed as cash-poor and incompetent, whilst large-scale capitalist providers were hailed as innovative and efficient (Baer, 2017; Wilder & Ingram, 2018; Bakker, 2007; Vélez Torres, 2012). It was claimed that to *not* leave the water management to the private sector would be unethical (Bakker, 2018). Such accounts, however, overlook the existence of commonplace state-corporate collusion (e.g. Tombs & Whyte, 2009; 2010; Tombs 2011) and that private, risk-taking entrepreneurs often count on governments to create an enabling environment (Harrison & Mdee, 2018). In addition, it has been evidenced that many local water users would sacrifice efficiency and other economic gains if it meant their cultural system and autonomy was protected (Maass & Anderson, 1978). These and other demands are easily overlooked by private water suppliers, whose accountability lies with overseas shareholders rather than local communities (Franco et al., 2013).

Water sector privatisation represents a clear supremacy of the needs of capital accumulation over the integrity of local indigenous systems dating back thousands of years. Elitist models of development legitimise the formal establishment of water bureaucracies and markets that serve a dominant minority whilst paternalistically constructing the knowledge of native actors as anachronistic, irrational, and against the national interest (Sosa et al., 2017; Cornellier & Griffiths, 2016; Boelens, 2009; Boelens et al., 2012; Conca, 2006; Vélez Torres, 2012; Franco et al., 2013). This technocratic dominance constitutes a substantial threat to the possibility of participation in decision-making (Ingram et al., 2008; Wilder & Ingram, 2018). Evidence presented by Vélez Torres (2012), of the strikingly disproportionate involvement in political processes of indigenous communities, too supports this view. This arrangement becomes self-perpetuating: as excluded communities are marginalised from political conversations, regional elites and foreign investors plan projects that further undermine local cultures and livelihoods (Boelens et al., 2012).

2.2.2 *The Neutralisation of Scientific Knowledge*

The modernisation of water systems is underpinned by a paradigmatic preponderance for the depoliticisation and neutralisation power of science and technology. Current decision-making is heavily informed by expert engineers trained in Western institutions, who present technical language and knowledge as rational, stable, and objective (Boelens et al., 2010, 2012). Conca (2006) classifies these taken-for-granted assumptions as "embedded meta-narratives" that fail to be questioned or regarded as variable. Yet, water expertise is not neutral – it represents a privileged identity and is reflective of historic authoritative dominance (Zwarteveen, 2010). Certain values and assumptions uphold much scientific and economic knowledge. These perspectives constitute political decisions and judgement calls that are inevitably informed by actor's contexts (Mdee, 2017; Harrison & Mdee, 2018). Van Koppen (2018) highlights how many technological solutions have a stanch elite-male influence, resulting in a perpetuation of gender inequality in access to, and control of, water systems.

It should be recognised that expert knowledge does not exist a priori, but is inspired by specific political ideologies and relies upon debatable ontological positions (Achterhuis et al., 2010; Allouche et al., 2015). The political nature of water management is demonstrated by Ingram et al. (2008), who explain that even if funding to the sector increased abundantly, water would remain polluted and misallocated. The context of scientific thought described above is not a mere analytical quandary but has detrimental implications on the ground. This homogenising narrative has social, cultural, and economic ramifications that directly contribute to the harm and eradication of indigenous and other rural water user collectives (Boelens et al., 2010, 2012). Only when mainstream knowledge producers are removed from a transcendental pedestal, and "common sense" is critically examined, will "democratic, inter-cultural and potentially emancipating dialogue" be attainable (Boelens et al., 2010, p. 330).

The framing of expert knowledge as objective and rational essentially justifies the universalisation of solutions to a complex myriad of issues felt by water users globally. This serves vested interests of transnational corporations and elites whose desired waterscape is uniformly constructed, so as to be conducive to the needs of the free market (Roth et al., 2015; Boelens, 2008, 2009). Justice-oriented narratives such as equality, unity, and impartiality are adopted (or appropriated) and used as discursive tools to create a "level playing field" that ultimately denies rights to cultural distinctiveness (Jackson & Barber, 2013; Achterhuis et al., 2010; Cornellier & Griffiths, 2016). Although the liberal state is seen to "include" subjugated groups in its restructuring of the waterscape, there are multiple indigenous forms of water management and uses not accounted for in the homogeneous and modernised model (Boelens, 2008). These range from elementary claims, such as recognition of the spiritual values of water, to deeper concerns surrounding political autonomy and self-determination, which question the legitimacy of the state altogether (Cornellier & Griffiths, 2016). Thus, indigenous claims to water are acknowledged only as far as capitalist hegemony is unharmed. This constitutes what Boelens (2009) labels an institutionalised domination: a simultaneous acceptance and rejection of rights in a manner that leaves intact the overarching power hierarchy.

The inadequacy of enforcing a formalised, one-size-fits-all model to thousands of uniquely complex water systems does not require explanation, but for the purpose of the current argument, some key reasons will be addressed. Firstly, it poses inclusivity limitations to groups that are ill-equipped to engage in administrative processes, negotiate their positions, and gain recognition for unrecognised water repertoires (Jackson, 2018b; Harrison & Mdee, 2017). Secondly, universal prescriptions do not account for crucial context-specific physical (climatic) and social (institutional, historic, customary) differences (Wilder & Ingram, 2018; Sosa et al., 2017; Baer, 2017). As explained above, homogenisations of solutions to water issues are ultimately tied to implicit Westernised norms that aptly serve interests of the dominant class (Boelens, 2008). Even if one moves aside the indigenous pursuit of fair social recognition, standardised policy overlooks the delicate ecological diversity across regions that point to the need to replace industrial, economies-of-scale solutions with agro-ecological development models (Boelens et al., 2010; Rosset & Altieri, 2017).

It has been advocated that mainstream actors must recognise the limits of their knowledge and instead adopt an "open-ended" approach, particularly in the realm of environmental science where current insights are hugely dynamic and unpredictable (Conca, 2006; Levy et al., 1993).

A third problem associated with homogenisation of technical solutions is the generation of capability traps and isomorphic mimicry, well-articulated by Mdee and Harrison (2019). These theories dictate that imported "best practices" fail to function as such, since recipient countries do not possess the required institutional capacity to purposefully implement and uphold these models. Once again, this comes down to failure to account for context and complexity, instead attempting to imitate idealised examples, in turn inhibiting the generation of workable, relevant local resolutions (ibid).

2.2.3 Indigeneity and Neoliberalism: Epistemological Disparities, Inexorable Differences?

A key reason that neoliberal capitalism has been so harmful to the recognition and inclusion of indigenous groups in water contexts globally is due to the inexorable differences between indigeneity and neoliberalism. This is exacerbated by the fact that the dominant paradigm extends far beyond its remit of an economic system. Neoliberalism has proliferated into a cultural programme, prescribing norms and relationships between the state, the market, and the society at large—it has become the "normal" way in which to view the world (Achterhuis et al., 2010; Boelens et al., 2010, 2012).

The differences between these two (broadly defined) systems in relation to the management of water can be partially explained by contrasting the notions of efficiency and equity. Efficiency has modern and Westernised political roots, rests upon formulaic principles, and is individualistic and reductionist (Conca, 2006; Ingram et al., 2008). When equity is discussed from a neoliberal perspective (that prioritises efficiency), authenticity is limited by the extreme asymmetries the paradigm upholds. "Equitable" policies in the water sector today rarely have truly equally dispersed costs and benefits across classes and geographies, but rather exacerbate disparities between the ruling minority and the rest of society, particularly marginalised rural groups (Wilder & Ingram, 2018). This can be contrasted with systems that place equity at their centre. Such approaches are culturally and contextually sensitive, grounded in reciprocity and community wellbeing – a notion that is not a mere tallying up of individual welfare, but is a collective concept that recognises the potential need for subordination of self for communal gain (Ingram et al., 2008). From this starting point, the presence of water represents the history, attachments, and obligations of the community, and it defines their identity and dictates their role in sustainable and equitable resource management (Wilder &

Ingram, 2018). Crucially, such an ontology too acknowledges and respects the needs of future generations and non-human water users.

It therefore becomes apparent that neoliberal and indigenous water systems have fundamental incompatibilities that cause their merging and/or co-existence to be problematic. An equitable approach to water aspires to remedy, not reproduce, political and economic inequalities of power (Wilder & Ingram, 2018). Klein (2007) describes neoliberalism as a "fundamentalist doctrine" that refuses to peacefully coincide with alternative ideologies. Similarly, Achterhuis et al. (2010) explain that the modernising objective of neoliberalism has an inherent tendency to destroy plurality. This is a vital point to consider when attempting to locate a strategy that consolidates, incorporates, or even recognises these two opposing systems in the same political space.

Another key disparity is the ecological disassociation that characterises the orthodox capitalist perspective. Through a neoliberal approach, complex, multifaceted natural resources such as water and land are seen as external, exploitable bodies. Volumetric measurements adopted in corporate environmental impact initiatives are one-dimensional and inadequate (Nikolakis et al., 2013; Mdee, 2017). Even truly well-intentioned neoliberal water projects are unable to meaningfully recognise and respect the true myriad of pluralistic values that exist. Strang (2018) highlights the instrumentalist rhetoric that typifies development discourse. In their most ambitious attempts, neoliberalists see cultural and spiritual value as beneficial for the individual perceiving it, rather than embracing nature's intrinsic right to exist, regardless of human affirmation. This unrecognised ontology has its roots in the capitalist dichotomies that were briefly introduced at the start of this chapter, in this case originating from René Descartes' supposition of a distinction between nature and society.

2.2.4 Indigeneity in the Contemporary Political Context

Through distinguishing between political recognition and economic redistribution, we can gain useful insights into the nature by which indigenous groups are included in global water policy decisions. The importance and relevance of this distinction has been articulated in a penetrating piece by Fraser (1995). Here, she articulates that solutions to *socio-economic injustices*, as theorised by influential writers including Karl Marx and John Rawls, will involve redistribution of income and reorganisation of labour arrangements (ibid). Contrastingly, *cultural injustices*, including symbolic domination and oppression, can only be solved through a genuine recognition and respect for alternative ways of living, which would require a societal transformation and necessarily entail all individuals (including the non-marginalised) to reassess their own identities (ibid).

Through this lens, it becomes visible that the neoliberal approach orients justice initiatives around redistribution to indigenous groups whilst framing these efforts as political or cultural recognition. Indigeneity is homogenised, simplified, and subsequently incorporated into dominant water governance institutions grounded in alien concepts and de facto hierarchies (Sosa et al., 2017; Boelens, 2008, 2009; Boelens et al., 2010). Commonly evidenced policies of "recognition" cluster around a foreseeable set of issues, such as granting of customary rights and constitutional acknowledgement, but underpinning such legislation is a restrictive liberal ideology that seeks to reproduce the status quo (Conca, 2006; Jackson, 2018b). Thus, more significant political claims surrounding territory and authority are silenced and ignored. As touched upon above, many indigenous groups question the authority of the nation state altogether, and so to participate in state-granted water allocation systems means recognising the states' advantageous hierarchical position as legitimate (Jackson, 2018b).

A central concern at hand is how to create space in the international political economy of water for diverse and alternative natural resource management institutions. However, as explained, inclusion in its current form reinforces indigenous subordination through subjection to external processes and unequal power structures (Boelens, 2008, 2009). Thus, contemporary recognition often materialises as attempts to suppress cultural distinctiveness, correlating with the aforementioned debate surrounding scientific objectification narratives. In keeping with calls from Roth et al. (2015) and Jackson (2018b), it is argued here that in future, decision-makers and academics alike must consider avenues by which recognition and integration can be meaningfully consolidated with self-determination and political autonomy in the face of powerful external players.

Whilst it is reasonable to assume certain common aspects of indigenous populations, such as shared ancestry and heritage, distinct language, unique relationship with nature, and commitment to reproduce cultures from precolonial civilisations (Jackson, 2018a, b), there is a Western tendency to romanticise and homogenise indigenous ways of being. These idealisms are perpetuated from both ends of the political spectrum. From the right, racist indigenous stereotypes of "backwardness" persist in many modernising bureaucratic circles (Ingram et al., 2008). From the left, hopeful radicals defend sentimentalised and exaggerated traits of indigeneity (Guerrero, 1994; Boelens, 2009; Boelens et al., 2010). Utopian expectations can overshadow the existence of hierarchical or discriminatory injustices within alternative institutions (Roth et al., 2015). To avoid the same universalisation and simplification criticised earlier in this chapter, critical examinations of power should too be applied to native systems, instructed by "empathetic objectivity" rather than longing for return to tradition (ibid).

Indigenous claims to water are dynamic and context-specific but generally adopt a holistic, intuitive, and harmonious perspective. Communities' interaction with water is often central to their identity and wellbeing; the health of the water is inextricably linked to their sense of self, for it provides not only health in a recognisably Western sense (drinking supplies, hygiene concerns), but it also has ritualistic and spiritual significance. The essence and centrality of water in indigenous mythology is well-documented (e.g. Armstrong, 2008; Toussaint et al., 2005; Jackson, 2018a, b). Many communities view rivers, sea, and other natural resources as living beings, gods, or places that ancestral spirits reside. Territory is also of fundamental importance, being intrinsically linked to a community's right to water, and sculpting collective identity through a sense of place and connection to the land (Aho, 2009; Barber & Jackson, 2011; Boelens et al., 2012). Legitimacy and respect are also gained by control over waterscapes (Wilder & Ingram, 2018). Thus, the significance of water to multiple vital tenets of indigenous life means that retraction of rights constitutes an onslaught to their social reproduction according to fundamental belief systems.

In contemporary political and social contexts, indigenous communities possess nuanced and multifaceted demands when it comes to water. These include equal access and treatment, environmental protection, autonomy and space for political organisation, democratic and regional decision-making, and fair participation and representation (Corpuz, 2006; Jackson, 2018a, b; Jackson & Barber, 2013; Fraser, 2009). Demands take place within a structure of rampant inequities of power that characterises indigenous existence internationally (Boelens et al., 2010). A key tension in the indigenous struggle for recognition, as demonstrated earlier in this piece, is that "successful" recognition under the dominant paradigm inevitably entails formalisation and thus integration into a fundamentally contradicting bureaucratic system (Harrison & Mdee, 2017). There is a need for academic understanding as to how alternative institutions can begin to exist in their own space, without needing to be legitimised by foreign or imported values and processes.

Indigenous recognition and participation are currently limited by the overarching political economic structure under which the water sector operates. One actor having the authority to include another itself constitutes a political choice rooted in power asymmetries (Bloomquist & Schlager, 2005), and so these processes of determination must also be examined. At the most woeful level, governments and businesses symbolically incorporate marginalised groups as part of a tick-box process so as to justify expansion of interventions and improve their image as development actors (Powęska, 2017; Ingram et al., 2008). Even if powerful actors invite marginalised groups to the decision-making table with a genuine openness to their input, contributions are often only considered as long as they fit within the paradigmatic restrictions of capitalist thought (Assies, 2010; Brugnach & Ingram, 2012). In this sense, indigenous groups are viewed as undifferentiated stakeholders (Jackson, 2018b) within a particular frame, rather than respected for their ability to generate alternative strategies. Gaining formal recognition also often entails arduous and expensive processes that many communities do not possess the human or financial resources to undergo (Sosa et al., 2017).

An expansion of institutional capacity is needed to meaningfully acknowledge indigenous water cultures and enable the political autonomy of marginalised groups. This will require a long-term shift away from positivist hierarchical management and anthropocentric perceptions of reality and towards the creation of normative frameworks that tolerate legal pluralism (Strang, 2018; Achterhuis et al., 2010; Boelens et al., 2010). Intercultural learning exchanges and indigenous participation in data collection, water allocation, and monitoring processes have been suggested as starting points in such a transition (Jackson & Barber, 2013). Path dependency dictates that transformative processes will be especially challenging in regions where water management systems are rooted in indigenous eradication and dispossession, since these sectors have been built to have an inherent rigidity and resistance to switch course (Garrick & Svensson, 2018; Jackson, 2018a, b).

2.2.5 Post-Capitalist Considerations

Insights from the work of Conca (2006) are invaluable when considering how to bring indigeneity to the fore. Conca fundamentally questions the legitimacy of state authority and technocratic knowledge and believes that viewing these notions as variable (rather than static and given) will open up flexibility and space for heterogeneity in problem-solving. Democratisation of the politics of water will not occur from a decision-maker having a benevolent epiphany, but from consistent, cumulative, widespread, and passionate grassroots movements forming intersectional alliances and creating alternative strategies from the bottom up (Conca, 2006; Boelens et al., 2010). Crucially, and in contrast to many developmental narratives of both the political left and right, nonstate actors will play a vital and central role in the realisation of this new landscape. This means civilians assuming authoritative roles themselves, rather than engaging in negotiations with powerful actors (Conca, 2006).

As global capitalism persists in its failure to provide a basic standard of living for millions, the inevitability of it as a paradigm is wearing thin. Contradictions increasingly generated by the prevailing economic order are giving birth to space in the political landscape for historically marginalised institutional forms (Conca, 2006). The challenge is learning how to embed these emerging forms into today's "tightly woven fabric" of institutionalised "trade liberalisation, development assistance and capital mobility" (Conca, 2006, p. 20). Whilst the scale, geographies, and cultures of most populations around the world mean that indigeneity does not provide a replicable form of water governance (Strang, 2018), the Global North nonetheless has much to gain from the knowledge, perspectives, and values that characterise the indigenous worldview.

Indigenous water management institutions can be understood as a decolonised, contextualised, participatory model. They defy the profit-seeking individualism of many corporate- and state-led models. Whilst indigenous systems have also been referred to as "water as the commons" and "ecological democracy", they often take the form of water user collectives. Such associations will comprise of several families, with individual rights and roles being derived from collective responsibility (Boelens, 2008). These groups actively contest the status quo, by resisting externally imposed, undemocratic water governance and conspiring to undermine mainstream "equalising" attempts that leave disproportionate local burdens (Boelens et al., 2012). Since collectives operate at grassroots level, they have unique capabilities and powerful impacts on social networks and norms that bureaucracies and top-down legislation struggles to reach (Boelens, 2009). Water user collectives are predicated on a set of values that will differ between localities according to culture, religion, community, and hierarchical structures, amongst others. Broadly, though, they are underpinned by a belief in shared ownership and obligation, centrality of nature to group identity and social reproduction, respect of the spiritual dimension of water, and a non-substitutability for ecosystem wellbeing (Hendricks, 2010; Bakker, 2007). Boelens et al. (2012, 2010), using the analysis outlined earlier by Fraser (1995), highlight that these alternative models creatively blend class struggles of economic redistribution with identity struggles of cultural recognition and representation.

We must move past the dominant ontologically dualist worldview and make way for relational perspectives and the materialisation of a pluriverse – a world where multiple ways of being can flourish (Escobar, 2011). In allowing alternative water management systems to exist, through genuine cultural and political recognition, costly formalisation processes will be avoided (Hendricks, 2010). Care should be taken to ensure notions of empathetic objectivity remain central when dealing with intra-community (gender, class, ability, sexual orientation, etc.) power imbalances (Wilder & Ingram, 2018; Roth et al., 2015). Grassroots organisations inspired by alternative ideologies should make arrangements to coordinate actions either regionally or globally (Getches, 2010). The Internet will be vital for these movements to form coalitions and share best practice, potentially representing a new, inexpensive organisational tool to replace existing cumbersome bureaucratic institutions (Conca, 2006; Tarrow, 2012).

2.3 Access to Water in the Face of Climate Change

2.3.1 Impacts of Climate Change

Despite a widespread analytical disassociation of these issues, climate change *is* water change. Competition for water is growing, with actors employing increasingly contentious tactics to shield water supplies (Öjendal & Rudd, 2018; Lynch, 2012). Shifting temporal and spatial distribution of water is causing many regions to experience heightened and extended periods of scarcity. Mehta (2014) has created a framework that categorises water scarcity into four components – physical, economic, adaptive, and socio-political – highlighting, in accordance with Garrick and Svensson (2018), the interconnectedness of institutional aspects with geographical volumetric changes. It is widely accepted that the planet is experiencing extreme weather events at increasing rates, threatening and displacing thousands of communities, creating a generation of climate refugees, increasing the risk of waterborne disease, and positing additional pressures on existing water infrastructures (Hess et al., 2008). Scandalous levels of chemicals, plastic, and sewage choke our rivers and oceans, substantially compromising the quality of resources that remain available. The pursuit for "green" energy has led to water-intensive quests for alternatives (Weinthal et al., 2018; Gilron, 2014; Siddiqi & Anadon, 2011). These difficult conditions are accompanied by unprecedented population growth and urbanisation in recent decades (Buurman & Babovic, 2016).

Ironically and tragically, indigenous communities who have played little-to-no part in industrialisation are often impacted the most. They feel the wrath of climate change on far deeper levels, by virtue of emotional connections with the natural world and cultural ties to ancestral territories (Green & Raygorodetsky, 2010; Alexander et al., 2011). The impact of climate change on indigeneity has been articulated by Whyte (2017) as an "intensified colonialism". The era of primitive accumulation laid the contours for modern-day industrial activity, the primary cause of widespread ecological deterioration, in many regions now beyond the point of rejuvenation. For centuries, indigenous communities have been subject to externally induced environmental changes, including pollution, deforestation, and alteration of soils, that have served commercial capitalist expansion to the detriment of indigenous systems and culture (ibid). Wildcat (2009) concurs with the position offered by Whyte (2017), describing indigenous displacement from climate change as a déjà vu, referring to previous waves of colonially induced territorial dispossession.

As aforementioned, indigenous peoples are affected by climate change on multiple levels. Ecological changes, such as flora and fauna species decline, are poignantly felt by communities; an indigenous participant in a study by Petheram et al. (2010) expressed that "mother nature is now weeping", whilst another explained "we can sense something . . . there is a strange roaring in the water . . . spirits are visiting people in dreams more often". Forced relocation due to changes in ecological conditions has deeply troubling implications for the integrity and survival of each community's unique culture and intricate knowledge, which typically centres around the specific ecosystem of their ancestral land (Alexander et al., 2011). Indigenous scholar Whyte (2017) powerfully describes the current state of the natural world "post-apocalyptic" from an indigenous viewpoint, pronouncing that if ancestral generations were to hear about the obstacles native communities are faced with today, they would think it was a farcical dystopian tale.

2.3.2 Prevailing Climate Approaches: Mitigation and Adaptation

The dominant approach to solve climatic change-induced water crises grounds itself in narratives of conservation and efficiency, upheld by interconnected scientific and political ideologies. Under the guidance of IOs, the majority of governments in the Global South have adopted large-scale projects that aim to advance efficiency through water allocation mechanisms (e.g. World Bank, 2016b; IFC, 2019). Other widely promoted solutions to climate-water threats by actors with institutional power include establishing disaster planning initiatives such as early warning systems, developing metering and rationing processes, encouraging complementarity in water use, and utilisation of unconventional or wastewater resources (IFC, 2019; World Bank, 2016a; Sowers et al., 2011; De Graaf et al., 2009).

In many regions, actually existing and politically constructed scarcity is used to justify external intervention and market approaches. Narratives of scarcity and environmental degradation are sometimes co-opted and used as political tools, portraying water markets as inescapable and legitimising action against "perpetrators" (Mdee, 2017; Wisner et al., 2012). Many have commented on synergies between scarcity/conservation rhetoric and neoliberal governance models (Bakker, 2018; Argyrou & Hummels, 2019; Grafton et al., 2013). This inevitability is implied by the World Bank (2016a) who state that providing a resource for free is destructive, whilst gains from a market approach would be "immediate". Redirecting water from lower- to higher-value uses is a basic premise of this analysis, since economic theory indicates that high prices will inspire water-saving techniques (Ingram et al., 2008; Garrick & Svensson, 2018; Grafton et al., 2013). Underlying assumptions of supply and demand models that uphold such claims (such as the existence of willing and all-knowing participants on either side of the transaction) go unexamined.

In line with the earlier discussion regarding the neutralisation of Western scientific approaches, dominant solutions to climate-water problems are founded upon technical expertise that carry significant political and social implications. Reid et al. (2014) and Petheram et al. (2010) demonstrate that insights from biological and physical sciences prevail in climate adaptation strategies, striving for concrete predictions and technological solutions. Experts who operate in this realm tend to conceptualise climate issues within a specific frame, predetermining a range of problems and solutions (Buurman & Babovic, 2016; Lemos & Kirchhoff, 2018; Dewulf et al., 2005). This circumscribes many climate conversations in the water sector to narrow parameters that only recognise other viewpoints through a Western lens whilst passively accepting the political status quo. These processes fail to contextualise climate impacts or recognise the institutional backdrop against which they occur (Tennekes et al., 2014; Reid et al., 2014). Such oversight leads to a dissociation between expert knowledge and on-the-ground water management, since many insights are unable to be effectively adopted or implemented. This is linked to the isomorphic mimicry debate touched upon in Sect. 2.2.2 of this chapter but has a further dimension in that it perpetuates structural imbalances. Although technical advice can improve decision-making quality, this is to the detriment of inequalities of power and access to information (Lemos & Kirchhoff, 2018). Whilst it is theorised by some that peer-reviewed science is favoured because of the extreme public scrutiny climate strategies are subjected to (Alexander et al., 2011), Harrison and Mdee (2017) argue instead that such reoccurring inclinations have colonial roots.

Neoliberal solutions to climate-water crises largely fail to benefit indigenous communities, having been evidenced to exacerbate social, political, and economic vulnerabilities of marginalised populations. Scientifically delineated need to implement efficiency mechanisms through allocation and monitoring systems inevitably entails creating a culturally insensitive hierarchy of water users, establishing a set of accepted social norms and privileging some needs over others (Sowers et al., 2011; Miller et al., 1997). It is unsurprising that indigenous claims to water for spiritual and cultural rituals are omitted from such models, whilst large-scale commercial redirection is repeatedly consistently prioritised. This can result in a perpetuation of the rural-urban divide and contribute to local and regional conflict (Öjendal & Rudd, 2018; Lynch, 2012; Bakker, 2018). Orthodox responses to climate change give little room to indigenous groups to contribute to the formulation of adaptation strategies (Petheram et al., 2010). This one-dimensional approach means that climate initiatives focus on a foreseeable, generic set of issues, aiming to resolve a narrowly defined conception of ecological harm (Conca, 2006). Climate strategies required to tackle the currently deplorable state of the natural world transcend the technical realm that contemporary thought predominantly operates within (Öjendal & Rudd, 2018). A paradigmatic shift must be enabled – solutions that promote change without critical examination of currently prevailing international ideals of mass consumerism and incessant capital accumulation will necessarily fall short of what is needed to save our planets' delicate ecology.

2.3.3 Alternative Climate Approaches

Traditional ecological knowledge, a component of indigenous knowledge, refers to native communities' cumulative, evolving, and intricate knowledge of the local ecosystem upon which their culture has its foundations (Kihila, 2018; Berkes, 2012). Information is passed through generations via word of mouth, and ecological insights are embedded within stories, song, and other cultural practices (Whyte, 2017; Ajani et al., 2013; Alexander et al., 2011; Nyong et al., 2007). In addition to ancestral transmission, knowledge can too be received directly from the spiritual realm through dreams or communications with the natural world (Williams & Hardison, 2013). To these communities, adaptation in the face of harsh and changing ecological conditions is not a new phenomenon. Aboriginal Australian heritage can be traced back 50,000 years (Green et al., 2010). Severe climatic variations, not dissimilar to contemporary concerns of drought and irregular precipitation, have been recorded in the African Sahel since the mid-1600s (Nyong et al., 2007). For millennia, rural populations have developed coping mechanisms and techniques necessary for their survival, withstanding conditions marked by extremity that has exceeded predictions of modern climate change models (Johnston, 2012; Kihila, 2018; Stigter et al., 2005; Nyong et al., 2007).

The knowledge held in indigenous communities is currently underappreciated and underutilised in climate bureaucracies. The mammoth task of adapting to climatic fluctuations should be harnessed to revive cultural practices and traditional remedies which have been discarded as backward since colonial times. Whilst some contend that indigenous knowledge should be incorporated into mainstream approaches to allow for equity and fairness (Sakona & Denton, 2001), the reasons that powerful actors should pay attention to alternative insights extend far beyond this. Approximately 80% of the globe's surviving regions of ecological diversity lay within indigenous territories (UN, 2020), where local people are the primary knowledge bearers of site-specific intricacies dating back centuries (Green &

Raygorodetsky, 2010). Current efforts overlook the ability of native groups to meaningfully contribute to plans surrounding best-practice resource management in the face of uncertainty and extremity (Sosa et al., 2017).

Indigenous climate knowledge and adaptation mechanisms are highly varied and context-specific; particular local examples have been identified in numerous academic studies. Crop diversification and adoption of agro-ecology and agroforestry in farming practices are recurring themes (Kihila, 2018; Rosset & Altieri, 2017; Ajani et al., 2013; Nyong et al., 2007). This is often combined with switching to shade- or drought-tolerant produce, harvesting water within trees, shifting planting patterns to avoid extreme dry weather, or switching to livestock with fewer nutrition requirements (Ajani et al., 2013; Kihila, 2018; Petheram et al., 2010; Nyong et al., 2007). Other interesting place-based climate and weather indicators used by local people include the observation of specific plant and animal behaviours, such as leaves shedding of particular tree species, early flowering or fruit production, premature ripening, date of bird migration, date of reproduction season for certain animals, levels of intrusion by ants or termites, and a particular sound produced by male goats (Nkomwa et al., 2014; Green et al., 2010). Occasionally, indigenous groups and farmers considered either temporary or permanent relocation/migration and livelihood diversification (Ishaya and Abaje, 2008; Petheram et al., 2010; Kihila, 2018; Ajani et al., 2013).

There are, however, some limitations of indigenous knowledge that demonstrate the need to carefully evaluate it against intended climate outcomes, to avoid succumbing to simplified and romanticised notions of indigeneity. This is in keeping with Kihila (2018) and Ajani et al. (2013), who point out the need to scrutinise indigenous practices and knowledge in the same way an academic might examine the aptness of a new technology. Limitations of traditional ecological knowledge include existence of climate change misconceptions within communities, de-contextualisation rendering knowledge irrelevant, elders not recalling weather events that did not impact them specifically, and the epistemologies of collective knowledge and rights to this information that mean it is not easily transferable into a Western system (Nkomwa et al., 2014; Green et al., 2010; Petheram et al., 2010).

2.3.4 Knowledge Sharing

Absorption of indigenous insight into international climate approaches will require long-term processes of cross-sectoral knowledge sharing and formulation of indigenous-Western alliances. Sharing knowledge between these systems can assist in the creation of culturally appropriate climate adaptation plans, since grassroots indigenous actors can advise on realistic, implementable, and affordable strategies that are in line with local values that will be easily disseminated and employed throughout their particular community (Egeru, 2012; Subrahmanyeswari & Chander, 2013; Reid et al., 2014; Green et al., 2010; Ajani et al., 2013; Nyong et al., 2007; Kihila, 2018; Petheram et al., 2010; Pelling et al., 2008). Combining indigenous knowledge with contemporary Western insights also has the potential to constitute substantial modern scientific gain and complement dynamic indigenous cultural processes. Traditional ecological insights can inform baseline measurements for regions with less recorded data or to track historical trends and weather patterns (Alexander et al., 2011; Thornton & Scheer, 2012; Green et al., 2010; Green & Raygorodetsky, 2010; Williams & Hardison, 2013). Other scientific gains, including identification of new adaptation tactics and prioritisation of climate mitigation impacts, have also been noted (Kihila, 2018; Williams & Hardison, 2013).

In an extensive literature review, Lemos et al. (2012) summarise a disparity between what climate scientists portray as necessary and what is actually achievable on the ground. Issues that constitute this "fit gap" include tailoring information to local need; integrating external knowledge with local values, practice, and institutions; and a disassociation between knowledge producers and knowledge users (ibid). It is suggested here that these shortcomings could be remedied through respectful, organised collaboration with indigenous communities. Crucially, though, indigenous groups should not be expected to voluntarily hand over knowledge accumulated over hundreds of generations whilst accepting the unequal power structures underpinning such a transaction. Decision-making processes should be re-examined, with indigenous groups steering co-governance arrangements: a setup found to result in better prospects for societal benefit (Hill et al., 2012), assumedly due to the former actively pushing institutional boundaries by rejecting the status quo.

To integrate indigenous systems into mainstream policy contexts, avenues by which to generate accommodating and fair knowledge sharing spaces must be considered. The most cited element for creating productive indigenous-Northern coalitions is that relationships must be long-term, in order to build trust, closeness, and mutual understanding (Campbell and Christie, 2009; Kirchhoff, 2013; Lemos & Morehouse, 2005; McNie, 2013; Engle, 2010; Pagano et al., 2001; Rayner et al., 2005). Successful knowledge sharing channels included forums, alliances, and resource centres – all of which give space for indigenous independence and autonomy, innovatively utilising traditional insight without subjecting it to suffocating bureaucratic requirements (Nkomwa et al., 2014; Petheram et al., 2010). Countries where indigenous knowledge has been already begun to be integrated into climate strategies include Fiji, Tanzania, Australia, Malawi, Kenya, India, Peru, Colombia, and Canada (Painemilla et al., 2010; Nkomwa et al., 2014). Green and Raygorodetsky (2010) advocate for establishing "intergenerational programmes" to formalise indigenous ancestral knowledge. Whilst their intention to preserve traditional ecological knowledge is commendable, there are several logistical and philosophical barriers to creating such a scheme, some of which will be discussed below.

When speculating how indigenous groups might share knowledge to assist in the revival of natural systems, there is a tendency to overlook the depth of connection that these communities have with this knowledge. Groups are being asked to contribute to solving profoundly emotional issues, of which few indigenous peoples have contributed to or felt much benefit from (Williams & Hardison, 2013).

Collaboration or knowledge sharing without acknowledgement of the wider political setting will not guarantee to improve the wellbeing of local communities – these efforts must necessarily be paired with changes in the institutional structure to be more inclusive of alternative ways of being (Hill et al., 2012; Alexander et al., 2011; Williams & Hardison, 2013). Historically, collaborations between indigenous groups and the Western world have been marked by extreme power asymmetries. Smith (1998) explains that this is no different in the realm of research – cynicism is rife in many indigenous communities, who have come to feel over-researched and concerned that researchers will exploit information they hand to them (Green et al., 2010; Whyte, 2017). The difficulty of sharing knowledge between different epistemologies and cultures should also not be underestimated. Indigenous knowledge is often embedded within a set of traditions, customs, and relationships that define who may use particular knowledge, under what circumstances, and through which rituals or processes (Thom & Bain, 2004). This poses substantial challenges when it comes to being translated into an entirely alien legal system, predicated on fundamentally different values, and subject to intellectual property rights and the like.

2.3.5 Political Constraints

A fundamental limitation of the current global political-economic context is that it grants priority to certain actors and ways of thinking and being. Water scarcity in the face of climate change is not a mere availability issue, but a far deeper political dilemma regarding power and representation (Lynch, 2012). Path dependency has stark relevance with regard to global, national, and local climate adaptation and mitigation strategies. Structures are built to withstand and resist change or external interference. So, when posed with alternative climate strategies that question some of the central principles of the existing system, powerful entities in the neoliberal sphere are likely to reject such information and label it as illegitimate, simply because it is unrecognisable to the political and economic framework that they operate within.

There is a need to break down political boundaries and develop institutional capacities to give space to alternative approaches in tackling the burdens posed by climate change that are set to worsen in the near future. Discursive political pledges will no longer suffice. We must move towards more radical discussions surrounding the legitimacy of prevailing bureaucracies and begin to map the formulation of fundamentally different societal relationships and hierarchies (Uittenbroek et al., 2014; Tennekes et al., 2014). Decision-makers must be pushed beyond their comfort zone and have their authority questioned (Conca, 2006; Tennekes et al., 2014). The once-hailed durability and rigidity of water management treaties can now be understood as a major impediment to effective climate action (Öjendal & Rudd, 2018). Flexibility and allowing for uncertainty and complexity will be essential in the construction of a political framework that can aptly deal with the reality of climate change (de Graaf et al., 2009; Buurman & Babovic, 2016; Quay, 2010; Lemos &

Kirchhoff, 2018; Pagano et al., 2001; Snover et al., 2003; Tang & Dessai, 2012). Several authors have contributed ideas on how flexibility can be incorporated into decision-making, including methodologies such as scenario planning, adaptation pathways approach, anticipation analysis, additional monitoring and action measures, multi-layer decision analysis, and safety margin strategies (Buurman & Babovic, 2016; Swart et al., 2004; Harvey et al., 2012; Hallegatte, 2009; Quay, 2010). Unprecedented and unforeseeable climate challenges, described as "unknown unknowns" (Buurman & Babovic, 2016), point to abandonment of the current institutional fixation on appearing as "all-knowing", a characteristic derived from the inherent assumptions of the dominant economic model.

2.4 Conclusion

This chapter has shown how the capitalist global paradigm has invisiblised and delegitimised the political demands of indigenous groups. Indigenous recognition and inclusion is often shallow and tokenistic, reinforcing indigenous subordination through their subjection to external processes and asymmetric power hierarchies. The colonially inherited political economy within which the water sector functions limits the water rights and autonomy of indigenous groups. Current efforts by dominant institutional actors in the WASH sector, including constitutional recognition, scientific objectification, and human rights-equality narratives, bolster the domination and suppression of cultural distinctiveness. The development sector at large must move from counter-neoliberal remedies to post-neoliberal transformations in order to authentically manifest positive change for indigenous and other marginalised rural communities. This will entail acknowledging the inherent politicisation of current water decisions by water professionals and politicians at decision-making levels.

The destruction created by capitalist logic is fuelling an emerging social force metamorphosing insurgency and fury into a political revolution (Esteva & Escobar, 2017). Meaningful democratisation of the politics of water will be generated through cumulative, bottom-up grassroots movements, supporting, and learning from one another to strengthen and proliferate alternative water governance systems. These alternative systems, based on collective participation, ecological harmony, and spiritual enhancement, will not be subject to bureaucratic interference or evaluated against a set of irrelevant and external modernist criteria.

As climate change carries us towards an era in which our very existence is threatened and questionable, we cannot allow its magnitude to be strategically harnessed to further neoliberal agendas of efficiency, homogenisation, and technical objectivity. We must use the climate crisis to answer passionate calls by indigenous communities and activists, who have longed for abandonment of anthropocentrism, individualism, and commercialism towards an ecologically balanced way of being. Indigenous systems of social reproduction must no longer be seen as an anachronous utopia, but as a sustainable and viable paradigmatic alternative. Learning from indigeneity will be an essential part of undergoing the necessary post-capitalist societal transition. In making this transition, we must be aware of the intricate emotional involvement that indigenous groups have with the tragedy of widespread natural degradation. Knowledge sharing between indigenous and currently dominant capitalist institutions to formulate climate strategies must be paired with efforts to transform the hierarchy of the institutional structure.

If the political underpinnings of water decisions are not owned and addressed by those operating in this realm and continue to be presented as objective and unquestionable, the marginalisation of indigenous perspectives will persist. It is these very groups who have lived in tune with the Earth for millennia and who live amongst and protect the vast majority of the planet's remaining biodiversity. The reprehensible poverty and inequality in accessing water, the central resource dictating survival and social and spiritual expression, is not a problem that relates only to "them" but one that burdens us all. It is therefore the duty of those with influence and resource in the WASH sector to begin listening to indigenous voices.

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Part I
Religious, Cultural and Spiritual Values of Water

Chapter 3
Water Symbolism in Hindu Culture

Piyali Mitra

Abstract Metaphorically and metaphysically, the Hindu ancient mythologies refer to water as the container of life, strength, and eternity. The cult of water is described in the Vedic literature and followed on vividly in the Puranic literature. Water is one of the five elements of nature. The "wash away sins" quality of water is associated with the power of sanctity and cosmological connotation so much so that the rivers are revered as remover of pollution. Rivers in India are personified as female and are perceived to be nurturing and quenching and when angered cause flooding. As people face the challenge of sustaining the world's water today and for the future, this chapter focuses on how culture and religion would endeavor to play an increasingly recognized ethical and practical role.

Keywords Water symbolism · Hinduism · Cultural value · Mythology · River Ganga · India

3.1 Introduction

The Vedic philosophy which is considered the primordial basis of Hindu culture and thought identifies that water and human body in the Hindu social system are not mere physical realities. Water has been described in the Hindu mythology as the foundation of the whole world, the ground for life, and the elixir of immortality (Satapatha Brahmana SBr., 4.8.2.2; 3.6.1.7; and 4.4.3, 15). The Atharva Veda (2.3.6) holds that the waters bring us well-being. Metaphorically and metaphysically, the water in the ancient Hindu mythologies is regarded as the substratum of life, strength, and eternity.

Water is conceived as a purifying medium. The water is perceived as the "living water" in the Hindu texts. To attain the source and receive the merit of "living water" concerns a chain of consecrations, rituals, and religious activities like pilgrimage and

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sacred baths. In the Vedic literature, the cult of water is signified and followed on vividly in the Puranic literature.

The "wash away sins" quality of water is bound up with the power of sanctity and cosmological connotation in mythologies. Eliade (1959, p. 131) describes "Everything that is form manifests itself above the waters, by detaching itself from the waters." The running water in general and the running water of river Ganges in particular, and sacred ponds, too, are signified as bestowers of sanctity and miracles. Accordingly, a common series of interrelationship between waterbodies and human society is maintained by the varieties of performances and rituals. The psychic attachment associated with a place and maintenance of cultural traditions reflects a realization of the divine manifestation at the place.

The three more generally identifiable factors for popularity and acceptance of sacred places are unique natural landscape, unique body of water, and an association with some great sage.

3.2 Water as in the Indian Philosophy

The philosophical visions of the various Hindu schools depict the earth, the universe, and the nature in many exalted ways. Nature is considered as profane for some schools of thought; the Prakriti is divine immanence and has potential power. The philosophical images of Prakriti are often awe-inspiring. These links have been explored in a quest for indigenous paths to resolving the environmental crisis. Quite connectedly, the five elements of nature—earth, water, fire, ether/space, and air—are sacrosanct. Rivers are particularly revered.

The Vaiśeṣika school of philosophy is one of the significant among the other schools of thought in the Indian philosophy. The Vaiśeṣika school of thought, as propounded by Kanada, holds water as one of the important elements of nature and body. Vaiśeṣika admits the reality of the external world of matter, space, time, and ether. The composite products, the reality (*avayavin*), are not mere conglomerations of their component parts (*avayava*), but unique wholes with an existence over and above that of their parts. Water is eternal and non-eternal. The atoms of water are eternal, whereas the composite watery substances are non-eternal. The products of water are bodies, sense organs, and objects. The denizens of Varuṇaloka possess watery bodies, which are not due to copulation. They comprised of parts of earth which are subordinated to water. They are capable of producing pleasure and pain. The gustatory organ is comprised of water. It perceives taste. Rivers, oceans, hail, and the many as such are watery objects.

In the Hindu texts, there is a close correlation between dharma (righteousness, duty, justice, or that which sustains) and the ravaging of Earth. When dharma declines, human beings despoil nature. There is, however, no Hindu text focusing on dharma that puts to words to us to be passive and accept the end of the world with a life-negating philosophy. Many Hindu texts are firm in their perspective about how human beings must endeavor to enhance the quality of life. A popular blessing uttered in many Hindu temples and homes focuses on human happiness in this life, on this earth: Sarve Bhavantu Sukhinah Sarve Santu Nirãmaya—"May everyone be happy/May everyone be free of diseases!/May everyone see what is favorable/May no one suffer from misery!"

3.3 Water as a Profane Element in the Indian Scripture

Water is considered as an essential part of nature that has a major role in the sustenance and propagation of life. As per the Indian mythology, Indra is referred to as the God of rain, and he was defeated by the legendary King of Lanka. The epic Ramayana holds that, "Indrajit, the son of Ravana, had the ability to camouflage and hide within the clouds and could fight with his foes while remaining hidden within the clouds, and so he was called as Indrajit."

One of the most important facts to be noted is that the sources of water in India are considered to be sacred and holy and imbued with the presence of a deity. People living in the villages near the course of river Ganges take utmost care to save it from all sorts of pollution and disgrace because to them it is not just a river, but a heavenly entity associated with lord Shiva and his wife Parvati. It is believed that the mother Ganges flows from the curled hair locks of lord Shiva.

Similarly, Yamuna River originates from the Yamunotri glacier which is again considered to be a sacred place. In the places where rivers fail to reach human habitation, people rely on wells which depend upon the supply from the water table located below the surface of the earth. The water from the wells is used for drinking as well as irrigation purposes.

In Hindu mythology, all the rivers are revered generally as remover of pollution; however, the Ganga is embodying the most prominent and purifying power. No river in the world's history has achieved such fame as the sacred river Ganga. From about the third century, river Ganga has played one of the vital roles in various ceremonies and worship, in rituals of birth and initiation, of purification and religious merit, and of marriage and death. The Ganga is even referred to as Mother Ganga (Ganga Mai) bringing life in the form of sacred water. The Ganga water is a sacred fluid, an essential element for all the Hindu rites and rituals.

3.4 River Ganga as One of the Significant Waterbodies in Hindu Culture and Rituals

The river Ganga is often described as the river flowing in heaven, on earth, and in the netherworlds (*Tripathaga*). That is how the river Ganga is a "liquid axis mundi, a pathway connecting all spheres of reality, a presence at which or in which one may cross over to another sphere of the cosmos, ascend to heavenly worlds, or transcend human limitations" (Kinsley, 1987, p. 193). Paraphrasing one of Carl Jung's statements, one could propose an ethics for the Ganga River and Hinduism: "People of India would never find true peace until they could come into harmonious relationship with and deep feelings of reverence to the Ganga River who is the cradle and identity of India's culture and civilization since time immemorial" (Singh, 1993, 301).

By bathing in the great rivers of India, one is said to be morally cleansed of sins and to acquire merit or auspiciousness. A story popular in oral tradition makes the point: a king goes to sleep on the banks of the river Ganga. When he wakes up in the middle of the night, he sees some women covered in filth taking a dip in the holy river. They emerge from the river cleansed and then disappear. The king returns on several nights and sees the same thing. Eventually he asks them who they are; they reply that they are the embodiments of the rivers of India. Every day, they tell him human beings bathe in the rivers and their sins are absolved by that act. The rivers—embodied as women—absorb the moral dirt and then come to the Ganga, the grand purifier, to purify themselves (Narayanan, 2001, p. 192). Moral dirt or sin, known as *papa* in Sanskrit, is perceptible as physical dirt in the bodies of the river. The story, therefore, makes a direct connection between morality and physical pollution. In addition to moral purity and physical purity, one may also note that in other Hindu contexts, there is a third kind of purity: ritual purity.

It is believed that bathing in rivers and other waterbodies ritually purifies the pilgrims and their clothes. Ritual purity concerns physical purity, but it is to be noted that which is physically clean is not ritually pure. Also, even if a person is clean both physically and ritually, his mere association with people and garb considered ritually impure or unclean may in that case be contagious enough to pollute the so-referred clean person. Given the pollution of India's rivers, the traditional story about the river Ganga and the need of other rivers to purify themselves in its waters is particularly poignant. Rapid industrialization has produced dangerous levels of toxic waste in many of India's rivers. However, it is to be noted that the mythology of Hindu tradition and the sacred topography of the land of India flow inseparably together. River Ganges is referred to as both the Goddess and the river.

Pandit Jawaharlal Nehru, the first Prime Minister of the Republic of India, in his book *Discovery of India* (Nehru, 1946) mentioned:

> The Ganga, especially, is the river of India, beloved of her people, round which are intertwined her memories, her hopes and fears, her songs of triumph, her victories and her defeats. She has been a symbol of India's age-long culture and civilization, ever changing, ever flowing, and yet ever the same Ganga.
>
> The Ganga to me is the symbol of India's memorable past which has been flowing into the present and continues to flow towards the ocean of the future.

In fact, the respect for river Ganga is a part of Indian identity and the very symbol of Indian culture. Nothing else would qualify as a better symbol of the "Heritage of India" than the river Ganga. It is also a well-known belief that dying at the banks of Ganga is in a way a path to reach the heavenly abodes. And out of this belief, Hindus perform cremation along the banks of river Ganga, or the cremation ashes of the deceased are flown, or they were made to float in the river. The *Ganga Ghats* (banks) of Varanasi and Hardwar are the most popular funeral sites of the Hindus. The water itself is the divinity; it is accessible and is believed to contain the all-encompassing divine qualities.

Gangajal or Ganga water is one of the important ingredients in Vedic rituals. *Gangajal* is held so sacred and holy that no Hindu ever dares to dishonor it and is obliged to speak truth if he holds the water. Many Hindus keep water from the river Ganga in glass bottles as a sacred relic or for use in religious ceremonies. In *Narada Purana*, it is declared that in the present *Yuga* (era) of *Kali*, river Ganga is of utmost importance, and worship of river Ganga is a sure path to salvation. For Hindus, the water flowing in Ganga "*Gangajal*" is not meant for mere drinking, domestic use, irrigation, or fisheries and, hence, does not require to meet any criteria or standards set by WHO or MoEF (Agarwal, 2008). Ganga water has often been observed to remain fresh for long periods of time, and her unique, natural characteristics have made her a fascinating subject of study for many scientific inquiries. The putrefaction-resisting, selectively bactericidal qualities and the capacity for speedy self-purification are perceived to be some unique qualities of Ganga water. These qualities are not merely believed to be factual but have been personally experienced by most Indians and can be easily verified, quantified, and compared in analytical laboratories. Unfortunately, very little scientific research has been carried out to test and verify the widely believed pollution-removing and self-cleansing powers of *Gangajal*, probably due to apprehensions that any findings supporting such beliefs shall go against "Modernity," while a negation might rock the foundational beliefs of the masses.

3.5 Purity and Pollution in the Hindu Symbol of Water

There are other strands in Hindu religious traditions that have helped contribute to the current ecological crisis. One is the Hindu conviction that rivers like Ganga are so inherently pure that nothing can pollute them. While the great water mythologies and cosmologies of Hinduism are often portrayed in the literature, most of the holiest rivers are severely polluted, raising the poignant question why and how is it possible and ritually accepted to pollute holy water?

In case of the Ganga, revered as the supreme holy water, it is possible that not only the corpses that get rot are immersed in the river in Varanasi (apart from the cremated remains which are more or less burnt) but also sewage is thrown into the rivers, and other wastes are disposed in the water. In short, depending upon the water cosmology, it is possible to pollute the most holy. This seeming paradox can be understood by the ways in which holy water is believed to work.

And then there is the focus on "individuality" in some of the Hindu traditions. Anil Agarwal (Agarwal, 2008) noted: "Hinduism's primary focus lies on the self, one's immediate family, and one's caste niche, to the neglect of the larger society and community… Whereas the private sphere is carefully scripted in Hindu tradition, public life in India borders on and often descends into chaos… A Hindu may go down to the Ganges River to purify himself or herself. The next moment, the same person will flush the toilet and discharge effluent into the very same sacred river. . ." While this remains true more in some Hindu communities than others, the emphasis on the "self" must be noted, at least in some traditions.

In understanding the social system, in practice and in daily interaction, it is to a large extent not only about the individual's ritual purity in body and mind but also how pollution and impurities are transferred through water, food, and bodily substances. The body can be seen as a "vessel" where pollution of the flesh or bodily substances influences the spiritual purity and vice versa. "The code for conduct of living persons is not regarded as transcendent over bodily substances, but as immanent within it," and as such "Bodily substances and code for conduct are thus thought to be not fixed but malleable, and to be not separated but mutually immanent features: the coded substance moves and changes as one thing throughout the life of each person and group. Actions enjoined by these embodied codes are thought of as transforming the substances in which they are embodied" (Marriott & Inden, 1977, p. 228).

As Marriot & Inden said, persons are therefore "unique composites of diverse subtle and gross substances derived ultimately from one source; and they are also divisible into separate particles that may be shared or exchanged with others" (Marriott & Inden, 1977, p. 232). The flesh of the body is hence a bio-moral substance that encompasses morality and materiality, and sin becomes manifested in the flesh (Parry, 1994, p. 127). Hence, the human may transfer impurity by their very existence onto another human. Impure bodies of water may transfer impurity and sin from one person to another. Water, as Bachelard pointed out in another context, "can be cursed. . .evil can be put in active form. . . what is evil in one aspect, in one of its characteristics, becomes evil as the whole. Evil is no longer a quality but a substance" (Bachelard, 1994, p. 139). Thus, water may cause opposite effects, both ritual purity and pollution and impurity.

From the devotee's perspective, the essence is that spiritual impurity is transferred from the individual being to the external body of water. This would be a holy process as it is beyond the mere human capacity and necessitates a divine agency. Furthermore, water transports impurities away. The physical qualities of water have the function of dissolving impurities and transporting dirt away. In religion, physical and spiritual impurities are perceived in similar ways as both types of pollution can be transferred to water. However, the religious role of holy water does not stop by only transferring and transporting pollution. As humans are sinful, according to religious logic, sin and pollution would accumulate and increase as an external substance flowing further downstream (which is of course what happens with physical contamination of rivers, including many of the holy Hindu rivers). The last and most important quality of holy water is that it transforms pollution into purity. This is, in essence, the reason why holy water works. Given the ontological and superior status of gods as pure and eternal, they will remain forever, despite humans transferring their impurities onto them. In a discussion of the holy, water occupies a special place. Holy waters and rivers will always remain holy and pure despite physical and spiritual pollution. It is precisely because they are holy and they have the capacity to transform impurity to purity.

It is to be noted that the British physician Dr. C. E. Nelson observed and recorded that even samples taken from the dirtiest sections of Ganga remained fresh during the long boat journey back to England. The East India Company also preferred using *Gangajal* for the 3-month journey back to England in the company's early days, as they found that the water stayed "sweet and fresh" (Gurudev, 2008). E. Hanbury Hankin in the French journal *Annales de l'Institut Pasteur* in 1896 mentioned that the bacterium which causes the deadly cholera disease could be killed within 3 h of being treated with water from Ganga. Hankin also suggested that the water of this river and its tributary Yamuna were responsible for containing the spread of cholera in the region in those days. This unique factor present in *Gangajal* is now known to be a bacteriophage (Gurudev, 2008). In a landmark judgment, the Uttarakhand High Court on 19 March accorded the status of "living human entities" to the rivers Ganga and Yamuna, two of India's most sacred rivers (PTI, 20 March 2017).

3.6 Conclusion

This chapter provides a detailed encounter about the spiritual and ritualistic value of water with a special discussion on river Ganges which is considered sacred from the Hinduism point of view. One of the most important characteristics to be mentioned is that holy water transmits purity and holiness, but it also transfers, transports, and transforms impurities. While holy water as sacramentals in solely profane spheres apart from religious contexts is atypical, it gives testimonies to the beliefs of the works of holy water. In most cases, however, holy water is believed to work precisely because it is ritualized and a part of ritualization processes. Water is omnipresent, omnipotent, generative, and life-giving, and these powers come from water itself. From a religious perspective, this directs attention to the holy and holiness in the making as these life-giving qualities are not only about what separates mortal humans from immortality in eternity, but they are also in essence divine qualities and gifts to humanity. Holy water is often the most profound and precious object and divine process people experience and partake in, and therefore, it has also shaped significant perceptions of what holiness means and implies for humans.

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Chapter 4
Ways of Water Management in Islam: Potential Insights for Future Water Governance

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Abstract Water is recognized as a universal right and a crucial component of the people's life and a country's security and sustainability. The Holy Qur'an and Hadith instill in their followers' values of social justice and equity, which extends to the practice of conserving the earth's natural resources, most notably water management. According to Islam, water is a communal resource and a human right. This article discusses water availability and use, ethics, and overall management from an Islamic perspective. This chapter examines water's legal, political, and social implications in Islamic law (sharia) for water management. The issues discussed include the law and political complexities associated with water, the basics of sharia and water, the significance of practice in that relationship, the development and practice of water codes and their relationship to sharia, the reforms in the modern era, the dominance of Western law and its significances, the continual consequence

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of sharia to water, and the ecological conservation. This article also explains the ethics of water management in terms of stewardship, conservation, water pricing, and privatization in the light of sharia (Islamic law based on the Holy Qur'an and Hadith). It puts the potential insights forward to solve the current challenges of water management for which a considerable number of people suffer worldwide and enhance future water governance.

Keywords Water management · Religious views · Islamic sharia · Environmental conservation · Water ethics

4.1 Introduction

Water is seen as a human right and a vital component of a country's survival and security. Ensuring water security is a complex challenge with interconnected effects and repercussions on human rights, economic growth, ecosystems, food, and energy security. By 2025, about 67% of the global population might be living in water-stressed countries. Due to the intricacy of the global water problem, the idea of water security was developed. The word encompasses hazards, human and environmental demands, disputes, competitiveness, and physical availability. This complicated interrelationship creates a societal issue, which needs several parties' collaboration to address (Daoud et al., 2022).

Humans may use and exploit natural resources following Islamic beliefs, but they should not alter nature in a way that irreparably destroys the environment (Absar, 2013). According to the Islamic faith, Allah owns the biosphere and entrusts humanity with passing it on relatively undamaged to future generations. This adheres to the principles of sustainable development and intergenerational justice. People should share in the abundance and scarcity of all resources, given that those are limited, and the people are fully accountable to Allah (God) for their activities on earth as inheritors. Muslims maintain unique cleanliness routines that distinguish them from other civilizations. Following Islamic custom, all Muslims rinse with water after urinating or defecating, and toilet paper is used only for drying (Burke, 2009). This demonstrates the significance of water and the necessity of having access to clean water in restrooms. There are particular sanitary fittings connected to the plumbing that feeds water to the toilet (Absar & Syeda Mariya Absar, 2013). The need to wash before each of the five daily prayers and after using the toilet increases all Muslims' per capita water demand and consumption (Al-Alawi, 2019). According to data on water resources from the Pacific Institute, around 75% of Muslims can easily access fresh drinking water, and 60% of the population has access to sanitation (Gleick et al., 2009).

People face a variety of environmental, economic, and political difficulties in accessing water worldwide, and it is bound together by religious and ethical principles that may serve as the foundation for water management policy (Ghafran & Yasmin, 2020). Globally, there is a greater awareness of people's traditions and expertise influencing resource management and policy, but the potential significance of religion as a basis for policymaking is undervalued. A water management program based on Islamic precepts has a higher chance of being an effective solution for humanity.

In Islam, two key sharia ideas apply to water rights: "shafa," or the right of thirst, which provides the most basic need of humans and animals to satisfy their thirst (Loodin & Wolf, 2022), and "shirb," or the right to irrigate fields (Shroder, 2016). According to these two main ideas, priorities are given to human and household usage, followed by animals, agriculture, industry, and recreational activities (*shafa* and *shirb*) (Saatsaz, 2020). Due to geographic, social, ethical, and cultural variations, many Islamic nations interpret these two core sharia concepts (*shafa* and *shirb*) differently. After a community's drinking and domestic needs are addressed, *shirb*—the right of irrigation—takes precedence (Loodin & Wolf, 2022).

Upstream users have priority over downstream users in Islamic water management since the river flow reaches upstream users first (Odeh Rashed Al-Jayyousi, 2021). If new communities are built upstream after the downstream societies have been founded, downstream consumers are given priority with water usage, followed by the newly established upstream communities (Scotto, 2021). Furthermore, even if the requirements of the communities are supplied and met, storing extra water is strictly banned in Islam. However, surplus water is divided among users in Islamic communities based on mutual agreement or customary norms and regulations (Abdelzaher et al., 2019). Despite the distinctions between the Shiite and Sunni schools of law, the utilization of *shafa* and *shirb* principles in Islamic countries is comparable. Regardless of how *shafa* and *shirb* are implemented in Muslim-majority countries, Islam instructs its adherents to coexist peacefully and in harmony with one another and the environment. According to Islamic water management philosophies, *Allah* (God) entrusted the natural environment to humanity (Abderrahman, 2000a). As a result, humanity is responsible for maintaining the environment.

Many studies have been focused on water management (Bereskie et al., 2017; Lefers et al., 2015), Islamic water management (Abderrahman, 2000a; Amery, 2001; Loodin & Wolf, 2022), water conservation (Majeri Mangunjaya & Elizabeth McKay, 2012; McKay et al., 2014; Lefers et al., 2015), ethics (Abedi-sarvestani & Shahvali, 2008), and environmental sustainability (Joseph, 2015; Islam & Repella, 2015; Saatsaz, 2020). Some studies focus on ethical issues in water management in various religions and ethical issues in business. But how Islam promotes ethical water management and future water governance is still missing. Therefore, this chapter attempts to explore the potential of Islamic knowledge for ensuring ethical water management and future water governance.

4.2 Methodology

A qualitative approach has been applied in this study due to its nature. Data and information have been collected from the major databases like Web of Science, Scopus, Springer Link, ScienceDirect, and Google Scholar. An analytical method has been used to extract relevant information from collected documents. The useful information has been extracted in the light of Islamic sharia (the Holy Qur'an and Hadith). The arguments of Islamic scholars have been used to interpret the obtained findings. A theoretical framework has been developed through the Holy Qur'an and Hadith knowledge. Besides, *Tawhid* and *Fitra* have been considered as the basis of explaining water management in Islam.

The main objective of this study, ways of water management in Islam, has been assessed through explaining stewardship, conservation, water pricing, and privatization. Besides, water governance has been described based on the legal, political, and social aspects in the light of Islamic sharia.

4.3 Theoretical Framework

According to Islamic beliefs, water belongs to God, who has committed it to humanity for use and transfer without causing it serious harm. The Islamic doctrine of water management is founded on two fundamental concepts: *Tawhid* and *Fitra* (Saatsaz, 2020). While Tawhid requires humans to use natural resources (such as water) responsibly and sustainably, Fitra encourages basin- and inter-basin-level cooperation. The Holy Qur'an and authentic Hadith are also sources of the instruction of the Almighty God (Majeri Mangunjaya & Elizabeth McKay, 2012). Therefore, these two sources have been undertaken as a source of interpretation of water management and governance in Islam (Loodin & Wolf, 2022).

4.3.1 Tawhid

Tawhid is the first pillar among the five pillars of Islam. According to Tawhid, it means Muslims should submit themselves and their activities to God, the single creator of the cosmos (Amery, 2001). Ibn Taymiyyah, a notable Islamic jurist in the thirteenth century, enhanced the work of early Tawhid scholars by adding his own interpretation that broadened the area of Tawhid from a purely theological term to encompass socio-ethical whole-life problems (Al Karaimeh, 2019). *Wahdat al-wujud* (the oneness of all creatures) is often referred to it as the one truth, the one essence, or the one reality. Humans are obligated to regard each other as equals in light of this oneness and the sovereignty of the one Lord to whom Muslims bow. Equal opportunity and cooperation are also implied. Because they are incapable of generating these resources, which belong to the "Creator of Everything," people should partake in both the abundance and scarcity of all resources (Jamalinezhad et al., 2012). People are accountable to God for their acts on the world since they are inheritors, trustees of the earth, and not sovereign of Him. There is a basic oneness between humans and nature (Kaminski, 2019).

4.3.2 Fitra

Fitra refers to humanity's intrinsic essence or standard and the harmony that exists between people, creation, and God (Qadir & Zaman, 2019). This idea is a measure of truth in our acts and beings and the level of harmony we have with the cosmos at some point. Fitra, like Tawhid, is a unified concept that connects humans to their surroundings (Hasan, 2020). An interdisciplinary effort can best understand and manage the oneness of all species and the relationship between them and their Creator. Islam, in this perspective, makes people "responsible for maintaining and protecting the integrity of their domicile." This is in line with the concept of Tawhid, which states that there is only one ultimate and Almighty God. As a result, it is wicked for people to utilize their technical and scientific skills to undermine the Creator's power by irreparably damaging the hydrological and terrestrial ecosystems (Loodin & Wolf, 2022).

4.3.2.1 From the Holy Qur'an

In Islamic culture, water is extremely important. In reality, Islam has taught its adherents to use natural resources with equality, justice, and sustainability in mind. According to certain scholars, water is referenced more than 63 times in the Holy Qur'an (Amery, 2001). Water is considered sacred in Islam due to its life-saving nature. The Arabic word "ma'aa," which means "water," appears 60 times in the Qur'an. Furthermore, rivers, oceans, fountains, springs, rain, hail, clouds, and winds, among other things, are frequently mentioned as signs and indications of Allah's Compassion and Kindness (Catovic, 2012). The Qur'an also mentions the phrases *Nahr* (river) and *Shariba* (drinking water) 54 and 39 times. Similarly, Amery claims that several types of precipitation (rain, dew, and snow) have been mentioned over 100 times in the Bible, including the passage "And we made from water every living creature" (Qur'an, 21:30).

Water as a Basic Element

> And it is He who created the heavens and the earth in six days, and his Throne was upon water, that He might try you... *Surah Hud (Hood) 11:7*

> . . .We made from water every living thing. Will they not then believe? *Surah Al-Anbiyah (The Prophets) 21:30*

Ensuring Quality of Life

> And Allah has sent down the water from the sky and therewith gives life to the earth after its death. . . *Surah an-Nahl (The Bees) 16:65*

> Say: if your stream be some morning lost, who then can supply you with clear flowing water? Surah Al-*Mulk (The Dominion) 67:30*

Water as Purifier

Wudu (ablutions) are a religious requirement that must be carried out correctly before *Salat* (ritual prayers) in order to achieve cleanliness. The technique for conducting *wudu* is described in depth in the Qur'an.

> . . .It is He who sends down water upon you from the sky with which to purify you... *Surah Al-Anfal (The Spoils of War) 8:11*

> O you who believe! When you prepare for prayer wash your faces and your hands up to the elbows, and wipe your heads and wash your feet up to the ankles. . . *Surah Maidah (The Table Spread) 5:6*

4.3.2.2 From the Hadith

Muslims believe that the cornerstone of Islam is maintaining social justice or equality in society. Almost all Hadith, including those on water, are concerned with maintaining equality (Dieye, 2020). "None of you will have faith unless he wishes his (Muslim) brother what he desires for himself," for example. This applies to the demand for a sufficient supply of clean, fresh water and everything else. A Muslim cannot keep surplus water for himself; rather, he must share it with others. "A guy [who] owned surplus water on a path and withheld it from the travelers," the Prophet (Peace Be Upon Him (PBUH)) said, "is one of the three persons Allah would disregard on the day of resurrection."

Water is a common item to all humanity. "Humans are co-owners in three things: water, fire, and pastures (and therefore must share them)" (Muslim).

On Conservation of Water

When the Prophet saw Sa'd performing *wudu*, he said: "What is this? You are wasting water." Sa'd replied: "Can there be waste while performing ablution?" The Prophet replied: "Yes even if you perform it in a flowing river" (Musnad of Imam

Ahmed). One full palm was used for ablution by the Holy Prophet Muhammad [PBUH]. Hadith from Bukhari and Muslim say that Prophet Mohammad [PBUH] would perform ablution with one "mudd" of water, which is equivalent to around 0.544 L of water (Al Mamun et al., 2014). Based on the records of Islamic history, there are some scholars who opined a slightly higher amount, but the right quantity is less than 1 L (Zaied, 2017).

Water Distribution

According to *Sahl bin Sad*, a glass (full of milk or water) was delivered to the Prophet, who drank from it, while a youngster, the youngest of those there, sat on his right side and old men sat on his left side. The Prophet asked, "O boy, will you allow me to give it (i.e. the rest of the drink) to the old men?" The boy said, "O Allah's Apostle! I will not give preference to anyone over me to drink the rest of it from which you have drunk." "So, the Prophet gave it to him" (Bukhari).

4.4 Discussions

4.4.1 Water Management in Islam

Water is an important aspect of Islam, as seen by its inclusion in Islamic beliefs and texts. As Muslims, we must recognize water as one of the many blessings Allah (swt) has bestowed upon us. Muslims are obligated to conduct *wudu* and *ghusl* (ablution rites) using water before prayer throughout the day, utilizing the blessing of water as a source of development, nutrition, and cleansing (Kamali, 2016). We know that water will assist us in the hereafter since tales of heaven describe decorated gardens with flowing rivers, underlining its relevance to humans.

4.4.1.1 Stewardship

Water management must incorporate elements of local cultures and religions due to the cultural aspect of the environment and the changing geographical and temporal settings of water resources (Amery, 2001). Water and other hydrology-related terms appear frequently in the Holy Qur'an. The word "water" (ma') appears 63 times in the Al Mu'jam Al Mufahras (index) of the Holy Qur'an, while "rivers" appears 52 times. Other words that appear less frequently include "fountains," "springs," "rain," "hail," "clouds," and "wind." The eternal destination of believers and those who do good deeds (4:57) is frequently shown in the Holy Qur'an as having running rivers, among other desirable services and objects. A management tool that incorporates non-traditional cultural and spiritual approaches in addition to traditional (economic) water management tactics is potential to succeed in the Muslim nations (Chuvieco, 2012).

A khaleefah, or earth vicegerent or steward, is expected of a faithful Muslim. In the natural environment, humans are equal participants, but we also have extra obligations (Chuvieco, 2012). We are not the lords and masters of it. Muslims, he claims, are protectors and friends of the environment. A khaleefah should establish the boundaries and penalties of human behavior prescribed by Almighty God and prohibit indecency and despoilment. Individual rights cannot be abused in Islam because the concept of acting in "good faith" underpins Islamic law (Abdelzaher et al., 2019). All of humanity inherited in the world. Each generation only serves as a trustee. Actually, no one has a right to pollute the environment or use natural resources to leave only a polluted or severely resource-depleted planet for future generations (Abdelzaher et al., 2019). In other contexts, the term khulafa, a derivation of khaleefah, alludes to the concept that successive waves of mankind will inherit on earth (Maliva & Missimer, 2012).

People are taught to be religious, conscious of God's presence, and considerate of future generations' needs. According to Prophet Mohammad (PBUH), excellence (ihsan) is "to worship God as though you saw Him, God sees you even if you don't see Him." Muslims, according to Hamed (1993), recognize God's ongoing presence and intervention. This "directly modifies a Muslim's relationship with his surroundings" and "prevents him from transgressing," according to this perspective on excellence. In addition, one important Hadith urges a Muslim to "act in your life as if you were living forever, and perform for the Hereafter as if you were dying tomorrow." A Muslim is effectively expected to have a longer-term perspective on life, which will alter how they interact with nature (Abedi-sarvestani & Shahvali, 2008). If you could live "forever," you'd probably conserve natural resources and safeguard the environment.

Furthermore, even if previous generations "cheated" them, they should not cheat future generations. "Deliver what you have been entrusted with to the trustee, and do not betray whomever has deceived you," the Prophet stated. As a result, people who practice fassad are practically sinners. Their ecologically destructive behavior violates "God's covenant" (2:27), which required the "seed of Abraham" to diligently serve Him in exchange for "God's benefits." At another level, every creation of God figuratively enters into a similar covenant: we owe God the deepest appreciation and ready obedience for His loving care. As a result, a person who willfully "forsakes the way" and refuses God's "Grace" would suffer losses on his own.

4.4.1.2 Conservation

Two unequivocal references in the Holy Qur'an about water support water demand management (McKay et al., 2014). First, water is limited in supply; therefore, it should not be squandered. "And we pour down water from the sky in definite proportion," says the phrase, implying that because water resources cannot be infinitely replenished, demand must be handled at some point (Majeri Mangunjaya

& Elizabeth McKay, 2012). Therefore, the Holy Qur'an instructs humanity to use God's resources for sustenance in moderation, as long as they do not abuse them: "O Children of Adam!. . .Eat and drink: But waste not by excess, for God loveth not the wasters" (7:31). It is even more clear in the Hadith. The Prophet Mohammad (PBUH) used one mudd of water for ablution and one sa' to five mudds of water for bathing (a "mudd" is approximately 0.7 L and "saa" is a measurement of approximately 2.5 L). This Hadith reveals the Prophet's rational approach to sustainable water management in desert Arabia. "Do not squander water even if doing ablution on the brink of a fast-flowing (big) river," the Prophet warned, even under seemingly abundant circumstances.

Prophet (PBUH) stated in a Hadith that when a person dies, his "legacy is severed save from three things: an excellent flowing achievement (*sadaqa jareeyah*), knowledge from which others (would benefit), or a good offspring who supplicates (to God) for him/her." A graceful good deed is defined as a source of "flowing water," among other things. Many Islamic towns have public, freshwater water fountains along main streets that typically lead to popular souqs (market areas) or prominent mosques, demonstrating the physical expression of this Hadith. The shielded fountain box is usually adorned with a marble plaque and a cup suspended from a rope. On the marble plaque are frequently etched the Holy Qur'anic verse(s), the name of the deceased in whose honor the public tap was created, and a request that passersby or those drinking the water pray for that departed person.

Many Muslims interpret the Hadith above to suggest that if they want to continue earning heavenly rewards for their good actions after they die, they must ensure that future generations have access to safe drinking water (Chuvieco, 2012). This aligns with God's message to Muslims, which states that they are only heirs to the Earth and should not irreversibly harm it. "One is not regarded loyal until he wishes/desires what he loves for his fellow human being for himself," according to a Hadith recounted by Bukhari and Muslim. As a result, Muslims must share the surplus of God's blessing with others to survive and ensure that future generations will be able to fulfill their basic necessities (Amery, 2001). On another level, the Qur'an makes repeated allusions to natural resources being available for human use. "Eat of the excellent foods that We have given for your sustenance," it says, "but commit no excess ("*la tatghou*") therein, lest My anger should fall on you justly" (20:81). It's important repeating that God doesn't grant mankind blanket permission to exploit His resources; they must be used intelligently and sparingly to meet their basic requirements (Bauer et al., 2022).

A Muslim is taught to remedy environmental mistakes by refraining from practices that squander or damage water. At the same time, when there is an excess of water at the home, farm, community, or provincial level, one is obligated to share it with others. According to a Hadith recounted by Bukhari, "Allah will not talk to, nor look at," three categories of individuals on the Day of Resurrection, one of them is "a guy who withholds his extra water." "Today I will withhold My Grace from you as you withheld the surplus of what you had not created," Allah would declare. Furthermore, withholding "extraordinary water" to "prevent people from grazing their animals" was forbidden by Prophet (PBUH). Note that, in Islam, relationships between a person and social and natural surroundings are often cast in a broad meaning that encompasses all individuals, regardless of whether they are Muslims or not (Emari et al., 2017). This is crucial evidence of the natural environment's oneness and interconnection, especially the hydrological cycle.

A Muslim should inquire about the intended usage of shared waters when it comes to resource sharing. They must inquire the consequences of the allocation of water resources on the communities and ecosystems that supply them. Several religious schools of thought about sharing water must be considered (Yezli et al., 2021). Furthermore, and this is crucial to the Arab-Israel conflict, it may be difficult to understand Muslim jurists' positions on water sharing with non-Muslims, particularly if they are your enemies. Given Islamic law's larger ethical foundations, it's fair to believe that the general principle of sharing enough water to fulfill people's fundamental, life-sustaining requirements will be respected.

Conservation of water is just as vital as sharing it. A man is said to have observed Prophet Mohammad doing the obligatory pre-prayer ablution. He informed him that even though he was "placed on a rushing river," he should not use too much water (Lefers et al., 2015). Even if water is abundant and being utilized for religious purposes, it should be used cautiously.

4.4.1.3 Water Pricing

According to Islamic law and custom, humans were given precedence, followed by animal watering and last agricultural needs (Abderrahman, 2000a). Despite its initial origins as a common good, most current Islamic scholars have determined that people have the right to use, sell, and collect value-added costs of developed water infrastructure for water supply distribution. To avoid water shortages and individual control over water resources, the Prophet gave everyone the right to water. On his advice, Uthman purchased Ronna's well and converted it to *Waqf* (a collective property for public use) for the Muslim community's benefit. Az-Zubair and an Ansari man fought over a waterway in the Harra that was used to irrigate date palms.

The benefit of separating Almighty God's basic ownership of wealth from humanity's "managerial" ownership has two conditions: first, people has no right to harm themself, his properties, others, or the environment, and, second, no one can abuse wealth sources or put one's interests ahead of the public interest in their affairs (Maliva & Missimer, 2012). To improve social fairness and combat corruption, Islam supports moral self-regulation, followed by a legal system to enforce its moral code (Abderrahman, 2000b). Combating unequal distribution of wealth-generating resources is a core value in Islam, "in order that it may not (merely) make a circuit amongst the rich among you." In regulating water resources, Islamic jurisprudence strives to balance the reward of labor and the public good. "Muslims have common share in three (things): grass, water, and fire," the Prophet is reputed to have declared. Selling water was forbidden by the Prophet (PBUH) (Kavezeri-Karuaihe et al., 2003).

Tariffs are one of the demand management techniques for reducing water use (Islam et al., 2020). Water tariff designs can help households utilize water more efficiently while also ensuring income security for service providers (Naff & Dellapenna, 2002). Residential water conservation might be rewarded through pricing improvements. Water shortage is causing state and municipal governments and water agencies in several nations to take conservation measures (Al-Alawi, 2019). Alternative and conventional views and value systems can be reflected in a successful Islamically based water policy. It is suggested that in Islamic nations, a widely sustainable water resource management system is more likely to be realized if management tools include a variety of extra inputs from the religious, spiritual, and resource-based realms (Shroder, 2016). After all, stronger levels of Muslim adherence to their religion's principles have been seen. Demand management solutions that are culturally responsive involve a concerted effort to educate people about the good relationship between Islam and water conservation.

4.4.1.4 Privatization

Privatization is permitted with public and private sector participation so long as customers are treated equally and given a reasonable price for water. Specifically, most Muslim scholars classify water resources into three categories for commercial purposes: private commodities, restricted public goods, and public goods (Nabiafjadi et al., 2021).

A private good is water held in private containers, private distribution networks, and reservoirs. This includes water recovered from wells and rivers with specialized equipment or from water distribution corporations (Hefny, 2009). This water is privately owned and cannot be utilized without the owner's consent. The owner can use, trade, sell, or give the item. Even though this water is privately owned, a person in need may utilize it with permission from the owner. Similarly, purified water may be exchanged since the institution responsible for its treatment has invested money and time. This policy may apply to water from treatment facilities, privately delivered and stored water, and any water for which labor, infrastructure, and expertise have been spent.

Open water sources such as rivers, lakes, and water streams are considered restricted public utilities on private property. The owner does not own the water in the conventional sense; rather, the owner has exclusive rights and privileges over other users. Other people can use it for drinking and basic requirements, but only with the owner's consent may it be used for agricultural and industrial uses.

Water found in rivers, lakes, glaciers, aquifers, oceans, precipitation, and snow is a public benefit. Everyone has the right to utilize it (correctly) for drinking, agriculture, and industry, so long as it does not negatively impact the environment or public welfare (Helfaya et al., 2018). This water may be delivered for private use through pipelines, canals, and containers. The government should not prohibit its use unless it can demonstrate that it poses a threat to public welfare and the environment, excessive usage, or fair trade. This kind of water cannot be sold or purchased for private gain. However, if any value is added to the water, such as purification, storage, or transportation, it becomes a private product that may be sold for a profit (Jamalinezhad et al., 2012).

4.4.2 Integrated Water Resources Management (IWRM) in Islam

Islam teaches that Almighty God created the universe and mankind. And the source of water is God, the creator, yet Islam accepts reasonable and pragmatic scientific answers (Odeh Rashed Al-Jayyousi, 2021). The first verse of the Holy Qur'an is "Read," and it contains other allusions that exhort humankind to study the cosmos, nature, and God's creation. Islam says that "all is generated from water" and that global water is limited ("*bekadar*") and in equilibrium ("*mawzoon*").

At the level of water usage, Islam holds that water should be distributed for distinct purposes, with drinking water receiving priority (Fig. 4.1). Moreover, Islam acknowledges the right to the environment. The emphasis on equilibrium,

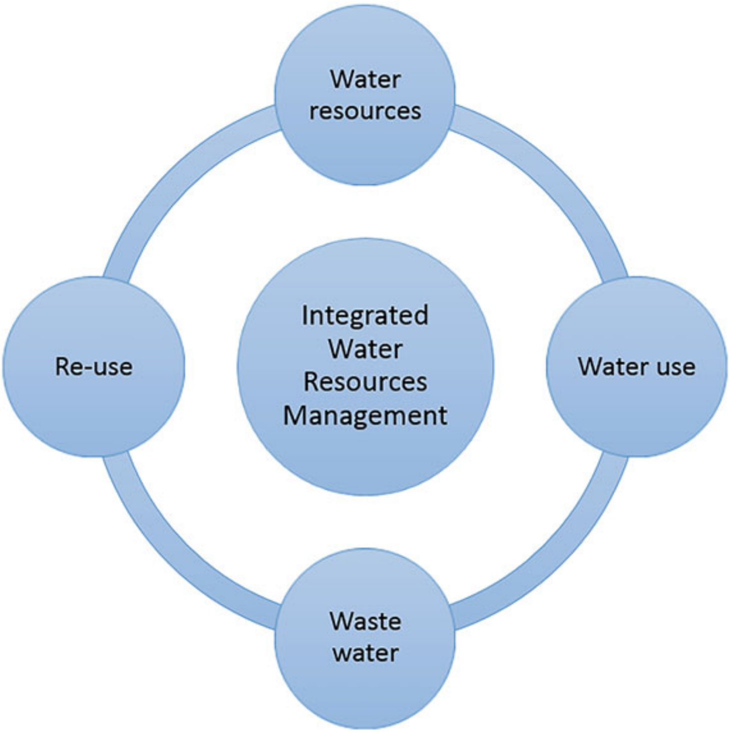

Fig. 4.1 Islamic water resources management framework. Sources: Adapted after (Odeh Rashed Al-Jayyousi, 2021)

conservation, and harmony is central to the Islamic perspective on water usage. Muslims have a unique connection with water, even though all humans require water for survival and well-being (Absar, 2013). Each prayer is followed by *wudu* or ablution, which is the ritual washing of the hands, feet, and face with water. Prayer is one of the five pillars of Islam. Prophet (PBUH) linked the five prayers to the cleaning power of water, stating "the similitude of five prayers is like an overflowing river passing by the gate of one of you in which he washes five times daily."

Islam disapproves of the inefficient use of water, even when there is no water shortage, because it does not permit waste among even nonliving creatures. It teaches how to minimize all forms of waste and maximize the use of all resources (Odeh Rashed Al-Jayyousi, 2021).

Islam transforms the concept of "waste" and enlightens the human mind to reevaluate the concept of trash by studying nature and natural processes. Human existence is compared with the biosphere and its changes. In the Holy Qur'an, it is mentioned that water is scarce. It should not be wasted.

> ...And we send water from the sky in fixed measure... *Surah Ghafir (The Forgiver) 40:13*

> O Children of Adam!...Eat and drink: But waste not by excess, for God loveth not the wasters. *Surah al-Araaf (The Heights) 7:31*

4.4.3 Water Governance in the Future

Like ozone depletion and climate change, water's future requires a worldwide approach. Future water challenges will require collaborative efforts from all nations, depending on their local science, culture, and understanding; this is called water globalization (Bereskie et al., 2017). Controlling population expansion, conserving water through water pricing, being aware of water footprints, considering measures to supplement water supplies, and using integrated management approaches are all examples of local initiatives.

To be sustainable, local initiatives must balance human water requirements and environmental health (Tortajada & Islam, 2011). Large sums of money spent on water infrastructure in the industrialized world have ensured water supply at the price of the environment, but most developing nations cannot afford such expenditures. Scholars argue poorer nations do not pursue the same route as the industrialized world (Al Karaimeh, 2019; Joy & Lu, 2004). Rather, it recommends that governments ensure a proper water management system that integrates infrastructure with "natural" solutions like protecting watersheds, wetlands, and flood plains. As a response to global water stress, development groups advocate for integrated water and watershed management, in which all users' requirements are considered, and natural elements are combined with human engineering (Helfaya et al., 2018). Instead of draining wetlands and flood plains for agriculture, the developing countries may use them for water purification and aquaculture, which is a greener, less expensive choice. The watershed should be maintained to ensure that all competing uses have enough water.

The basic principles of water management lie in the Holy Qur'an and Hadith. Most Muslim nations do not employ these principles as the foundation for their water policies (Kamali, 2016). In Islamic history, there was no precedent of creating distinct water policies for water management and distribution. Water was always considered a human right and a gift from Allah, but water shortage was considered a matter of fate and God's prerogative. With the introduction of new water management and storage technologies, largely developed in the west, the paradigm altered, allowing people to participate in water availability rather than relying exclusively on nature (Absar & Syeda Mariya Absar, 2013). As water scarcity collides with other contemporary stresses like population growth and climate change, Islamic values must be integrated into water management techniques.

4.4.3.1 Institutional Intervention

Islam acknowledges the fallibility of humanity and their susceptibility to temptation. Thus, the *hisba*, or public inspection office, was established (Ghafran & Yasmin, 2020). Throughout most of Islam's history, the *hisba* had both a religious and a secular character, but the religious part was lost about the middle of the fourteenth century. The *hisba's* ethical foundations are the Holy Qur'anic injunction to "command what is good and forbid what is evil" (3:104) and the sharia norm of "no hurt" or harm (Gümüsay, 2015). The official in charge of the *hisba* is known as the *muhtasib*, whose duties include monitoring the appropriate conduct of individuals during public activities. This covers the protection of non-human species' rights. A *muhtasib* is intended to prevent animal abuse, safeguard and administer public land reserves, and control water uses, among other responsibilities. According to Ibn Taymiyyah, the essential qualities of a muhtasib are subject-matter mastery, compassion, and patience. If the *hisba* institution is reconstituted, it might be charged with implementing fair and equitable water management procedures (Hamed, 1993).

4.4.3.2 Societal Access

Islam always supports humanity and ensures people's equal access to water resources irrespective of religion. Developing a network to achieve fairness should stimulate cooperation and exchange of water resource management information among Muslim scientists and nations. For the same reason, the cooperation and exchange of water resource management information should be fostered among scientists and countries of all faiths (Williams & Zinkin, 2010). Unsustainable population expansion and its repercussions have become a growing concern that law and legal institutions must consider when water shortage becomes acute and protracted. Communities and governments become unstable when ruling authorities fail to provide essential public services (Joseph, 2015). As a result, water quality, distribution, and use are frequently negatively impacted locally, nationally, and at regional levels. Technological solutions will not suffice unless proper water laws and institutions accompany them (Hefny, 2009). While the law cannot resolve water conflicts, it is an important component in establishing and sustaining an orderly and peaceful resolution.

4.4.3.3 Meeting Water Demand

Islam ensures the effective use of water so that people worldwide can meet their demands. Water conservation incentives, as well as punishments for misusing it, should be recognized. Wastewater must be treated and reused correctly (Abderrahman, 2000b). Water resource management should be established properly, which should be integrated. Muslim nations must agree on the missions of various international Islamic bodies, give them the authority to adjudicate disputes over water usage rights between Muslim governments, and follow their rulings. All parties should follow fair and reasonable judgments by relevant international institutions in conflicts between Muslim and non-Muslim governments.

4.5 Conclusion

In the Islamic religion, water is not only a necessary component of existence; it is also seen as a divine gift that must be loved and protected. Protecting the water supply has been emphasized several times in the Holy Quran's verses, as it is limited and can be taken away. According to the Holy Qur'anic verses, water is the source of life for all living beings, and it also plays an important part in the growth of food crops and cattle. As a component of the environmental system, Islam places a premium on water. It is a divine blessing that supports life. Water is referenced 63 times in the Holy Qur'an. The Hadith discusses the assurance of justice, equality, and access to water supplies for all. This article examines the availability and usage of water, ethics, and general management from an Islamic standpoint. A cultural approach is very necessary for actualizing water usage and management principles. Soft elements such as human nature and social learning require more attention for transformation in the water sector of countries and regions. As a result, water ethics is a vital tool for these societies' long-term water resource management. It is feasible to organize and coordinate UNESCO's efforts to promote water ethics as a noble goal through networking. There is no conflict between Islamic beliefs about water and internationally acknowledged integrated water resource management (IWRM) principles, which balance social equity, or fairness, economic efficiency, and environmental sustainability across society. Muslims can be encouraged to conserve water by being reminded of their highest example, the Prophet (PBUH). The teaching of Holy Qur'an and Hadith is helpful for all irrespective of religion in managing effective water governance, and sustainability.

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Chapter 5
Water and Shintoism: Exploring the Link between Spirituality and Water Values in Japan

Hsin-Hua Chiang, Mrittika Basu, and Yuki Sano

Abstract Amidst all the scientific and technological interventions regarding water use and conservation, pollution, and recycling, the spiritual and cultural value of water is often overlooked. Whereas local people can relate to specific water sources and uses more through local legends and narratives than through technical jargons, ignoring these values creates a gap between planning and implementation. Shintoism is an indigenous animistic and shamanistic religion from Japan that believes in the tripartite relationship between *Kami* (or deity), human beings, and nature. The present chapter explores how water is valued in Shintoism and attempts to identify how this valuation translates into practical conservation practices. The study investigates the spiritual aspects of water and waterbodies, including *temizuya* or ablution rituals, holy/sacred water, and *yutate-kagura*. It is found that these aspects are embedded deep into the culture of Japanese society and imbibes the value of water among Japanese population. Realizing the value of water leads to mindful use and conservation. Shintoism and its deep-rooted philosophy of valuing nature and its components inculcate nature mindfulness among its followers.

Keywords Shintoism · Spiritual value · Kifune Shrine · Water ablution · Japan

5.1 Introduction

The importance of different services generated by water is long recognized. Being the most important natural resource, actions and policies provide the highest priority to availability of safe and sufficient water for everyone to use, for agricultural practices and for industrial needs. Cultural services of water ecosystems have started gaining attention in addition to the provisioning, supporting, and regulatory services.

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However, the transformation of cultural ecosystem services to conservation and sustainable water use is not yet clear. Moreover, values like aesthetic and spiritual values of water are well-recognized with identification of various sacred water sources across the countries. Water management across Global South still highly relies on technical and scientific interventions. Though the beliefs of sacred landscapes and holy water are reported from Global South, detailed information of why the water is considered holy, how local people value them, or how being sacred contributes to sustainable water use is not clear. In addition, how different spiritual beliefs represent water is yet to be explored and understood. These values are often intertwined with indigenous knowledge and practices, and the knowledge generated is passed across generations.

"Shinto" is an indigenous religious belief, primarily practiced in Japan, adopted to distinguish indigenous Japanese beliefs from Buddhism. Buddhism came to Japan, around the beginning of the sixth century, and went through a transformation from a human-centered religion to a nature-centered one (Umehara, 1990; Umehara & Yasuda, 1993). Buddhism has dominated Japanese spiritual life for a long time, and in the process of acceptance in Japan, it has accepted some indigenous Shinto characteristics including worshiping indigenous deities (deities of the heaven and earth) and ancestors (Takatori, 1993). Shintoism has been prevailing in Japan throughout history. It has been adopted twice as the state religion: first, between the seventh and eighth centuries and, second, between the nineteenth and twentieth centuries (Underwood, 2008). Unlike many organized religions, Shinto has "no founder, doctrine, or sacred texts," and Shinto rituals often provide a way of maintaining relationships with ancestors and a connection with their cultural heritage. Two ancient chronicles, *Kojiki* (Records of Ancient Matters) and *Nihon Shoki* (The Chronicles of Japan), are the guiding books of Shintoism and include myths, ancient legends, oral traditions, genealogies, etc.

One of the main concerns of Shintoism is the management of spiritual impurities through ritual purification (*Harae*). Impurities are presumed to accumulate as a product of living in this world and through contact with different sources, such as death or disease, and committing inappropriate acts. Various rituals are practiced by the Shinto priests to purify themselves regularly as spiritual impurities tend to offend the *Kami* (God) and are capable of threatening social order and people's well-being (Lee et al., 2018). Shintoism is characterized by two distinct properties: existence of multiple *Kami* and the significance of woods/forest. Shintoism is referred to as "incurably polytheistic and is able to create new *Kami* from time to time" due to its distinct property of multiple *Kami* (Underwood, 2008, p. 18). As Jean Herbert states:

> According to the Holy Scriptures, after some preliminary stages, when Creation came to the stage of solid matter, a pair of Kami, Izanagi and Izanami, procreated all the existing Universe, including both what we see and what we cannot perceive. Everything and everybody being Kami-born therefore has a Kami-nature and is a potential full-fledged Kami, which may come to be acknowledged as such. (Herbert, 1967, p. 21)

The second most significant characteristic of Shintoism is the meaning of woods and forests. Woods, forests, and mountains are considered as the ultimate sign of strength and abundance of life because water and Sun provide the life base for trees that make up the woods, forests, and ultimately mountains (Sonoda, 2000). Most Japanese woods are found in the mountains, where there are *Satoyama* (里山, forests that people have used for a living) and *Okuyama* (奥山, deep in the mountains where people do not enter). The first type, *Satoyama*, is inseparable from local life as the low-rising hills were incorporated within the ecological system of local life (Kawai, 1995). *Okuyama*, on the other hand, is thought to be a place where ancestors' spirits and deities reside and is not considered as a place for enjoyment or frivolous activities. In Shinto shrines, forests function as objects of nature worship. In the first nation-wide phytosociological study of shrine/temple forests in Japan in the 1970s (Ryokuchikenkyuukai, 1974), the Shinto shrine/temple forests were reported to include many rare plant communities, remnants of the regional endemic vegetation, and large, heritage trees. For example, of the 55,983 large, heritage trees listed by the Japanese Ministry of the Environment, 58% were in shrines and temples. Hence, conservation of forests and woods has been an integral part of Shintoism which in turns lead to conservation of natural forests as well as plantations around Shinto shrines/temples.

Considering the above, the present chapter aims to understand how water is valued in Shintoism and explores the role of Shintoism, if any, in imbibing the value of water which in turn leads to conservation and proper usage of water by Japanese society. The findings of this chapter will significantly contribute to the existing knowledge on how water is valued spiritually and culturally which transforms into water conservation activities. The study has been mainly carried out through the careful reviewing of a number of existing literatures on Shintoism in general and how water is valued and represented in Shintoism.

5.2 Shintoism and Water: General Overview

5.2.1 Origins of Water Worship: Birth of the Water God, Ancient Legends, and Folk Tales

The origins of water worship can be traced back to traditional understandings of the nature. People rely their livelihoods on natural resources, and worshiping is a way to present their gratitude (Yazawa, 1989; Shintobunkakai, 2006). For instance, rain is considered as water from the heaven where the gods are living in (Shintobunkakai, 2006). Other than providing the fundamental resource, ancient legends show that the Japanese archipelago is created by two central deities in Shintoism, *Izanagi* and *Izanami*, when they stirred the sea (Komatsu, 1999). As the source that incubates everything, water worship is also reflected in the belief of purification. The purifying power of water in Shintoism is highlighted by "*Misogi* (禊)" and "*Harae* (祓)."

Fig. 5.1 Kifune Shrine in Kyoto that enshrines the god of water, *Takaokami-no-kami* (Photographed by Mrittika Basu)

"*Misogi*" is connected to the inflow of water that brings freshness and vigor to people, while "*Harae*" utilizes the outflow of water that washes off the guilts or unfortunes and refreshes one's life (Komatsu, 1999). The ritual of "*Misogi*" removes defilement, and the rituals of "*Harae*" compensate one's guilts and then wash them away in the water (Komatsu, 1999; Shintobunkakai, 2006). Another example of applying water for purification is the belief of holy water. Holy waters can be from hot springs that are often used for healing, the "freshest water" (*Wakamizu* in Japanese) taken from the water source in the beginning of New Year, or the waters that have connections with Buddhist saints or other folk religions (Ogawa, 2013; Komatsu, 1999; Tsubaki, 2003; Ikesue, 2020).

In "*Nihon Shoki* (The Chronicles of Japan)," one of the oldest books of classical history of Japan, the god of rain is described as a rain dragon (Komatsu, 1999). In local folk stories, the water god is portrayed as a giant snake that can bring disasters, which also reflects as a metaphor of flowing rivers (Hojo, 2008; Komatsu, 1999). Water and fire exist in an antagonistic relationship; fire is believed to quench water and water to quench the fire. This relationship is reflected in the supernatural beings known as dragons and *Kappa*, which are primordial manifestations of water spirituality. Water spirits make people happy or unhappy by bringing them water. The "*shachihoko*" (mythical fish-shaped spear) on the castle's keep was also intended to ward off fire.

The Kifune Shrine in Kyoto (Fig. 5.1) enshrines *Takaokami-no-kami* who is believed to be the child of *Izanagi-no-mikoto* who rules over water. As mentioned in *Kojiki*:

> Through the combined power of Izanagi-no-mikoto and Izanami-no-mikoto, many Kami (gods) came into being in this land. When Izanami-no-mikoto lastly birthed the god of fire her body was immolated and her life lost. Seeing this, Izanagi-no-mikoto complained, "my beloved wife was sacrificed for this one, single child..." Izanagi-no-mikoto wept, overcome with grief. Before long, hatred began to fester. Izanagi drew the sword Totsuka-no-Tsurugi hanging from his hip and slew the fire god. The blood dripping from the blade, guard, tip,

> and handle spawned many different gods. (Omitted) the blood that gathered in the handle and flowed and dripped from between his fingers poured and became a god. The name of the god was Kuraokami.

Nihon Shoki also reports that:

> Izanagi-no-mikoto drew his sword and slew the god of fire, Kagutsuchi, cutting him into three pieces. One piece became the god of thunder. One piece became Oyamatsumi. And one piece became Takaokami. (Volume 1 Chapter 7)

Hence, *Takaokami-no-kami*, the god of water, is presumed to be born out of the god of fire and presides of the supply of water to maintain vitality and well-being of all living beings.

An ancient legend on the establishment of Kifune Shrine (Fig. 5.1) stated that the *Kami* descended from heaven into the *Kagami-iwa* (mirror rock) up Mt. Kibune on the day of ox, in the month of ox, and in the year of ox. In a different legend, approximately 1600 years ago, *Tamayori-hime*, the mother of the first Emperor Jimmu, declared that she controls the rain and the winds to make the land prosper and the soil fertile. She commanded to build small shrines wherever her boat stops. She rode her boat from current Osaka harbor up the Yodogawa, Kamogawa, and Kibunegawa rivers, finally reaching the source of water, the location of the current rear shrine. *Tamayori-hime* found the sacred fountain with pure water in the current location of the shrine, thus resulting in the built of Kifune Shrine.

5.3 Role of Shintoism in Water Use and Conservation

5.3.1 Water for Purification

The water for purification is broadly utilized in Japanese everyday life. When entering a Shinto shrine, people are requested to wash their hands and gargle at the *temizuya* or *Chōzuya* (the hand-washing place) (Fig. 5.2). In a mythic narrative, *Izanami* gave birth to the *Kami* of fire and died due to the burn. To save her, *Izanagi* decided to follow *Izanami* to *Yomi* (the underworld), but he discovered her in a horrific state of decay, and she attempted to catch him and keep him there with her. *Izanagi* fled, narrowly escaping the confines of the underworld, and he wanted to cleanse his body from its pollutions. *Izanagi* then entered the ocean to purify himself from the contaminants of his contact with the underworld. And, as he bathed, his pollutions were stripped from him, one after the other. Hence, at the entrance of every Shinto shrine, purification ritual must be done in *temizuya* by washing the hands and mouth with water. The *temizuya* is usually a type of stone trough or basin, with a guardian figurine representative of the site, for example, a dragon or an ox, and bamboo ladles with long handles that rest on the edge of the basin (Fig. 5.2). The process is to take one of the ladles in the right hand, dip it into the water, and then pour the water over the left hand. This is repeated to then cleanse the right hand.

Fig. 5.2 *Temizuya* in Kifune Shrine (Photographed by Mrittika Basu)

Finally, one pours a new ladle of water into the left hand and brings it to the mouth to rinse (the water is expelled afterward).

Besides washing off one's dirt, Shinto rituals also use water to wash away the unwelcomed guilts, unfortune, or impure things. On the first morning of the Japanese New Year, people go to a nearby water source to get the "*Wakamizu*" (the freshest water). The water is used for preparing New Year foods, and people believe that the spiritual power of water contributes to rejuvenation and refreshment of life (Komatsu, 1999). In Kyoto, burial at Kamo River was once popular in the former centuries. Burying one's body in the river was believed to purify the guilts, and in Buddhism, sacrificing for other (here refers to the living creatures that eat the body) was also considered as a respectful practice (Ikesue, 2020).

Kiyomizu-dera temple of Kyoto has another water feature other than temizuya—the *Otowa-no-taki* (sound of feathers) waterfall. It is considered to have wish-granting properties attributed to its sacred water. There are three fountains whose waters are supposed to grant health, longevity, and wisdom. The legend is that water from all the three fountains cannot be drunk together as they are supposed to bring bad luck three times over.

5.3.2 *Water in Agricultural Civilization*

The god of water is essential in Japanese life and culture, which has been centered on rice farming since ancient times and is closely related to water (Hojo, 2008). Water deities are enshrined beside the water for rice cultivation. The primary character of the belief in the water god is to wish for the contribution to the blessings of water and the elimination of fear (Isogawa & Torigoe, 2005). The worship of water, which moistens the region, inevitably led to a close relationship with the development of

Fig. 5.3 Seimei Shrine in Kyoto and the Shrine's well (Photographed by Mrittika Basu)

arable land and domination of the surrounding area by the powerful local families who hosted the shrine. In the Heian period (794–1185), shrines were used to pray for rain, rainfall, and annual crops. For instance, the Kifune Shrine was committed to a water god for flood control, rain control, and stopping the rain, as well as an agricultural god for a good harvest. Rituals of water deities, such as prayers for rain, have been actively practiced. At Kifune Shrine, black horses were dedicated to praying for rain and white horses to pray for sunshine (the origin of ema) (Sato, 2001; Furutani et al., 2022).

Lake Kasumigaura, the second largest lake in Japan, has a religious symbol of the shore, *Suijin*, a sort of guardian deity of water (Naoe, 1969). It is said that there are more than 200 stone shrines of water deities. The functions of the belief in the god of water are classified into (1) blessings of water for daily life, (2) blessings for agriculture, (3) blessings for a fishery, (4) blessings for water transportation, (5) fear of water hazards, and (6) fear of flood damage (Isogawa & Torigoe, 2005). Many shrines dedicated to water deities still exist in the middle and lower reaches of the Kiso River (Gifu, Aichi, and Mie Prefectures). However, as flood control becomes more widespread, many new inhabitants have become apathetic to these customs, and ceremonies have become a simple formality (Murakami, 2020). In Hyogo, Okayama, Tottori, Kyoto, Shiga, Fukui, and Ishikawa Prefectures, the deity of water, called "*Kawa-shimo*," "*Kawa-suso*," and "*Kawa-so*" (related to *Seoritsuhimenomikoto*, a water goddess), and its purification rituals were confirmed in the river basins (Funayama et al., 2018; Funayama & Murakami, 2016). Rituals associated with wells have been performed as wells and springs were places that brought essential water. There are many examples of wells regarded as sacred in the *Kojiki*, *Nihon Shoki*, *Fudoki*, and other ancient records of Japan (Shintobunkakai, 2006). Seimei Shrine in Kyoto, is dedicated to *Abe-no-Seimei*, a diviner active in the mid-Heian period. Emperor Ichijo built the shrine in 1007 to appease the spirit of the *Abe-no-Seimei*. The water from the shrine's well (Fig. 5.3) is said to aid in healing any kind of ailment. Also, *Sen-no-Rikyu*, the famous exponent of tea ceremony, is believed to use this well water for his practice. The water from the well falls in different direction every year, thus showing the lucky direction for that year. In Kagoshima, Serikaku Stream serves as the center of the community (Nagasako, 2017). Water transport operators and fishermen prayed to the deity of water to help them resolve their fears of water hazards, as well as to contribute to the blessings of their livelihoods (Isogawa & Torigoe, 2005; Yanagi, 2015; Jinnai, 2015).

5.3.3 Water and Sake

Rituals called "*yutate-kagura*" have been handed down throughout Japan. The Shimotsuki Festival in Nagano Prefecture is a well-known example and designed as an important intangible folk cultural property in Japan in 1979. The people of these areas found doubled spiritual and purifying power in the water heated from the spring (Komatsu, 1999). Spring water beliefs also exist in major sake brewing areas such as Nada, Fushimi, and Saijo. Sake is a sacred offering to the gods in Japanese Shintoism. Spring water deitified by sake breweries has become an object of worship for residents and often gives new local value to the water source (Sasao & Okada, 2021).

5.3.4 Water Faith

In the beliefs of giant snakes as the water god, an embankment is considered as a "snake pile" that stabs in its critical part (Komatsu, 1999). However, it is also regarded that floods are brought by people breaking the taboos or displacement of the water god – in other words, abuse of the environment (Komatsu, 1999).

The dragon and Kappa emerge as symbols of many riparian environmental conservation movements in Japan (Ito, 2019). In Shimizu City, Shizuoka Prefecture, there is Kappa folklore over the Tomoe River. Tomoe River is essential to water transportation from the castle since it flows into Suruga Bay and Shimizu port, the logistic hub to Edo, while its river was prone to flooding since it was a slow gradient and winding as a dragon. It is said that there is Kappa since the Kamakura period. In 1611, *Tokugawa* built a bridge over the Tomoe River, nicknamed "Kappa Bridge." Even today, Kappa is worshipped in shrine and temples (Nakagawa, 2006).

Near the main hall of Shimogamo Shrine are the Inoue Shrine and a pond called Mitarashi Pond. The shrine is dedicated to *Seoritsuhimenomikoto*, a goddess of purification who sends sins and filth into the sea. The shrine is also called "*I-no-ue* (on the well in Kanji)" because it is built over a well. The Mitarashi Pond was a natural pond whose primary water source was groundwater seeping from the Kamo, Takano, and Izumi Rivers through this well. However, due to river maintenance work on the Kamo and Takano Rivers, the water level has dropped, and the volume of groundwater has decreased. Currently, the shrine has started to pump groundwater.

The current study has limitations, and these can inform the direction of future studies. Firstly, the current study only used existing literature for drawing inference. Future attempts should be made to collect primary data through interdisciplinary research methods and present the results based on primary data. A more innovative approach is required to methods in future study endeavors. This may include research techniques that can capture deeper levels of meanings (e.g., in-depth interviews, observations with conversations, etc.) as well as diverse use of materials, such as films. Secondly, an insight into how Shintoism and the rituals play a role for the conservation of other natural resources and the link between different *Kami* and their interlinkage will be significant to understand the environmental philosophy of Shinto religion.

5.4 Conclusion

The chapter explores the representation and value of water in Shintoism. Shintoism is an indigenous and animistic religion, practiced in the archipelago of Japan for a long time. One of the main characteristics of Shintoism is "*Harae*," i.e., ritual purification from impurities. Water plays the most important role in the purification process as being believed to have the capacity to wash off impurities, and hence, *temizuya* are found at the entrance of every Shinto shrine. Anyone entering Shinto shrine needs to carry out few ablution rituals to purify oneself from bodily impurities. The second most important characteristic of Shintoism is the existence of multiple *Kami* or deities including the god of water, *Takaokami-no-kami*, enshrined in Kifune Shrine, Kyoto. There are ancient myths and legends regarding the creation of these *Kami* and how they function for the prosperity and well-being of people. Water is highly valuable and holy in Shintoism, and there are various ancient legends associated with human-water relationship. The beliefs can be observed in activities such as agricultural production, sake brewing, or Japanese tea ceremony. Various waterbodies like wells, springs, lakes, and rivers are considered holy and believed to have exemplary power. All the Shinto rituals and ancient legends demonstrate the significance of water in everyday life of Japanese people. Many Japanese people do not consider themselves to be "religious." But they do interact with objects and participate in rituals within the religious and sacred contexts of shrines and temples. In instances where people are visiting a temple or shrine for sightseeing, they too are exposed to symbolic meaning, and knowledge can still be gained throughout a visit, even if they do not "practice" it. For example, signs are present to instruct the visitor on how to perform ritual practices, such as the use of *temizuya* or the procedure to worship. Thus, integrating these spiritual and cultural values of water into environmental management decisions increases the acceptability of the decision among local communities. Knowing these spiritual and cultural values also helps in understanding how water has been valued across the history, and across generations, and shows ways to use water sustainably for future generations.

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Chapter 6
Muslim Peoples and the Challenges of Water Security: A Socio-Anthropological Analysis

Abdel-Samad M. Ali and Chedli B. Chatti

Abstract The philosophy of Islam related to water is based on two main principles: public and collective ownership of water and its rational use. Humans can use Islam as a guide and a code of conduct when it comes to resource management. From the Islamic perspective, people are considered as trustees, with the task of ensuring that all resources, including water, are used in a reasonable, equitable, and sustainable manner. Refraining from monopolizing, wasting, or contaminating water in Islam is more than just a matter of being wise, civilized, or acting responsibly as a citizen – it is an act of devotion. This complies with all of the Dublin Statement's principles in spirit. Freshwater supplies are sensitive and crucial for all areas of existence, according to Islamic thinking. At all levels, participatory approaches to water management should be improved. Women play an important role in water conservation and awareness, and their role in water education should be reinforced through both formal and informal channels. It is necessary to conduct research on the reform of the sphere of women's position in society. Women's participation in water users associations and other NGOs must be encouraged.

Keywords Climate change · Integrated water management · Islamic culture · Water security

6.1 Introduction

Religion is the source of many value systems. Recognizing the importance of religion can help us better understand how individuals and groups make decisions, regardless of our own beliefs or attitudes toward religion in general or a specific religion (Rokeach, 1969; Roccas, 2005). Understanding Islam's real or potential role in water resource management is crucial because it is the religion of nearly one-fifth

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of the world's population and the official faith of several countries, many of which have water as a key scarce component for development.

Influenced by (a) the sounded alarm of the United Nations regarding the water crisis that the world may encounter in the foreseeable future, (b) the urgent need for effective programs to improve the efficiency of water use, and (c) the search for alternatives with authentic cultural roots, this chapter tracks the water knowledge and practices of Muslim-majority countries. Through an anthropological extrapolation accompanied by a sociological analysis of those knowledge and practices currently prevailing as well as the experiences lived by these peoples, this piece of research attempts to add to the global stock of knowledge lessons that can be employed for the efficient management of water, especially in light of climate change that the planet is witnessing.

The Muslim-majority areas suffer the most from water deprivations now and are expected to suffer more in the future than others do (Faruqui et al., 2001; Châtel, 2007; Klarsfeld et al., 2021). Many studies indicate that this problem may be attributed to environmental causes (water scarcity) or anthropogenic ones (water management practices). There is almost unanimity on the existence of a clear contradiction between Muslims' practices and behaviors related to water on one hand and the value system defined by Islamic culture on the other hand. "We produced every living creature from water," says the Qur'an (21:30). This striking verse from the Qur'an encapsulates the significance of water in Islam. Nevertheless, the way water is currently managed in Muslim societies remains in question. While a variety of social, cultural, economic, and political variables influence the practices and policies of water management, not all of which are related to religious value systems, the similarities between Islamic ideals and those presently emphasized, such as the Dublin principles, are worth mentioning. However, this chapter sheds some light on the following research objectives:

- Getting acquainted with the Islamic value system relevant to water.
- Determining the current reality of water use in Muslim-majority countries.
- Determining the gap between Islamic concept and international statements in the management of water resources.
- Presenting practical proposals to confront the expected water crisis based on authentic practices as well as a value system rooted in the Islamic culture around water.

6.2 Methodology and Conceptual Framework

Employed is the traditional narration approach through searching several databases and search engines during time series for what is documented in Arabic, English, and French. Adopted in this chapter is the theory of deep ecology by Arne Naess (1973), which argues that the solution to environmental problems, including the water problem, mainly passes through the promotion of resource-conserving values to avoid behaviors that are harmful to them (Næss, 2005).

6.3 Results and Discussions

6.3.1 Water-Centered Life in Islam: A Very Brief Reading

Summing up the importance of water in Islam is the concise statement in the Qur'an "We made every living thing from water" (The Qur'an, 21:30). The Qur'an distinguishes between two types of water when discussing one of the world's most valuable resources, freshwater and seawater, stating that "one is palatable and sweet, the other is salty and bitter" (The Qur'an, 35:12). The word "water" appears in the Qur'an over 60 times, "rivers" over 50, and "the sea" over 40, while "fountains," "springs," "rain," "hail," "clouds," and "winds" appear less frequently (Haleem & Haleem, 2010).

Humans are completely reliant on God's gift. Water-related sentences typically begin with "It is God...It is He Who. . .," reminding mankind that God, not humans, is the source of freshwater (Oestigaard, 2005). However, since the Qur'an is not a scholarly work, when it comes to the subject of "water," it doesn't present it as a separate chapter, but rather weaves it into the fabric of beliefs, practices, and advice, giving it depth and presenting it as part of God's power, grace, and direction.

6.3.2 Outlines for the Rational Use of Water in Islam

6.3.2.1 Islam's Perception of the Absence or Scarcity of Water

Water is regarded not only as a necessary and beneficial element but also as one of great significance, having far-reaching implications in the lives of individual Muslims as well as in Islamic society and civilization. When humans combine the water world of daily life into society and religion, the lack of water is often more essential than the presence of water. The Qur'an originated in a dry, desert environment (Fig. 6.1). As a result, the ecology of Islam's high religion is adapted to deserts and the lack of water.

The Qur'an teaches humanity how to use water in practical ways. Because God "created everything alive from water" and because He "brought down freshwater from the sky out of His kindness and mercy and gave it lodging in the land," this crucial resource should not be monopolized by the powerful and privileged and kept out of the hands of the poor.

In general, Muslim jurists acknowledge man's essential need for water. According to legend, the second Caliph Umar Ibn Al-Khattab forced some water owners to pay the *diya* (blood money) for a man who died of thirst after they ignored his plea for water. Aside from the prohibition on water monopolies, there is also a prohibition on excessive and inefficient water use. The Qur'an serves as a reminder to readers that water resources are finite:

Fig. 6.1 The emergence of Islam in a dry desert environment

> We sent down water from the sky in due measure and lodged it in the earth. (The Qur'an, 23: 18)

The Qur'an's references to water distribution among human beings, such as "Tell them that water is to be divided amongst them" (The Quran, 54:28), constitute the foundation for legal reasoning in Islamic law. "People are co-owners in three things: water, fire, and pasture," the Prophet declared, and "God does not look with favor upon three sorts of people." One of them is "a man who has surplus water near a trail and refuses to let a wayfarer use it." "Excessive water usage is forbidden, even if the user has the resources of a whole river at his disposal," the Prophet said in an attempt to teach his people how to use water responsibly. It is strongly recommended that such valuable resources not be wasted: "Do not squander [your wealth] wastefully: those who squander are Satan's siblings."

6.3.2.2 How Does Islam Deal with Water Pollution?

The effects of a desert environment on cognition and imagination are distinctive. The less water there is, the more reliant on reliable and clean water sources one becomes. As a result, water control in desert water worlds plays a structural role in all aspects of social life. Polluting rivers and oceans is corruption since it contradicts the Qur'an's declared tasks and objectives for them: "Corruption has appeared on land and sea as a result of people's actions" (The Quran, 30:41).

Pollution of water is prohibited. Out of His grace, God sent it down from the sky "pure," "for you," "to cleanse you with it" (The Quran, 25:47; 8:11), to give drink to animals and humans in great numbers (25:49). Thus, in Islamic law, it is forbidden to contaminate water. Pollution that harms plant, animal, or marine life throws off the balance equation and is a long way from "giving appreciation" for the gift of water. Figure 6.2 shows the garbage dumped in the Nile River in Egypt. Refraining from

Fig. 6.2 Garbage dumped in Nile River in Egypt

this kind of wasting or contaminating water in Islam is more than just a matter of being wise, civilized, or acting responsibly as a citizen – it is an act of devotion in and of itself.

6.3.2.3 Women's Roles in Islamic Water Management (IWM)

Both men and women play an important part in making the world a habitable place in an Islamic community. They serve as God's earthly representatives. Women in Islam have significant roles as water providers and consumers. Women's roles as caretakers of the living environment are thoroughly documented in Islam (Saniotis, 2012; Haq et al., 2020; Islam et al., 2022). Women were traditionally responsible for bringing water from springs and wells.

An excellent example of the role of women in Islam in water development that demonstrates how women can show leadership and take social responsibility is Ain Zubaydah. The historical Ain Zubaydah is the most important and oldest water network in Makkah Al-Mukarramah for centuries (Fig. 6.3). It has provided pilgrims, visitors, and the people of Makkah with water for more than 1200 years. The historical fact says that Ain Zubaydah was commissioned by Zubaydah, the wife of the Abbasid Caliph Harun al-Rashid. Ain Zubaydah is a canal of water that was cut in 808 AD, from Wadi Numan, east of Mecca, to Mount Arafat, to water the pilgrims, and residents, after Zubaydah touched the fatigue and effort faced by pilgrims at that time, as a result of water scarcity. The length of the channel is 26 km, and it includes two parts, the first of which is visible (under the surface of the earth) with a length of 16.35 km, and the other is visible above the surface of the earth with a length of 9.47 km.

Fig. 6.3 Ain Zubaydah: an unprecedented project to transfer and distribute water in Makkah Al-Mukarramah

6.3.3 The Demographic Composition of Muslims

Islam's adherents make up the world's second largest religious community. Islam has 1.98 billion members, or roughly 24.9% of the world's population, according to the Pew Research Center (Klarsfeld et al., 2021). In various sub-regions, including Central Asia, West Asia, North Africa, the Sahel, and the Middle East, Islam is the majority religion. The Asia Pacific region has the world's largest Muslim population, substantially outnumbering the Middle East and North Africa combined. Figure 6.4 demonstrates the distribution of Muslim population by country.

By the middle of the twenty-first century, if current demographic trends continue, Islam will have nearly caught up. Between 2010 and 2050, the global population is predicted to expand by 35% to 9.3 billion people (Fig. 6.5). Muslims, a relatively young community with high birth rates, are expected to grow by 73% within the same time span. The number of Christians is expected to grow at a similar rate (35%) as the global population. As a result, according to Pew Research forecasts, by 2050, Muslims (2.8 billion or 30% of the population) and Christians (2.9 billion or 31%) will be nearly equal in number, possibly for the first time in history.

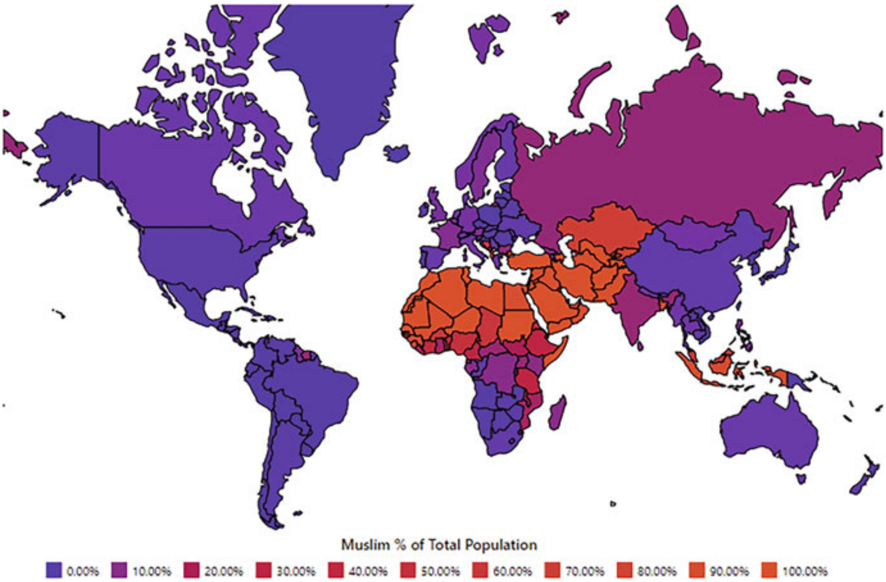

Fig. 6.4 Muslim population by country 2022. Source: Religious Composition by Country, 2010–2050 – Pew Research Center

The countries of the Middle East and North Africa (MENA) are among the poorest in the world in terms of water resources. For such countries, water security is as much about its use as it is about its availability. Especially in recent years, managing risks in these regions such as starvation, disease epidemics, migration, inequalities within and between countries, political instability, and natural calamities relies heavily on water.

Based on the abovementioned population statistics and projections, it is clear the importance of achieving sustainable management of water resources for these large numbers of people. It is important to point out the fact that the vast majority of the world's water resources are shared by two or more territories. As a result, water resource development and management have an impact across trans-boundary basins, necessitating cooperation.

6.3.4 Water Management between Islamic Concepts and Dublin Principles

The emerging international consensus on water management was outlined at the 1992 UNEP Water Conference held in Dublin, Ireland (Secretariat, 1992). Agreed upon at the conference are the following frequently referenced principles: (1) water is a social good; (2) water is an economic good; (3) water management should be

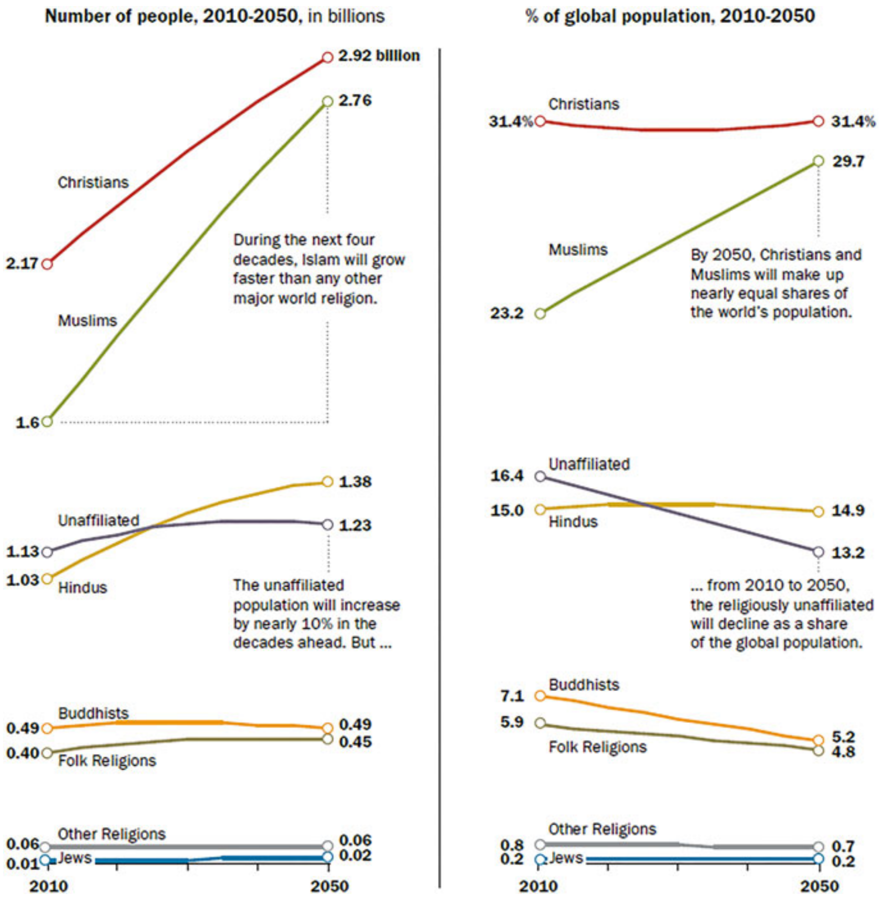

Fig. 6.5 The future of world religions: population growth projections, 2010–2050. Source: Pew Research Center

participatory and integrated; and (4) women play a central role in water management. Several practices and policies may help achieve these principles including water conservation, raising tariffs, wastewater reuse, privatization, water markets, and community-based water management. With a few caveats, policymakers generally agree that these approaches are valuable and will help improve equity. However, some Muslims have stated, both before and after the Dublin Conference, that Islam forbids the sale of water or the reuse of wastewater. Therefore, it is important to look at the Islamic viewpoint on these proposed behaviors. Table 6.1 compares Islamic water management principles to those enunciated by the Dublin Statement. It proves that a number of shared bases exist and that a mutual approach can be developed. The primary characteristics that overlap are reasonable shares, equity, public interest, consulting, and safeguarding the public interest and the ecology.

Table 6.1 A comparison between Islamic principles and the Dublin Statement in water management

A principle/ rationale	Dublin statement	Islamic concept	Consistency
Rationale	All ecosystems, food security, human health, and economic development will be at risk, unless water and land resources are managed well	Excessive and inefficient water usage is prohibited. Water supplies are finite, according to the Qur'an: "We sent down water from the sky in due measure and lodged it in the earth" (the Qur'an, 23: 18)	In line with each other
Principle 1: Water is a social good	Freshwater is a finite and vulnerable resource, essential to sustain life, development, and the environment	Many passages in the Qur'an depict the importance of water, its formation, and its vulnerability: "We made every living thing from water" (the Qur'an, 21:30) "Say: If your stream be some morning lost (in the underground earth), who then can supply you with clear-flowing water?" (the Qur'an, 67:30)	In line with each other
Principle 2: Water is an economic good	Water has an economic value in all its competing uses and should be recognized as an economic good	According to Islam, there are two types of water: public and private. Water that is available to the public, such as rivers and lakes, belongs to the entire community (Caponera & Nanni, 2019). It should not be sold, and access to it should be considered a human right. Private water, such as wells and reservoirs, or any water for which a fee is paid for its extraction, treatment, or transportation, is private property, and users must pay for the costs of running, treating, and maintaining it. Taking into account the poor and vulnerable members of society, they must be subsidized to obtain their water needs	In line with each other in terms of private water, but differ for public water

(continued)

Table 6.1 (continued)

A principle/ rationale	Dublin statement	Islamic concept	Consistency
Principle 3: Water management ought to be participatory and integrated	Water development and management should be based on a participatory approach, involving users, planners, and policymakers at all levels	Islam emphasizes the importance of group consultation and consensus in decision-making (*shura*). Believers are described in the Qur'an as "those who hearken to their Lord, and establish regular prayer; who conduct their affairs by mutual consultation" (Qur'an, 42:38)	In line with each other
Principle 4: Women play a central role in water management	Women play a central part in the provision, management, and safeguarding of water	In Islam, the responsibility for resource management is not separated by gender. Both men and women are regarded as resource stewards at Islamic water management	In line with each other

6.3.5 The Status of Water-Related Sustainable Development Goal (SDG6) in Muslim Countries

To characterize and monitor contemporary changes in water availability and management in Muslim-majority countries, Goal 6 of the post-2015 Sustainable Development Agenda was adopted as the best framework for monitoring progress in achieving the goals at the global level. This goal assumes that to ensure availability and sustainable management of water for all is pivotal to health care and human well-being (Robert et al., 2005). In addition, advancement toward the targets of SDG6 has catalytic consequences across the entire 2030 Agenda as a goal concerning the life of society and the planet.

As reported by UN-Water, 2021, the world in general is not on track to achieve SDG6. Many millions of people around the world still lack access to safe drinking water. To achieve the worldwide goal of universal access by 2030, present rates of progress must quadruple. If this is the case at the global level, the situation is worsening in many Muslim-majority countries in the SDG regions of North Africa and Western Asia, as well as Central and Southern Asia. Many Muslim-majority countries have to spend more efforts to further increase national-level capacity for SDG6 monitoring by developing technical and institutional capacity and infrastructure. However, this chapter has focused on the targets of water stress, water use efficiency, and water management among several targets of SDG6.

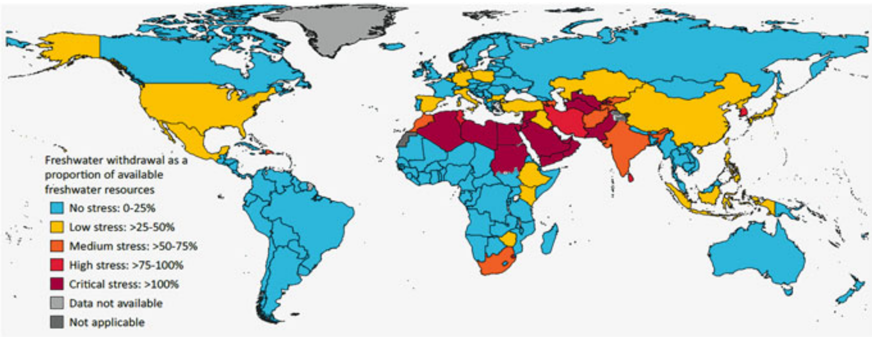

Fig. 6.6 Level of water stress by countries: freshwater withdrawal as a proportion of available freshwater resources in 2018 (%). Source: FAO IMI-SDG6 adapted from FAO (2021)

6.3.5.1 The Level of Water Stress

Data of UN-Water states that there are about 25 countries in the world in 2018 with more than 733 million people or about 9–10% of the global population suffer from water stress more (Needs & Indicator, 2021). The most majority or about 89% of those people live in high and critically water-stressed Muslim countries. These countries, however, are divided into two categories, one of which suffers from critical water stress (16 countries) and the other is experiencing high water stress (9 countries). The 16 countries all belong to the Organization of Islamic Cooperation, meaning that the vast majority of their population are Muslims. As shown in the map of freshwater withdrawal as a proportion of available freshwater resources, these countries are located in North Africa and Western Asia (Fig. 6.6). They are withdrawing all their renewable water resources (100%) and, even more, reaching more than 1000% annually in some countries (3851% in Kuwait, 1667% in the United Arab Emirates), forcing them to rely on non-renewable resources, some of which will eventually dry up as groundwater drawn from limited aquifers. For the rest nine countries with a high level of water stress, significant efforts and resources should be spent toward improving water management in these countries.

Population growth and rural-urban migrations are among the most important human factors in the countries of interest driving increased demand for water. Such factors represent a challenge to current water stress levels as they lead to a decrease in production yields and thus make livelihoods unsustainable and thus could be a driver of temporary or permanent rural-urban migration.

6.3.5.2 Water Use Efficiency

Achieving Goal 6 of the Sustainable Development Agenda requires increasing the efficiency of water use, which is measured by calculating the ratio of value added in dollars to the volume of water used. There is an urgent need to increase it efficiently

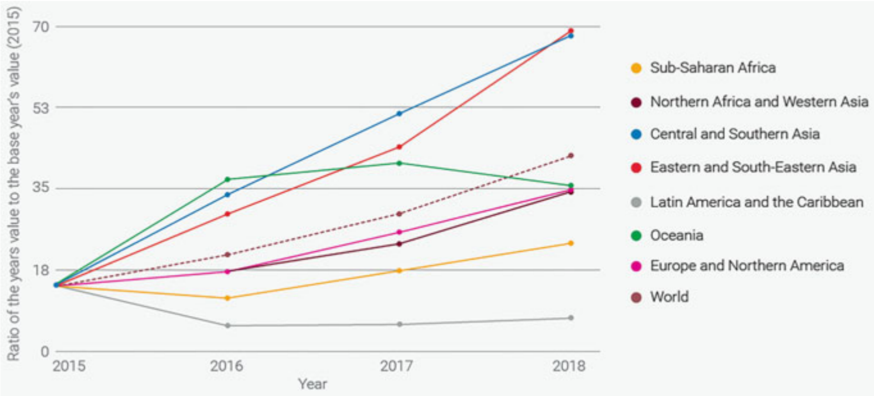

Fig. 6.7 Trend in water use efficiency in the different regions and globally during 2015–2018 for 166 countries. Source: FAO IMI-SDG6 elaboration based on FAO (2021)

in the three sectors, agriculture, industry, and services, in order to ensure sustainable withdrawals and supplies of freshwater to address water scarcity and significantly reduce the number of people suffering from water shortage. Regarding the analysis of the current situation, it is clear that there is an increase at the global level in the efficiency of water use between 2015 and 2018, as shown by the data of the 2021 report (Needs & Indicator, 2021). Although Muslim-majority countries have also increased water use efficiency during the mentioned period, this increase was less than the global average increase for North African and West Asian countries (Fig. 6.7). The most ironic fact is that with the exception of a few Gulf countries such as Kuwait and Qatar, the water use efficiency recorded in Muslim countries in 2018 is much lower than its counterpart at the global level. All of this calls for decisive actions to improve water efficiency through effective approaches, for example, by fixing leaky water distribution systems, using thirst-tolerant crops, and investing in new technology, leading to more sustainable food and industrial production systems. Agriculture, which is the most water-intensive economic sector, requires increased efforts there.

6.3.5.3 The Participation of Local Communities in Improving Water Management

Changes in water availability are frequently witnessed as a result of climate change, with rising water shortages in some areas. In addition to the impact of climate change on the availability of water, human factors come to play an important role in maintaining the amount of available water and maximizing its use or, on the contrary, pushing it toward an accelerated waste. This is precisely what is referred to as water resource management.

Integrated water resource management implies the perception of water as an integral part of an ecosystem, a natural resource, and a social and economic good (Halisçelik & Soytas, 2019). To ensure the availability and sustainable management of water for all by 2030, integrated water resource management (IWRM) must be implemented at all levels as a strategy for balancing competing water demands across society and the economy without jeopardizing the long-term viability of vital ecosystems. Regrettably, the world is not on track to meet this SDG goal (Paul et al., 2018). For Muslim countries especially in the SDG regions of North Africa and Western Asia, as well as Central and Southern Asia with low levels of IWRM implementation, where development constraints are common and capacity is often lacking, the rate of implementation must more than double. As presented in Fig. 6.8, a lot of such countries are marked with limited progress of IWRM implementation through 2017–2020. However, during the same duration, there is definite evidence of moderate progress in some of the countries of focus, although this must be accelerated. Indonesia, Malaysia, and Libya have achieved substantial progress and significant gains. Morocco, Oman, the United Arab Emirates, Qatar, and Kuwait are among the 44 nations in the globe that are close to meeting the target, but they must maintain their efforts because achieving and sustaining the goals of sustainable water resource management is a continuous process. They prove that Muslim countries may make real and rapid improvement of IWRM implementation.

The literature and empirical studies indicate that the participation of local communities can significantly improve water management in any country (McCartney & Brunner, 2021; Bezerra et al., 2022). A lack of public participation in water resource management may lead to a fragmentation of policy and institutions between levels, actors, and sectors. Accordingly, decisions made in one sector (e.g., agriculture, energy, health, or the environment) often do not consider the effects on water availability and quality in other sectors. This principle should be of particular importance in Muslim societies, which require cooperation as a general command of God that must be implemented "And cooperate in righteousness and piety, but do not cooperate in sin and aggression" (Al-Qur'an, 05:02). However, investigating the existence of participation approaches in legislation or policy coupled with determining the actual amount of involvement in water management helps track the participation of local communities in water management within a country.

To encourage inclusive partners' participation in the management and use of water for equity and sustainability in the Muslim-majority countries of concern, the most effective approaches are context-specific. However, there is a consensus that meaningful participation of stakeholders in policy formulation and planning processes leads to better outcomes. However, the value added of this strategy is that it allows for greater participation of vulnerable groups of the population as well as gender mainstreaming in many countries. However, although considerations of participation are included in the laws of some of the countries referred to, practical channels to put participation into practice are not well provided and need to allocate a lot of financial and human resources.

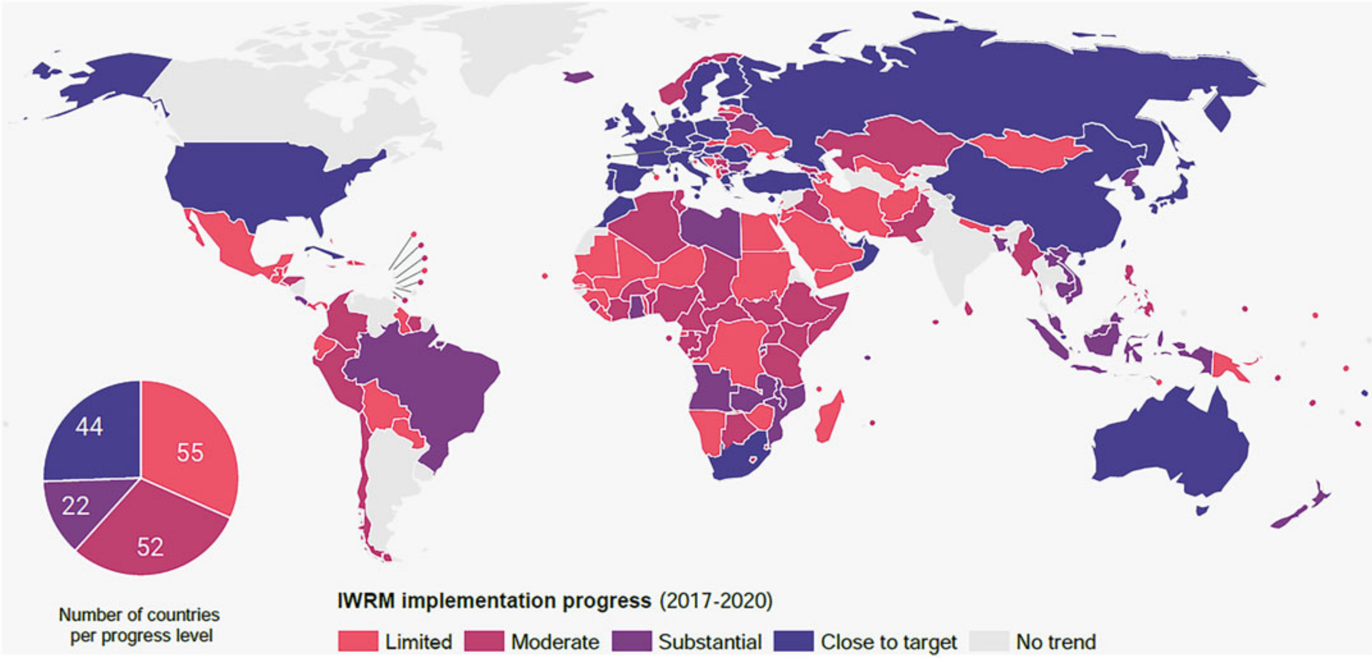

Fig. 6.8 Country progress toward IWRM implementation (2017–2020). Source: Environment (2018)

6.4 Concluding Remarks and the Way Forward

A closer look at the different areas in the water stress map shows that many Muslim-majority countries fall within the high or critical water stress range. To make Islamic countries more resilient in resisting the current and expected water shortages, integrated programs and policies should be developed that revolve around the following proposals. Such suggestions are based on the analysis of the current water situation within the framework of the sixth goal of Sustainable Development Goals, as well as guided by some successful experiences and practices achieved by some countries of the world.

Even though some Islamic countries with water problems have incorporated people's participation in water resource management into their laws and regulations, their implementation is still slow. More efforts are needed to develop regular channels for public participation, as well as financial resources to support local activities, in order to accelerate progress. The current study suggests the following initiatives that may help countries of interest manage water in a sustainable manner:

- Focal points: Analysis of the current situation of Muslim countries places urgent calls for the involvement of all stakeholders and institutions related to water management. Countries should designate a lead institution as focal points to coordinate these stakeholders.
- A framework for data collection: Urgently needed are reliable and timely water data to enable evidence-based policy, legislation, planning, and investments at the national and subnational levels, ensuring the most efficient use of resources in critically water-stressed areas.
- Capacity building: National and regional on-site and online training courses have to be organized on sustainable water use SDG targets.
- Regulatory frameworks: It is important for the countries under study to establish or amend laws to reflect progressive, integrated water resource management practices and maintain policy consistency between current and emerging water-related legislation.
- Financial resources: To enhance the participation of users and local communities in water services in Islamic countries, especially in rural areas, it is necessary to allocate sufficient financial resources.
- Water council: Institutions are too important to operationalize principles of integrated water management at both international and national levels. It is necessary to develop an effective consultative council to achieve sustainable water management. Members of the suggested council may involve scholars in both science and religion in addition to relevant governmental bodies to ensure interdisciplinary learning and help to promote innovation. To develop multilevel Islamic water policy is a main expected outcome of this council.
- Water user associations: The participatory approach entails educating policymakers and the broader public about the importance of water. It means that decisions are made at the lowest appropriate level, with full public consultation and user participation in water project development and implementation.

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Chapter 7
Indigenous Water Knowledge: Religious Values and Cultural Practices

Reeetsh Sah

Abstract The world's oldest human civilizations developed near major water systems. The same custom was followed in the Kumaon region of the Uttarakhand state in Indian Himalayas. The traditions of water management were established and developed by the inhabitants according to the local ecological knowledge, environment, and available resources, in which understanding of their geographical circumstances and foresights were inherent.

The mountain communities of Kumaon acquired knowledge of the nature of water sources according to the geography of the Himalayas for hundreds of years and developed indigenous techniques for water conservation accordingly. The terrain of the Himalayas is very diverse, so the water harvesting systems also vary, the availability of water in the Lesser Himalayas is very arduous, and so this part has rich religious, cultural, and social traditions of water conservation. The people of Kumaon implemented the knowledge and instructions received from the holy religious texts. In the tradition, water management was not considered a mere technical job, but it was taken as a cultural work and was governed by socio-religious values. Traditional rules for usage with water conservation were kept intact by the societies, where non-compliance with traditional rules was considered a sin.

The consciousness of water harvesting in the region has been there since ancient times. People had discovered the significance of water and well-built cultural, religious, social, and scientific methods for its use. The importance behind the conservation of water is the difficult geographic terrain of the Lesser Himalayas where water is not readily available so the water was given the form of divinity.

Keywords Water · Kumaon · Naula · Religious value · Traditional knowledge

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7.1 Introduction

In Indian culture five great elements Kshiti (earth), *Jal* (water), *Pavaka* (fire), *Gagan* (sky), and *Sameer* (air) are considered for the evolution of life, among them water plays an important role in the creation and conduct of life.

Water harvesting has been practised in India since time immemorial. The evidence of this custom is still reflected in the oldest writings, inscriptions, local rituals, and archaeological remains. The use of water is an integral part of human life, as old as civilization itself. The great Harappa civilization developed in this continent during 2500–1500 B.C. because of water only. Vedic literature (800–600 B.C.), especially *Rig-Veda* is replete with hymns about irrigated land, flowing rivers, ponds, wells, etc. In Vedic literature and later Vedic literature a driving force to Hindu religious life, many verses have been written given the importance of water, some of them have been described from the point of view of the importance of water.

Some of the important hymns are as follows:

अप्स्वऽन्तरमृतमप्सु भेषजमपामुत प्रशस्तये। देवा भवत वाजिनिः॥ Rig-Veda 1/23/19
(Apsvasntaramrtamapsu Bheshajamapaamut Prashastaye. Deva Bhavat Vaajinah).[1]

The Rig-Veda describes the importance of water, ‘oh man, water is nectar, it is folk medicine, Water has medicinal properties like nectar.’

इरा विश्विस्मै भुवनाय जायते।
यत्पर्जन्यः पृथिवीं रेतसावति।। Rig-Veda 5-83-4
(Ira Vishvasmai Bhuvanaay Jaayate. Yatparjanyahau Prthiveen Retasaavauti.)[2]

Considering *Parajainya* (Vedic deity mentioned in Rig-Veda) as a deity, happiness has been created in his praise, that is, *Parajanya* keeps the earth full of water, due to which the plant grows and becomes capable for the benefit of the whole world.

The Rig-Veda mentions the following description related to *Varuna* (the God of water) when there was neither sky nor earth nor gods, then in which seed life exists and in which all the gods were present. The answer is- there was the same seed in the water in which all the gods exist (Mishra, 2002).[3]

आपा नारा इति पुरा संज्ञा कर्मकृत मया।
तेन नारयणोऽप्युक्तो म मतत त्वयन सदा।।
(*Aapa Naara Iti Pura Sangya Karmakrt Maya. Ten Naarayanopyukto Ma Matat Tvayan Sada).* (Rawat & Sah, 2007).[4]

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[1] Rig-Veda 1/23/19…

[2] Ibid. 5–83-4

[3] Mishra, Dr. Anant Ram. 2002. Jal me Kumbhkumbh me Jal Hain, Ed. Janak Pande, Social Development, APH Publishing Corporation, New Delhi, pp. 212–214.

[4] Rawat Ajay and Sah Reetesh. 2007. Parvatiya Sanskriti Me Jal Parampra in Explorations of Indian History, Ed. Rizavi SNR & SZH Jafri, UP History Congress, Anamika Publishers and Distributors, New Delhi, pp. 394–406.

The significance of water has been expressed in the Rig-Veda in this way, the origin of Lord *Vishnu* (Known as *Narayan* also), the creator of this universe affirmed, due to being my name is *Naar* (water) + *Ayan* (to reside) = *Narayan*, so water is considered as the form of Lord *Vishnu* and Lord *Vishnu* is worshipped at the water source, where misuse of water is considered as a sin and its use as a virtue. Giving importance to the construction of water bodies, it has been considered equal to worship and it has been considered that the same benefits are obtained from its construction, which is derived from worshipping god.

The *Chandogya,* one of the principal *Upanishads* (the philosophical reflections of the Vedas, numbering 108 in all), points out, 'The rivers.... all discharge their waters into the sea. They lead from sea to sea; the clouds raise them to the sky as vapor and release them in the form of rain (Agarwal & Narayan, 1997)'.[5]

The *Puranas* are religious texts composed in Sanskrit, preserved orally for centuries before being written around the second century. *Puranas* are part of the sacred literature of the Hindu religion, there are 18 major Puranas in number. It is mentioned in *Agni Purana*, one of the significant *Puranas*, that 'after worshiping *Vishnu* and *Varuna*, a water reservoir should be constructed.'

विष्णु वरुणं च संपूज्य जलाशय निर्माण कारयेत।[6] – *Agni Puran* 282
(*Vishnu Varunan Ch Sampoojy Jalaashay Nirmaan Kaarayet.)*
जलमेव जगत प्राणः। जलस्य संरक्षणम् अस्माकं कर्तव्यमस्ति। – *Linga Purana* 35-13
(Jalamev Jagat Praan. Jalasy Sanrakshanam Asmaakan Kartavyamasti)[7]

According to *Ling Purana,* water is the lifeblood of the world. We must protect water bodies.

दशकूपसमा वापी, दशवापीसमो ह्रदः।
दशह्रदसमो पुत्रो, दशपुत्रसमो द्रुमः।। *Matsya Purana* 154:512
(*Dashakoopasama Vaapee, Dashavaapeesamo Hradah. Dashahradasamo Putro, Dashaputrasamo Drumah).*[8]

Matsya Purana discusses the importance of water and tree. It has been mentioned that a pond equals ten wells, a reservoir equals ten ponds, a son equals ten reservoirs, and a tree equals ten sons.

Even in ancient times, discussion of an excellent system of water harvesting has been found. Several descriptions of canals, ponds, and wells are found in *Puranas*, *Mahabharata*, *Ramayana*, Vedic, Buddhist and Jain inscriptions. In *Kautilya's Arthashastra*, the water management directed by the government for agriculture, drinking, and other works has also been highlighted.

[5] Anil Agarwal, Sunita Narayan. *1997. Dying Wisdom, Centre for Science and Environment, New Delhi,* p-13.

[6] Agni Puran 282–6-Page 570, https://ia902802.us.archive.org/27/items/agni-puran_201810/agni-puran.pdf.

[7] Ling Purana 35–13, https://ia801906.us.archive.org/9/items/puran_ling/Ling.pdf.

[8] Matsya Purana 154:512.

7.2 Historical Background

The Himalayas, an integral part of the Indian heritage, and their forests provide vegetative cover for the major river systems in India and are known as the water towers of Asia. They are a water reservoir for half a billion people living in the plains, a warehouse of biodiversity, and a climate maker for the whole of Asia (Rawat, 2000).[9]

Uttarakhand, the youngest and the 11th Himalayan state of the country, is the catchment area of the Indo-Gangetic plain and the cradle of the Indo-Gangetic civilization. Uttarakhand is divided into two Commissionaires, Kumaon, and Garhwal. Kumaon lies between $28^{0}44^{I}$ and $30^{0}49^{I}$ N latitudes and $78^{0}45^{I}$ and $81^{0}5^{I}$ E longitudes (Rawat, 1999).[10] The earlier known ruling dynasty of Kumaon was *Kuninds* (500 B.C.-300 A.D.) (Joshi, 1990).[11] They were succeeded by the *Paurav* (300 A.D.-500 A.D.) (Joshi, 1994),[12] *Katyuris* (500 A.D.–1200 A.D.),[13] and the *Chands* (1200 A.D.–1790 A.D.) (Dabral, n.d.).[14] The Gurkhas occupied Kumaon in 1790 (Raturi, 1998).[15] They ruled Kumaon from 1790 to 1815 until they were defeated by the British in 1815. After the Treaty of Sigauli in 1816 both Kumaon and British Garhwal came under British rule (Pandey, 1990).[16]

After the British occupation of Kumaon and Garhwal in 1815, Garhwal was divided into two parts, the British-Garhwal and Tehri-Garhwal State. The British Garhwal became a part of the Kumaon Commissionary whereas, in Tehri Garhwal State, the erstwhile Parmar rulers of Garhwal were reinstalled (Rawat, 1989).[17]

In Kumaon, the history of managing water is as old as the history of settled agriculture. The main sources of water in Kumaon are rainwater, glaciers, rivers, lakes, streams of all sizes, and springs. The use of water resources in multifarious contexts gives rise to different management systems, which are characteristic of the conditions through which they emerge.

The Kumaon region lies in the monsoon belt and over thousands of years, communities in this region have learned to collect rainwater, store it and use it for

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[9] Ajay S. Rawat. *2000. Managing Environment, Sherwood College, Nainital,* p-37.

[10] Ajay S. Rawat. 1999. *Forest Management in Kumaon Himalaya, Struggle of the Marginalized People, Indus Publishing Company, New Delhi,* p-13.

[11] M.P. Joshi, *Uttaranchal (Kumaon-Garhwal) Himalaya an Essay Historical Anthropology, Sri Almora Book depot, Almora, India, 1990*, p-36.

[12] M.P. Joshi, *Uttaranchal Himalaya Samaj, Sanskriti, Itihas Evam Puratatva, Sri Almora Book Depot, Almora, p-15.*

[13] M.P. Joshi, *op.cit.,* p-44.

[14] Shiv Prasad Dabral, *Uttarakhand ka Itihas (Kumaon ka Itihas), Veer Gatha Prakashan, Dogadda, Garhwal, Vol. -10, Smvat-2044, pp-54-55.*

[15] Harikrishna Raturi. *1998. Garhwal ka Itihas, Bhagirathi Prakashan Grah, Suman Chowlk, Tehri Garhwal, p-215.*

[16] Badridutt Pandey. *1990. Kumaon ka Itihas, Sri Almora Book Depot, Almora, p-429.*

[17] Ajay S. Rawat.1989. *History of Garhwal, Indus publishing Company, New Delhi,* p-94.

a variety of purposes throughout the year. Thus, a unique water harvesting civilization took shape in this area. Communities took pride in their water systems, as evidenced by the exquisite decoration and architecture of the structures around water bodies. A surprising aspect of these structures and systems is that many of them survive even today, hundreds of years after their construction.

Traditionally in Kumaon, the main systems of water management are *guls, naulas, dharas, lakes, kund, khal, simar* or *gazar*, and watermills. Many of these technologies are still in use and provide a considerable proportion of the water requirements of the people. The traditional systems are being detailed below:

Gul In Kumaon, cultivation is done largely on terraced fields and since ancient times, the problem of irrigating the fields was arranged by diverting water from nearby streams or rivers through channels called *guls*. They are the best example of water resource management in the hills and are typically dug along the contours of the slope. Apart from irrigation, *guls* were used for drinking water and for running *'gharats'* or watermills.

In some areas, water from the stream is first dammed and then the irrigation channel is created. The small dam built for the purpose is known as *'baan'* in local parlance and *'kulayana'* in the Kumaoni dialect means to irrigate the field with *gul* or *kul*. Along the length of the *guls* are outlets, which lead to smaller secondary channels and are known as *'hawarr'*. Irrigation channels are of different sizes, the one, which is smaller than *kul* is known as *'baul'*. A boulder kept at the outlet controls the flow of water. There is also an outlet at the lower end of the field, which allows the additional water to flow onto the lower terraces from where it ultimately drains back to the stream. Occasionally the flowing water in the *gul* is obstructed by a boulder or hard rock. In that case, the peeled bark of a banana tree is used as a water carrier, or it is channelized through a wooden pipe (Rawat & Sah, 2009).[18]

Naula They are designed to collect water from subterranean springs. The flow of these springs is very sensitive and can be disrupted by seismic activity and human disturbance. In Dwarahat town, it was found that *naulas* like *Khulkuda* or *Kholibhitar* have dried up owing to the tremor of the *Uttarkashi* earthquake (1991). *Naulas* are located mostly on the mountain slopes in the Lesser Himalayan region of Kumaon. They have covered reservoirs and have been built by ex-rulers and exhibit masterpiece architectural features. Some of the *naulas* like the Ek-Hatia (Fig. 7.1a), Baleshwar (Fig. 7.1b) and Maneshwar Naulas (Fig. 7.1c) in Champawat town are famous for their architectural splendours.[19]

The *Naulas* have a common design. They consist of a tank that is closed on three sides (Fig. 7.2) and covered on the open fourth side that has steps to lead down to the tank (Fig. 7.3). There is a pillared veranda surrounding them with engraving. Animals are not allowed to enter, and the system is so designed that the users do

[18] Rawat Ajay and Reetesh Sah. (April 2009). Traditional knowledge of water management in Kumaon Himalaya, IJTK Vol.8 (2) pp. 249–254.

[19] Ibid. pp. 249–254.

Fig. 7.1 (**a**) Ek-hatia Naula, (**b**) Baleshwar Naula, and (**c**) Maneshwar Naula

not contaminate the source (Fig. 7.4). The water is considered sacred, even to this day the basic rules of sanitation and hygiene are mostly observed. *Naulas* were considered community property and the villagers revered their *Naulas*. In the past *Naula* water was treated with amla (*Emblica officinalis*) and neem (*Azadirachta indica*) leaves. As the construction of *naulas* was considered reputed, these structures can be found in important towns, in and outside villages, and on important roads. Some *Naulas* are emblazoned with elaborate architectural designs. At times they are enormous with a raised platform for both bathing and washing.[20] For maintaining the water table, providing shade and fruit to the people as well as birdlife, and pay reverence to water, trees like oak, kharik (*Celtis australis*), siling (*Osmanthus fragrans*), peepal (*Ficus religiosa*), bargad (*Ficus bengalensis*), timil

[20] Ibid.

Fig. 7.2 Exterior of a common Naula built by the villagers

(Ficus patmala), dudhaila (*Ficus memolaris*), padam (*Prunus cerasodus*), amla (*Emblica officinalis*), shatut (*Morus albla*), and utis (*Alnus nepalensis*) were planted around and close to the *naulas*. The people were aware that all forms of life, human, animal, plant, and micro-organisms are so closely interlinked with one another that disturbance in one gives rise to an imbalance in others (Rawat & Sah, 2007).[21]

Naulas were traditionally built by the villagers with great devotion and many rituals were performed while building the *Naula*. All this was like building a temple. It was a custom among the local people to worship the *Naula* and the trees planted near it. This had a dual effect and taught the villagers to keep the *Naula* clean and to preserve water. Plantation near *Naula* is also a part of traditional water management, it is believed that the water of *Naula* is naturally filtered so it is pollution-free, being pollution-free, its water is healthy too. It appears warm in winter, in the summer season; the cold sweet water of *Naula* has its flavour (Ramesh, n.d.).[22]

Dhara The water stream of drinking water originated from the surface is known as *Dhara*. Small channels are taken out of rivers or mountain streams and it is given the form of a *Dhara*. In the catchment of *Dharas*, the practice of planting trees was in vogue for symbolizing the sanctity of water. The water from a spring or a subterranean source is channelled via a curved outlet. The latter are often in the shape of a

[21] Rawat Ajay and Sah Reetesh. 2007 *op. cit*. pp. 394–406.

[22] Pahadi Ramesh Ed. Kumaoon ki Aitihaasik Naule, Jal Sanskrti Issue-3, Lok Vigyaan Sansthaan, Dehradun,p 3–15.

Fig. 7.3 Interiors of a *Naula*, steps leading to the tank (two pictures on the top) and the roof of the *Naula* (bottom picture)

pipe or figures of animals (Fig. 7.5). The most common ones are lions, elephants and cows. This is a common source of drinking water in the region and can be compared with a drinking water fountain. *Dharas* are located both in mountain crests and valleys. They are popular in towns also (Rawat & Sah, 2007).[23]

There are three types of *Dharas* depending on their heights and the nature of the flow. If an individual can readily drink water from the *Dhara* in a standing position, then it is called *Sirpatia Dhara* (Fig. 7.6). In another condition, if one has to bend over for drinking water, then it is called *Murpatia Dhara*. Both types of *dharas* are decorated with animal figures. The third type of *Dhara* is not perennial. During the rainy season, certain wooden spouts or broad leaves are stuck in the path of a flowing stream or a spring that gets water easily. As they are temporary, they are called *Patveedia Dharas* (Rawat & Sah, 2009).[24]

Simar They are known as '*gajar*' also. *Gajar* is a marshy tract of land in an agricultural field and is created by the water table below. Cultivation of high-quality crops like basmati rice, medicinal plants, and herbs is a common feature.

[23] Rawat Ajay and Sah Reetesh. 2007 *op. cit.* pp. 394–406.

[24] Rawat Ajay and Reetesh Sah. (April 2009). *op. cit.* pp. 249–254.

Fig. 7.4 A pillared veranda surrounding *Jhanvi Naula*

Fig. 7.5 Curved outlet in the shape of an elephant and lion to supply water from *Dhara*

The medicinal plants normally grown in it are two varieties of brahmi, *Centrala asiatica* and *Bacopa monnieri*. The former is used as a memory tonic, as a diuretic, and for curing leprosy. The latter is used as a nervine tonic for asthma and diarrhoea. The other medicinal plants, which are congenial for cultivation in *gajar* are *bach* (*Acorus calamus*) and *halung* (*Cardamine empatiens*). The common use of *bach* is

Fig. 7.6 *Sirpatia* Dhara in the study area

in dysentery, bronchial asthma, and epilepsy and of *halung* in ulcer and colic pain (Rawat & Sah, 2009).[25]

Chuptaula They are water pits for animals and are sited mostly at high altitudes for use of graziers. They are not permanent and water is gathered in them from springs or from points where water oozes out from the ground (Fig. 7.7). Faunal and birdlife also use this accumulation of water and at times they serve as an important source of water for human consumption at high altitudes.[26]

Khal Large depressions in mountainous areas are used for rainwater harvesting and these features are called '*khals*'. Mostly they are on the top of the ridges in the saddle between two crests. At times, tiny dug ponds are also used for collecting rainwater. During the lean period, water accumulated in the *Khals* is used for irrigation purposes. When the discharge of water in *guls* is reduced due to the searing heat of summers, then water is first accumulated in a *khal* and subsequently used for irrigation.[27]

[25] Rawat Ajay and Reetesh Sah. (April 2009). *op. cit.* pp. 249–254.

[26] Ibid. pp. 249–254.

[27] Ibid. pp. 249–254.

Fig. 7.7 *Chuptaula* at a higher altitude

Dhaan Water is collected from small and large streams and given the size of a lake. The accumulated water[28] is used for domestic livestock to bathe and it is also used for irrigation (Rawat & Sah, 2007, 2009).[29]

Gharat (Water Mill) *Gharat* stands out as a unique example of the traditional management system for flour mills. Following this traditional arrangement on the banks of rivers in this area, *Gharats* can be seen even today. The tradition of making *Gharats* for grinding grain by taking out channels from the sharp sloping river or stream near the village is a century-old technique in Kumaon (Fig. 7.8).

It is a technique of harnessing waterpower that is collectively established by the residents of the village as per their requirements with locally available resources. There is a tradition of not locking the *Gharat* so that the needy do not face difficulty in grinding. Anti-social elements should not harm the *Gharat*, so it has been created as a symbol of the abode of *Bhairav Devta*, a close aide of Lord *Shiva*. After the first grinding, the *Gharat* is worshipped by the villagers. Its operator is called *Bhagwar* or *Ghatwar*, who is a person with a weak economic background in the village; it was given 1/6th of the grind (Prasaad, 2002).[30]

Apart from this, in this mountainous terrain, there is an everlasting relationship of water in folk life traditions, religion and customs, which can be understood through

[28] Rawat Ajay and Sah Reetesh. 2007. *op. cit*. pp. 394–406.

[29] Rawat Ajay and Reetesh Sah. (April 2009). *op. cit*. pp. 249–254.

[30] Purohit Bhagavati Prasaad. 2002. Gharat Eds. Puran Bisht & Ashutosh Upaadhyay, Himantar, Lok Vigyaan Sansthaan, Deharaadun, Issue- 8, p-9.

Fig. 7.8 Interior view of grinding stone (left) and turbine (right; blades made of wood) of Gharat

these traditions and religious practices prevalent even in the present day. Some of them are discussed here.

7.3 Religious Values and Cultural Practices

In the traditional water management of Kumaon, water and water sources are looked upon with reverence and they have been given the same respect as religious places and polluting water sources has been termed as a sin. This system determines the attitude of society towards the water. According to Hindu beliefs, 16 Samskaras (sixteen religious practices) hold an important place in a person's life and how important the place of water in these sacraments is in this hilly region, is mentioned through the following traditions.

7.3.1 Namkaran (Name Giving Ceremony)

Namkaran is one of the significant rites of life in the naming ceremony. This is a function of naming a child and is usually done on the eleventh or twelfth day after birth. On the day of this ceremony, the baby is bathed with the water of *Naula* and dressed in new clothes. His or her formal name, chosen by the parents, is announced during the ceremony. In this region, on this occasion, this ceremony is performed by worshipping *Matrika Chowka*[31]on the *Naula*, and the holy water of the sacred

[31] Matrila Chowka-*Gauri, Padma, Sati, Savitri, Vijaya, Jaya, Megha, Devasena, Sval, Swadha, Dhuti, Pusti, Thusti, Lokmatri, Senani, Kuldevi these sixteen matrikas (goddesses) are depicted in this Matrika Chawka (board). Matrika in the Kumaon region is necessary to use it in all auspicious works, worship of gods, and rituals. In this, 16 matrikas are marked on one wooden board and*

pitcher is immersed on the *Naula* and then the pitcher is filled with fresh water and distributed among the family members in the form of *prasad* (offering) (Rawat & Sah, 2007).[32]

7.3.2 *Upanayana/Yagnopavit (Sacred Thread Wearing Seromony)*[33]

At the age of eight to fifteen, the son of a family is initiated by the Acharya with the holy thread, known as *Janeu* or *Yagnopavit*. Amongst all the foregoing ceremonies, this is considered supreme for the intellectual and mental development of a child. Through this ceremony, practical and spiritual progress is established in the life of the child. Water has an important relationship with *Yagyopaveet* Sanskar. *Yagyaopaveet* is worn at the festival of *Rakshabandhan*. This is also called the full moon day of wearing the *Janeu* (sacred thread) by the people. In the scriptures, it has also been described as *Shravani Upakarma*, on this day of worship-recitation and other religious rituals which are necessary to wear new Janeu are performed. On the banks of rivers, water sources, *Naulas,* or streams, Brahmins in the presence of their chief hosts offer them by annotating them with *Raksha Sutra* and the *Janeu* made for wearing. A new thread is worn after bathing in these water streams and water sources. In *Yagyopaveet*, the worship of *Matrika Chowka* and *Nav Grah Kalash* (Worship of Nine Planets) is performed near *Naula*, and the water is distributed as *prasad* to the family members (Sah, 2003).[34]

7.3.3 *Naula Bhetna (Introducing the Place of* Naula*)*

This tradition is also called the ritual of *Naula Bhetne* (introducing the place of *Naula*) in this area. The work of filling water was usually considered the responsibility of women. The newly wedded female is thus sought to be as productive as the perennial spring (Rautela, 2000).[35] The tradition showing the importance of water

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these matrikas are marked in a symbolic form. In this, Lord Ganesha is also created on the right side. It is the one of the main main form of the folk art of Uttarakhand.

[32] Rawat Ajay and Sah Reetesh. 2007. *op. cit*. pp. 394–406.

[33] ** Prasad or *prasada* (Sanskrit: 'favour' or 'grace') in Hinduism, food and water offered to a deity during worship (puja). It is believed that the deity partakes of and then returns the offering, thereby consecrating it. The offering is then distributed and eaten by the worshippers. The efficacy of the *prasada* comes from its having been touched by the deity.

[34] Sah Reetesh. 2003. Kumaun Mein Jal Prabandhan: Saanskrtik Parampara, Sharad Nanda, Dr. Ajay Rawat Et. al Nainital, Sharadotsav Samiti, District Administration, Nainital. p 49.

[35] Rautela Piyush. 2000. Water Resources in the Himalayas Harvesting, Traditions and change, Concept Publishing Compnay, New Delhi, Page 40.

sources in their life is visible in the traditional marriage system of Kumaon. According to tradition, when the bride first came to her husband's house in the villages of Kumaon, she was introduced to the *Naula* or stream of the village and taken to worship (Sah, 2004).[36] Thereafter, the new bride was made to enter the *Naula*, and used to bring water from *Naula* in an urn, which was distributed in the form of a *prasad* (Upadhyay, 2003).[37] The tradition of *Naula Bhetne* is performed in all festivals and it is believed that the circumambulation of *Naula* brings happiness and prosperity (Sah, 2003).[38]

7.3.4 Marriage-Related Other Cultural Practices

On this occasion, the crowns of the bride and groom are also left on *Naula*. The bride also used to clean the wedding decorations (*Kurmul*) on her face with the water of *Naula*. This tradition has been going on for centuries in the hills which can be seen even today in many places.

The importance of water has been understood religiously and culturally in Kumaon. The folk songs sung in the wedding ceremony, which are called *Mangal Geet* (auspicious songs), also describe the use and importance of water, in which Lord *Vishnu*, who is a symbol of water, is requested for the happiness of the newlyweds.[39]

7.3.5 **Garhwa Dhara** *Ritual during* **Kanyadaan**

Kanya means daughter and *daan* means giving away. *Kanyadaan* means 'giving away of the bride to the bridegroom'. In Hindu ritual, *Kanyadan* simply means the father of the bride happily agrees for the wedding of his daughter. Water plays a very important role in marriages. *Kanyadaan* follows a tradition known as *Jal ki Dhara* or *Garhwa Dhara* (a small round shaped container for water, usually made of brass or copper) in the Kumaon region, in which the bride's parents pour water into the hands of the bride and groom from the container known as *Garhwa*. The continuum of water is carefully maintained in the ritual by the family of bride, with the bride and

[36] Sah Reetesh. 2004. Kumaun Kshetra me Jal Prabandhan ka Itihs, Unpublished Thesis, Kumaun University, Nainital, p-70.

[37] Upadhyay Ashutosh. 2003. Pani Parampara Ke Yaad Dilaate Naule, Jal Biradari, Center for Science and Environment, Volume 2, No. 4, February–March p. 7.

[38] Sah Reetesh. 2003. *op.cit.,* p 49.

[39] Ibid., p 49.

groom being blessed with an unbroken continuum of water in their relationship (Rawat & Sah, 2007).[40]

Similarly, on arrival, the groom's family is welcomed by the bride's father, the feet of the Acharya and the groom are cleaned with water, and then they are offered asanas. This is the first process of marriage that begins with water. Water is so important in marriage that without water a legal marriage is not possible in the Hindu tradition (Rawat & Sah, 2007).[41]

7.3.6 **Kumbha** ***(Pitcher) Marriage***

Sometimes when the husband is unavoidably absent, or astrological considerations render his actual marriage with the person of the bride undesirable, she is formally married to a pitcher of water as representing him (Pannalal, 1920).[42] In *Kumbh* marriage, considering the water in *Kumbh* as the form of Lord Vishnu, such girls are married whose marriage is not possible elsewhere due to certain reasons. Marriage is done by filling water in the *Kumbh*, taking it as the form of Lord *Vishnu*; the married woman changes the water of the *Kumbh* regularly and considers as her husband. She must spend the rest of her life as a widow in the event of the breakup of the *Kumbh*. Apart from this, according to traditional astrology if the planetary positions in columns 1, 4, 7 & 8 of the horoscope of the groom are not matched with the bride then it is believed that the life of the groom may be in danger, to avoid this the tradition of *Kumbh* marriage was prevalent in this area (Joshi, 1996).[43]

7.3.7 **Pani Dhara Vivah** ***(Water Stream Marriage)***

In the Kumaon region, as per customary law, so much importance was given to the purity of water that, water stream marriage was legally recognized. Due to the importance of water, water stream marriage was recognized in British Kumaon by society and law. In this context, Sir Panna Lal, ICS was sent by the British Administration to Kumaon Division to note down the customary law here. He submitted his report to the government on 7 April 1920, in which he has mentioned 'the bride is taken to some sacred place on a river, occasionally even to an ordinary

[40] Rawat Ajay and Sah Reetesh. 2007, *op. cit*. pp. 394–406.

[41] Rawat Ajay and Sah Reetesh. 2007. *op. cit*. pp. 394–406.

[42] Sir Pannalal. 1920. Kumaon Local Customs, Superintendent Government Printing Press, United Provinces, Allahabad, Page 6–7.

[43] Joshi Pandit Acharya Ghananand 0.1996. Ed. Vivaah Paddhati Darpan (Kurmanchali Reeti ke Anusar), Himalaya Publications, Hathras, Aligarh-01 ed. page 47.

spring, she is publicly 'married', and declared to be the wife of the bridegroom. Absentee soldiers are often married in this way.[44]

7.3.8 Antyeshti (Death Rites)

Death is the ultimate truth of life and *Antyashti* is the last rite of life of a person. The last rites performed by the relatives are important, as the value of the next world is higher than that of the present in all religions. The last rites of a deceased person are done carefully. Water is also related to last rites; the relatives of the deceased go to the drains or other water sources and perform rites for the peace of the person's soul for the next 13 days. It is important that last rites are not performed at *Naula*. The rituals related to this are performed at an isolated place near the river or springs. In the city of Almora, the capital of the Chand dynasty, a separate Naula has been built for the rituals, which is known as *Kriya Naula* (special *Naula* for last rites) (Sah, 2003).[45]

The Idol of Lord *Vishnu* at Naula The idol of Lord Vishnu is worshipped at *Naula*. It has been discussed earlier that Lord Vishnu is a form of water and worshipped at the water sources. Keeping this belief intact, the idol of Lord Vishnu is installed at the inner wall of *Naula* and linked with religion to ensure its sanctity like a temple so that the water source is not polluted and the purity of the water of *Naula* could be maintained (Fig. 7.9) (Rawat & Sah, 2007).

Naula *Silana* After performing any auspicious work in the village like worship, religious rituals, etc., the worship materials, generally biodegradable are immersed in the flowing streams or near natural water sources is called *Naula Silana*.[46]

Parthiv Poojan *Parthiv* means made of earth and *poojan* is worship. Since time immemorial the Hindu deity Lord *Shiva* is worshipped in his abstract form of a *Shivling* or *Shiva Lingam* (Lingam/Linga, in Hinduism, a votary object that symbolizes the god Shiva and is revered as an emblem of generative power. The lingam appears in Shaivite temples and in private shrines throughout India) (Lingam Hindu Symbol, n.d.),[47] as it is the wish of the Lord to be worshipped in this form (Rawat & Sah, 2007).[48] A *Parthiv Shivling* is handmade from clay and worshipped (Fig. 7.10). Lord *Shiva* is the Lord of Earth element and is also connected to nature. In the holy month of *Sawan* (August–September) after worship, worship material including Parthiv *Shivling* of clay, various herbs, minerals, flowers, and *belpatra* (*Aegle*

[44] Sir Pannalal, *op.cit*., p 7.

[45] Sah Reetesh. 2003. *op. cit*. p 49.

[46] Ibid.

[47] Lingam Hindu Symbol, https://www.britannica.com/topic/lingam, retrieved on 4 April, 2022.

[48] Rawat Ajay and Sah Reetesh. 2007. *op. cit*. pp. 394–406.

Fig. 7.9 The idol of Lord Vishnu at a *Naula*

Fig. 7.10 Parthiv Shivling, handmade from clay

marmelos) signifies the surrender of all three aspects of one's nature—tamas, rajas, and sattva. One must surrender the positives and negatives of their life to Lord *Shiva* and become free (Anon, n.d.),[49] after which the *Shivling* is immersed in the flowing water of river, rivulet, or streams.

Aanthu A special festival is organized in Kumaon called Aanthu (related to eight in number), in which women wash the soaked pulses like peas (*Pisum sativum*), gahat (*Macrotyloma uniflorum*), rainse (*Vigna unguiculata*), urad (*Vigna mungo*), and wheat (*Triticum aestivum*) with the freshwater of *Naula* for 7 days and on the eighth day it is offered to Lord *Shiva* and Goddess *Parvati* (Consort of Lord Shiva). There is a legend behind this that in the past a woman lost her seven children due to the jealousy of the second wife of her husband. The second wife drowned seven children of the first wife in *Naula*. When having the eighth child, the first wife went to pay homage to the past children, where she offered *durba* grass (*Cynodon dactylon*) at *Naula*. It is believed that after this her seven children came up and she got her children back, on this belief for the wellbeing of progeny, this Anthu festival is still celebrated in the region (Rawat & Sah, 2007).[50]

7.4 Restrictions Related to the Conduct of Water

Menstruating women are not allowed to go to the *Naula* as it is considered very sacred. The water of *Naula* should not be impure, for this reason menstruating women are not allowed to fill the water. In view of the scientific reasons behind it, this rule must have been made with a view to maintain the purity of water and to allow women to rest during this period.[51]

There is also a belief in this context that a pair of serpents resides in *Naula*, which does not harm anyone in any way, but in the foreshadowing of the water being impure, only gives a warning by coming to the surface of the water.[52]

The importance of water in this area is so much that many areas and places are recognized due to the availability of water, such as the prefix and suffix in the name of water (pani), Naula and lake *(taal)* like Garmpani, Jadapani, Pahadpani, Bhhedapani, Dharanaula, Naulagaon, Nainital, Saattal, Naukhuchiatal, Malwatal, Khurpatal, Harishtal, Lokhamtal, Shymalatal, etc.[53]

In addition, cleaning of *Naulas* and *Dharas* is done regularly by women, children, and elders, which not only inculcate values but also provide a platform to discuss

[49] https://www.artofliving.org/mahashivratri/bilva-patra *retrieved on 01/04/2022.*

[50] Rawat Ajay and Sah Reetesh. 2007. *op. cit*. pp. 394–406.

[51] Ibid.

[52] Ibid.

[53] Ibid.

general issues among themselves, share in each other's happiness and sorrows, which maintains social, religious, and cultural values.

Traditionally, water management is not considered as a technical task and every villager knows that it is basically a social, religious, and cultural work driven by moral values. There are customary rules for the maintenance and use of water resources and disobeying them is considered an anti-social act. The drinking water should be sufficient and clean, therefore the purity of *Naula* and *Dhara* was preserved for drinking water. Effectively, water harvesting was linked to water resources with religion and deities. As the gods are respected in the society, the same respect has to be bestowed to water and this is the reason that water is considered holy.[54]

7.5 Conclusion

Traditional rituals related to water show an excellent blend of artistry with spirituality and culture, particularly in the construction of *Naula, Dhara* and other water structures, with the purposes of storing water in the Kumaon region, as well as showing their craftsmanship. The social groups in the region which were financially strong as well as equipped with excellence in art and culture have shown grandeur to their water structures. These structures have not only been a strong base of water supply from generation to generation, but have also been a witness to the history of various periods. These practices are excellent examples of water resource management. These attractive structures convey a message that our traditions have great significance to social concerns in nurturing the rich customs and values even in the present times.

Such structures are present in large numbers in Kumaon, although many *Naulas* and other water sources are not able to fulfil the basic objectives of water availability, but it is not their fault but the present management system which has brought them to the brink of neglect. They have no match in their grandeur and historical importance even today, fascinating structures over water sources were found in abundance in ancient capital towns, forts and settlements. In several major cities and villages, when the modern drinking water system becomes inefficient, the old *Naulas*, streams and water sources still prove to be reliable means of water supply even after being in dilapidated condition.

The structures of traditional water harvesting of Kumaon depend on the availability of water. Several natural water systems are available in this area, which displays the cultural and traditional excellence of the region. All these water sources and water structures, from the point of view of history, are a proud transfer of tradition to modern societies.

[54] Ibid.

It is undeniably true that if the shrinking water sources are not taken care of in time, then a crisis will arise due to the rapidly diminishing per capita water availability because water is the need of everyone and lack of it affects the entire life cycle. Hence, active contribution of everyone in the management, planning and use of water is imperative.

For water management, two things are mainly important—water conservation and availability of clean water. This is the reason that water management has emerged as the most urgent need of the century. It is the collective responsibility of all of us to preserve the water available, to keep it free from pollution and proper management in the light of the religious values and cultural practices. Hence, it is necessary that the culture of water management of Kumaon should not only be kept protected but should also be conserved and developed so that the supply of water and transfer of specific culture related to water to future generations is uninterrupted.

Water is not only the base of life but also the most important condition of existence of religious, cultural, and social life. The world's oldest human civilizations have evolved near major natural water systems. Even in Kumaon, ancient human settlements were established and developed on the banks of the major river valleys, but because of an increase in population and other socio-economic and geographical reasons, these settlements started moving towards heights, but such areas were chosen for settlement where perennial water sources were available in enough quantity.

Due to this farsightedness and developed tradition, the traditional water management system has been meeting the needs of the residents of the area for years. The residents evolved water-related systems under the regional conditions which were favourable to the local environment, and developed folk beliefs to make them deeply penetrate the life of the people and connected it with religion, spirituality, and social concerns. These systems are not only useful even today, but they also demonstrate the consistency of technology and traditional water management according to the indigenous situation.

At present, due to the expanding population and additional pressure on resources, we have moved away from our traditions. But even today the traditional customs of water management can face problems. Therefore, we must not forget our rich water traditions, religious values and cultural practices to firmly face the water crisis by maintaining it in sync with the present.

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Part II
Indigenous and Local Water Practices

Chapter 8
Bringing Back the Wisdom: Tradition in Urban Water Management

Chandra Bhushan Kumar and Sonali Ghosh

Abstract The discovery of water as a chemical compound and its direct linkage with a disease brought a paradigm shift in water management in the cities of the nineteenth century. Contemporary imperial ambitions and control not only facilitated the spread of this newfound knowledge in the occupied Asian cities but also led to the replacement of the age-old water management system that evolved over centuries. Bereft of local geography and social wisdom, this new system introduced layers of risks, which continue to define modern Asian cities. The plurality of water, integral to urban cohabitation, as understood in pre-modern times (before the control of nineteenth century State), gradually got erased by the new Master of Cities. Its devastating consequences have led to rethinking the way the water management system needs to be redesigned taking 'traditional wisdom' into its fold. In this context, this paper discusses the future of water management in Asian cities.

Keywords Global South · Waterscape · Asia · Traditional Knowledge · Delhi

8.1 Introduction

Water is one of the five eternal elements in every civilization; and as personified in ancient Indian Philosophy (*Kshitij, jal, paawak, gagan, samira, panch tatva nirmit adham shareera,* i.e. earth, water, fire, sky, and air – these five elements make mortal body). Civilizations have evolved keeping water as a focal factor of survival and prosperity. It allowed societies to develop a symbiotic relationship with this

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ubiquitous, but finite natural element. Advancement in the idea of modernity created a rupture in this relationship, as a concept of co-existence started getting replaced by the notion of control. This change and its consequences became more evident in urban locations, which either appeared or became more populated in the last two centuries.

In the middle of the nineteenth century, there has been an earnestness to provide regulated water in the area inhabited by the power centres of the State. In the Asian setting, such locations were inhabited by colonial powers, who preferred similar arrangements to their homelands. Existing cities remained outside of this provisioning citing reasons of finances (Mann). Gradual expansion failed to match the speed of urbanization. It also ignored the existing hydraulic institutions in those habitations, which survived for centuries. After the retreat of colonial powers, several countries opted for a democratic form of government. These countries witnessed an explosion in urbanization during the twentieth century, which made the world more than 50% urbanized since 2007 (UN-HABITAT, 2008). This was anything but planned urbanization. Dotted by slums, the booming urban centres struggled to ensure the provisioning of basic amenities including water to its inhabitants.

Delhi, a megacity teeming with a population of more than 22 million is multi-layered. Located on the bank of river Yamuna and cornered with Aravalli foothills, it has been plundered and rebuilt over seven times over the last millennium. The city witnessed the development and promotion of a variety of hydraulic infrastructures including lakes, *baolis* (water harvesting structures), wells, canals, and gardens. Two centuries after the creation of Shahjahanabad, the new capital in Delhi, Thornton (1858) notes:

> *. . .in the space between the range of hills and the palace, numerous under-ground channels were cut, leading to the various residents of the nobles, and the different divisions of the city (*Delhi*); yielding to the whole city and its suburbs a supply of good water, from open well-shafts connected with these subterraneous watercourses* (Thornton; pp.260).

Under the control of colonial power, the city's waterscape changed fundamentally. The first tap water supply started in 1892. In 1915, the city got its current territorial shape. In its water governance, state instruments abandoned the age-old water practices and opted for centralized access and provisioning. Even after 75 years of Independence; Delhi, like many other cities, is struggling to cope with the water demands of its inhabitants and the city.

This chapter does not promote nor reject the modern hydraulic system. However, it attempts to highlight the perils of the complete abandonment of traditional water wisdom and argues to co-opt these by tweaking the current model of urban water governance to achieve greater sustainability, equity, and justice. The paper is structured in five parts: *first*, it presents a survey of literature; *second*, it traces the water history of Delhi; *third*, it situates the ongoing crisis in urban water governance; *fourth*, it advocates for the adoption of holistic water governance approaches by incorporating indigenous water wisdom; and *finally*, it concludes with recommendations.

8.2 Literature Survey

The word 'tradition' comes from the Latin *traditio*, the noun from the verb *traderere* or *tradere* (to transmit, to hand over, to give for safekeeping) (Giddens, 1999). Giddens further comments that 'tradition' is wrongly considered as old, as it signifies continuity. These are complex mechanisms that survived for long periods precisely because they could change insidiously (ibid). In the context of water, Agarwal and Narain (1997) produced a very appealing and popular book titled 'Dying Wisdom: Rise, Fall and Potential of India's Traditional Water Harvesting System'. Equipped with historical texts, archaeological evidence, and cultural and social meaning of water for the diverse society, it advocated the revival of a traditional system of water harvesting. However, it conveniently ignored the political undercurrents shaping these practices or the injustice inherent in these practices.

The 'traditional' system thrived on the prefixed social structures that remained far from equal. The caste inequalities impacted the management and the use of this system. In the post-Independence phase, these inequalities have reduced but not disappeared yet. The question of scale remains absent in this propagation. The romanticization of the community water management as an alternative to the formal state arrangements has been questioned on various grounds including scale, politics, management, and sustainability (Bakker, 2010). Sillitoe (1998) cautions that while indigenous knowledge may facilitate people's skilful management of their resources, it may be inadequate in situations of rapid change (Mosse, 2003). Baviskar (2003) suggests that identities, interests, and resources should not be seen as predetermined givens, but as emergent products of the practices of cultural production. In the same vein, other scholars highlight the mutability of identities and traditions, thus calling concepts such as local knowledge, custom, and indigeneity into question (Tsing et al., 2005).

While unbridled faith in scientific rationality needs a rethink, so does romanticization of the past as well as traditional knowledge. Traditional knowledge and practices are not static but continuously evolving in the face of the changes in the wider political economy (Gupta 2011). As Sundar (2000) argues, 'indigenous or local knowledge is not frozen, inert, timeless entity, but dependent on the material conditions of those whose knowledge it is and the uses to which it is put'.

Knowledge and wisdom earned by human societies find space in modern urban water management at a subtle level in nudge form to influence the behaviour. There seems scope to enrich the current urban water governance with the values and wisdom of the indigenous water system, which has survived for centuries. Before elaborating on these, it would be helpful to understand the journey of hydraulics in Delhi.

8.3 Water History of Delhi

In Hindu mythology, Yamuna was *Sarjuga*, the daughter of the Sun god and the sister of Yama, the Lord of death. Along with the Ganges and Saraswati (a mythical river with no physical trace in modern times), Yamuna is a sacred river and taking a bath in it is part of the ritual. It originates from *Yamunotri,* a glacier in the Himalayas, and reaches the city after travelling a distance of 396 km (Fig. 8.1). The river has dictated the physical and political characteristics of the city since its beginning.

Broadly, the river divides the rural landscape on its left side from the urban life on the right (Fig. 8.2). However, it has been temperamental for the city and its hinterland. The remains of at least six paleochannels (old channels or courses) have been identified in Delhi. While a major paleochannel has been located in west/north-west Delhi coinciding in the main with the Mungeshpur Drain, several paleochannels have been located in and adjacent to the river flood plain.[1] This gradual shift in trajectory has left several traces in the form of lakes, ponds, and water bodies within the megacity (Dhawle & Bhatnagar, 2010). Regarding its present trajectory and seasonal fluctuation in flow, the *Delhi District Gazetteer,* 1912 informs: '*The river enters, the district at a height of some 710 feet, and leaves it at about 630 feet above the level of the sea, with a course within the Delhi limits of rather over 90 miles, and an average fall of between 10 and 11 inches to the mile. 'the general direction is nearly due south. In the floods of the rainy season, the river has considerable breadth, swelling in places to several miles, with a maximum depth of some 25 feet. In the cold weather, its normal depth is said to be four feet only; the stream is only sufficient to supply the three canals which draw from it (the Eastern and the Western Jamna. and the Agra 'Canal) and is then fordable in many places'* (p.4).

The presence of river and ridge within the territorial boundary of the megacity was not sufficient to fulfil the vision of water-sustained civic life. Rather these physical features became the basis for human interventions.

Before the arrival of new rulers from Central Asia, local rulers, belonging to the Hindu community used the simplest prototype of rainfall-runoff control (the earthen, sometimes rock-clad, check dams across local streams) and/or construction of large ponds, like Surajkund for the needs of habitation (Cherian, 2004). After 1192, Delhi came under the control of Islamic rulers, the followers of Islam, which like other religions claimed, '*we have made from water every living thing'* (Qur'an 21:30). This belief and the political compulsion of meeting the well-being of the habitants influenced the evolution of a distinct urban landscape dotted by three forms of the structure surrounding water: *first,* large water tanks and reservoirs, *second,* step-wells, and *third,* gardens. These structures were not new for the new locations. However, these were grand in scale, complex in a plan, and symbols of political power and human (to show care for the public) statements (Singh, 2010).

[1] Blueprint for water augmentation in Delhi, NHD, INTACH, p.V, March 1999.

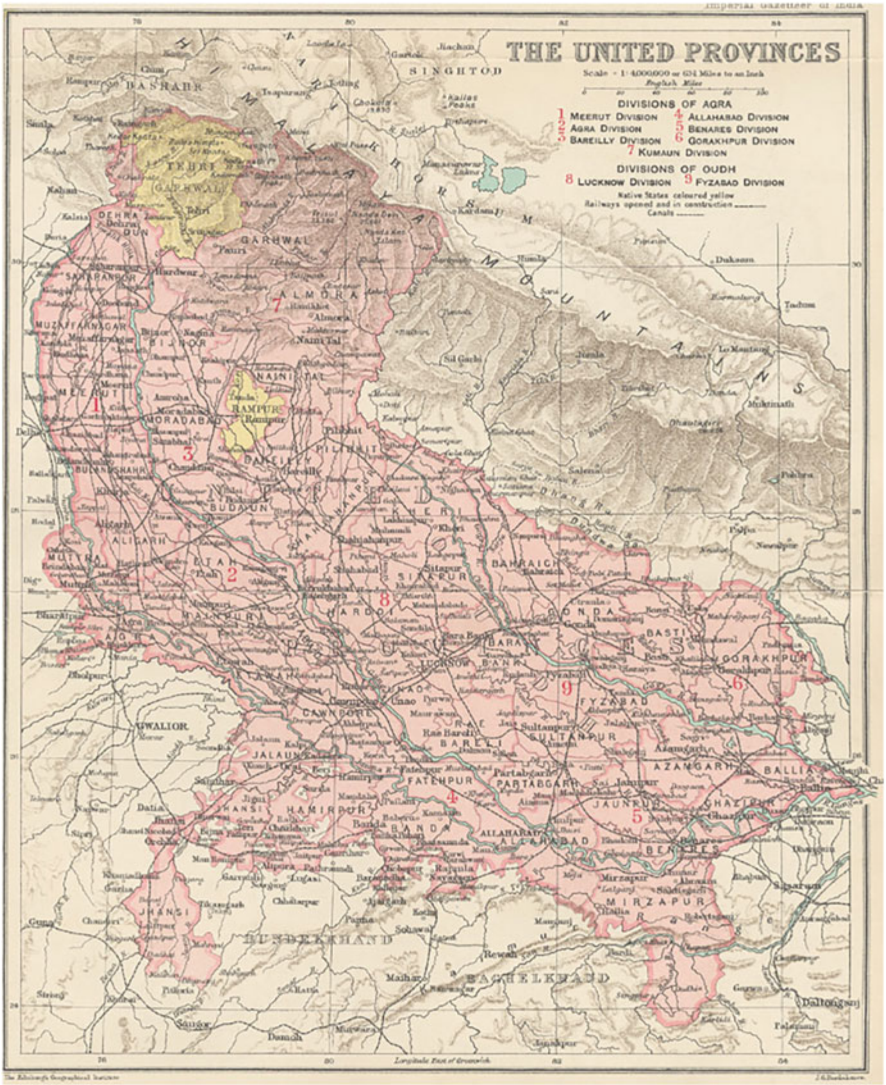

Fig. 8.1 The Yamuna and its cities (Source: Imperial Gazetteer Atlas, 1909, Available at http://dsal.uchicago.edu/reference/gaz_atlas_1909/ (accessed on 14/07/2012).)

Another popular water augmentation method was the construction of step wells. These wells, unique to India, create '*a link between underground water and surface life is as rich, colourful, and textured as India itself*', claims American photographer Morna Livingston, the author of *Steps to Water*. Her vivid photographic work focuses on step-wells in western India. These wells follow a common structural design: '*an excavation lined with stone allows the water level inside the cavity to fluctuate freely with the surrounding water table. Continuous steps from ground*

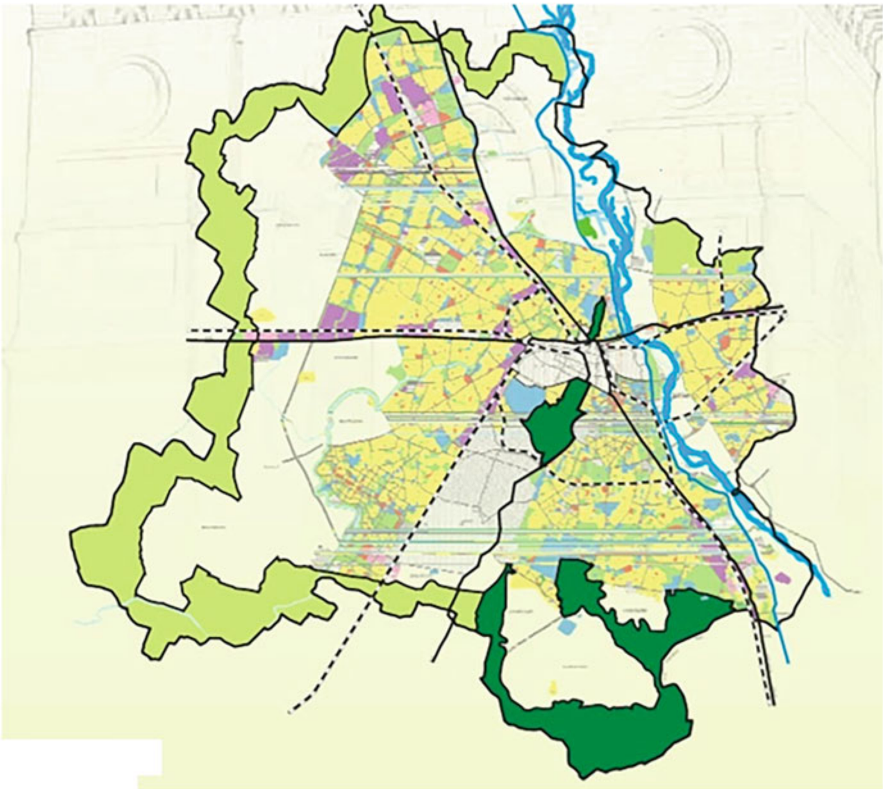

Fig. 8.2 Delhi and Yamuna (Source: GNCTD, 2010)

level to the bottom of the structure lead to water, no matter how great the variation in the water table' (Livingston, 2002: xix). Lort (1995) lists eighteen *baolis* (step-wells) from this period within the present megacity. All of these are located between the northern ridge and the southern boundary of the present megacity on the western side of Yamuna.

Two specific characteristics are noticed in the construction of these step-wells: these were mostly constructed by the men and women of repute from the society (including aristocracy and wealthy landlords) and the purpose of construction was twofold, first to invoke a sense of proximity to political power among the general population, and second, offering sweet water for the public (as pious and charitable activity). One such stepwell (at Naraina) claims, '*is this the water of the celestial river – cool, sweet and wholesome?...Thus exclaims the crowd of wayfarers when they proceed home, after drinking the sweet clear water of this well'* (quoted in Lort, 1997: 117).

These step wells survived in the landscape of the city amidst the changes in kings and emperors. This must have been possible due to local management, community engagement, and continuous utility for the people. Here nature, culture, and society seem to work in harmony at a specific location. It was an example of *collective consumption* that made the city of Delhi.

Another form of water practised and promoted during this period was visible (and invisible) in the construction of gardens. 'Delhi is (was) surrounded on three sides by gardens in straight lines, each one stretching to the extent of twelve miles' (Al-Umari, fourteenth century quoted in Singh, 2010). While promoting the water management practices of storage and conservation, the rulers in the middle ages, followed the saying in the Quran (3:15) to construct gardens: '*Say: Shall I give you glad tidings of things far better than those? For the righteous are Gardens in nearness to their Lord with rivers flowing beneath; therein is their eternal home; with spouses purified and the good pleasure of Allah, for in Allah's sight are (all) his servants'.* Tradition, devotion to faith, administrative necessity (of the agricultural economy), pleasure and aesthetics influenced the laying of innumerable gardens as part of broader water management practices during the period. This legacy, despite the considerable alterations during the last two centuries, has helped Delhi as one of the greenest cities in the world.[2]

The centrality of water in designing habitation and its sustenance according to local conditions remained intact. This was evident from the landscape works like gardens in the city. The location of the new city provided an opportunity 'to emulate the riverfront landscape of gardens of the previous Mughal capital city of Agra, which had a series of gardens lining the river on either side' (ibid:143–144). Within and outside the imperial city gardens of varying scales and functions—*baghs, bagichas, and bagichis*—were made possible with the availability of water through the canal linked to minor channels.

During Mughal times (1526–1857), the link between various forms of water continued and the structure was designed according to local terrain and the local patterns of rainfall. Delhi Gazetteer (1912) notes that '*..irrigation from bunds is a characteristic feature in all parts of the district lying under or near the hills. The principle is that of concentrating the rainfall to moisten thoroughly a given cultivated area, allowing surplus water to run or drain off; application of this principle was successfully made on a large scale by the former rulers of the country and in no respect perhaps does the civilization of the Mughal Empire show better than in this of artificial irrigation'* (p.127).

The Ali Mardan canal, or Western Jamuna canal, was a significant addition to the existing forms of water in the city. The purpose of the canal seems threefold: *first,* to bring assured water to the city; *second,* to connect it to intra-city sources through channels [Polier noticed watercourses running through every principal street (quoted in Thornton, 1858)]; *third,* to provide sufficient irrigation facilities for the hinterland. It did not act as a substitute for the existing water infrastructure. Rather it acted as a feeder system for the existing network.

[2] http://www.financialexpress.com/news/delhi-one-of-cleanest-greenest-cities-pm/287796/ (accessed on 11/08/2012).

The summer in Delhi was a critical factor in influencing the design of the water management system. Harvesting the water for its judicious use during these difficult days in the year was a way of life. It encouraged the creation of literary works and proverbs which still survive in society. Abdur-Rahim-Khankhana, the court poet of Akbar wrote: *'Rahiman pani rakhiye, bin pani sab soon Paani gaye na ubare, moti manas choon'* (Conserve water, as without this everything including pearls, humans, and lemons has no value). Besides these, recognizing the multiple values of water in many proverbs was prevalent in Delhi and its hinterland. The Delhi Gazetteer of 1912 notes:

> *There are many sayings in the popular vocabulary exemplifying this: —If it rains in Har, it will make (the country) prosperous. —The showers of Sawan are filled with pearls.—(In) the showers of Sawan, dry and moist (soil) all become green. —If it rains in Bhadon, then both harvest will be (good): while heat for Jeth and rain for Bhadon are pithily indicated as desirable in the forcible lines:-—Talk as a rule is good, but not too much; silence is good, but not too much. Rain is good, but not too much; sunshine is good, but not too much. But the more we get the better of rain in Bhadon, or sun in Jeth, or talk in our storytellers, or silence in our wives.* (p.112)[3]

The presence of a variety of water in social and cultural life was further complemented by the presence of the river Yamuna, in some or other way, remaining integrated into the daily lives of people in the city.

Nature was still an ally in the city not as an outsider, but as an insider. Cultural meanings were still part of state discourses while harnessing and utilizing various forms of water. Socially, it continued to shape daily life through various practices. These practices on one side reflected the deep-rooted social stratification based on caste, race, and religion and on the other side, they remained a vehicle to attain prestige, salvation, and *punya* (goodness) (Lort, 1995). However, nature was political as evident in the inscriptions on the stepwells in Delhi (Lort, 1995). If the rich from the community sought proximity to the political power of the time, the state itself used hydraulic structures as a weapon to exert control (Wittfogel, 1957) and/or command obedience.

The mid-nineteenth century was a revolutionary time for the municipal water system in the western world. The discussions surrounding miasmic and germ theories were influencing the redesigning of the system of city hydraulics in the western world. Its implications for the colonial cities were obvious. For Delhi, the Punjab Sanitary Commissioner, in 1869, suggested building waterworks for tapping the Jamuna and levying taxes to cover the cost. However, 'the Mofussilite wondered whether the inhabitants would agree to be taxed and whether the Hindus would accept Jamuna water if it flowed out of underground pipes' [P.A.R., 1869–70:132 quoted in Gupta, 1981: 88–89)].

In 1889, after a considerable gap of 20 years in conception and implementation (unlike Lahore which got the water supply system in 1876), Delhi witnessed the beginning of a new era in the water supply. Gupta (1981) notes: '*The water supply*

[3] All italicized words represent various seasons in northern India.

wells were located at Chandrawal, a village on the banks of the Jamuna. Its inhabitants were shifted out. The heavy cost, aggravated by the absence of any contribution from the Provincial Government, meant that the project was carried out in stages. The walled city was to be supplied first, followed by the western suburbs and then the Civil Lines – where the houses, spread out over a large area, unlike the crowded city, were adequately supplied with water from the canal. Shahjahanabad came first, because it included the Cantonment, and the project had originally been put forward as necessary for the health of the garrison' (p. 161). The seeds of infrastructural biases in the modern system were sown.

She further says, '*...the water supply scheme substituted purified river water for the traditional supply from the canal and the wells. The pure water made available by the waterworks helped to reduce the death rate and the incidence of typhoid, cholera, and the 'Delhi boil'. But the swelling population and the increased density, the fall-off in the supply from wells and from the canal, the need to flush the new open drains in order to avert plague and to water the roads where increasing traffic threw up more and more dust, the needs of the new sewage farm, all made it imperative to secure more water, both of the potable, and the unfiltered variety. The consumption of water in 1904, with two thousand private connections, was more than double of what it had been in 1900'* (ibid:p.166). The new water system, premised on public health needs, was a departure from earlier understanding which included need fulfilling, cleansing characteristics, and modes of salvation.

The creation of a new capital, which took almost 20 years to complete, put a severe strain on the existing system. It also brought institutional changes in the city water management. To deal with water supply amongst four urban bodies—the Delhi Municipal Committee; the Delhi Civil Lines Notified Area Committee; the Cantonment Authority, Delhi New Cantonments; and the Imperial Delhi Municipal Committee—a Joint Water Board was constituted through the enactment of the Delhi Joint Water Board Act, 1926. Its objective was 'to provide for the maintenance of the works established to supply drinking water in bulk for the urban area of the city of Delhi'. However, it did not intend to reach the 184,032 rural inhabitants residing within the official territorial limit of Delhi.[4] The functioning of this Board was polarized since its inception. Gupta (1981) notes that '*in the first joint service worked out for the two Municipalities... friction soon developed. The charges were made arbitrarily, and the Delhi Municipality refused to pay (C.C.O., Education, F.4 (35)B/1925). They were also dissatisfied with the reduced quantity of water available to them (a large portion was going to the Notified Area, New Delhi, and the new Cantonment). The Delhi municipal representatives on the Water Board Committee were militant Congress sympathizers'- Asaf Ali, Lala Pearey Lal, Lala Sri Ram – and they were able, by taking a firm stand, to get better terms for the Municipality'* (p.220). The inequity in treatment between the new imperial city (including civil lines and cantonment) and the old city was evident in distribution, funding and other

[4] In 1921, the urban population of Delhi was 304,420.

spheres. Legg (2007), using governmentality as a framework, demonstrates the contrast in these treatments in the context of decongesting the city.

It affected the well-being of the old city greatly as the inhabitants, on one side failed to receive due attention from the authorities and on another side, they were gradually forced to forget the wisdom of the past with constant neglect of traditional hydraulic structures. The waves of urbanization already created concerns about congestion (ibid). The need for decongesting the Old City arose because it posed a danger to the whole of Delhi. Hume (1936) in *the Report on Relief of Congestion in Delhi* wrote '*the city contains numerous well-defined slum areas of the meanest type and abounds in insanitary lanes and dwellings of constituting a menace to the public health of the whole urban area of Delhi'*. Focus on public health has been a significant feature of the modern municipal water system.

The limitation of the colonial design of urban water management was the result of some interrelated factors: one, the inability to blend with the design suitable to local climatic conditions; two, the distaste for the existing system. It was performed selectively, a 'selective modernity' (Kaika, 2005). Moreover, the colonial interventions brought a paradigm shift in introducing modern water as a monolithic substance with uniform value. The colonial urban water supply left a polyglot legacy of institutions, modernity, and ideology to be carried forward into a new political state with Delhi as its central location.

The Interim Plan for Greater Delhi (GoI, 1956) notes that,

> *In the case of water supply, the problem of the enormous increase in demand for filtered water is becoming seriously acute and authorities feel their inability to meet the increased demand since the capacity of existing reservoirs is not much to hold adequate quantum of filtered water for the necessary supply./ In this connection the tapping of new sources to supply water to cope with the increasing demand should be envisaged and immediate measures taken so that the calamity of an impending insufficiency of supply may be avoided well beforehand. Prevention of wastage from unnecessary use and provision of adequate water supply in the newly developed colonies and many of the existing refugee colonies are some of the important problems that require immediate solutions.* (p. 73)

Interestingly, the institutional design of water provisioning for the megacity followed the usual prescription of 'water for all', but with a rider of 'feasibility' of the water utility. As seen in previous sections, the provisioning of modern water followed a stratified trajectory from the core to the periphery: first the rulers, then its associates, and if feasible, then other urban residents. Segregation was inbuilt into its design from inception. It very much dictated the geography of the modern hydraulic in the city. Another dimension of this was urban centricity. Despite, the formation of a capital territory in 1915, the state water provisioning for rural areas within the city remained a distant dream. Since Northwest, South West and South areas in Delhi are predominantly rural, the historical neglect (or lack of foresight) in the hydraulic planning still affects a large portion of the megacity. Since the ideological premise of singular and modernist water remained embedded in the postcolonial governance and its apparatus, the compartmentalized treatment of waters became a norm. In colonial times, the rural areas continued to rely on other waters, but with independence, the desire for modern water grew, which got articulated in the vision of 'water supply for all' through the state-controlled network.

At the end of the twentieth century, the vision of a singular modern water supply in Delhi remained a distant dream. While replying to a question in the Delhi Legislative Assembly, the Chief Minister of Delhi stated that no timeline can be fixed for a 24x7 water supply in the city.[5] However, gradually, the limitation of the current vision has seen two major additions: one, the increased focus on other waters; and two, conservation at a household level.

8.4 Crisis in Water

Three elements viz., *first,* the transformation of 'waters' into 'water'; *second,* the increasing monopoly of the state in managing this water for distribution through a centralized hydraulic system by gradual dispossession of the indigenous methods of extraction and control; and *third,* incorporation of 'segregation' as an instrument to allocate this resource differently within the megacity, provide foundations to the multiple risks experienced in the urban water management system (Kumar, 2013). He further identifies:

> *A South megacity experiences two broad categories of risks- first layer risks and second layer risks. The first layer of risks mainly concerns five essential attributes of domestic water supply: sufficiency, accessibility, safety, acceptability, and affordability. The empirical results confirm the presence of these risks in the water supply system of Delhi. Existing inequity, denial of the right to water and infrastructural biases in the megacity water system aggravate the experience of these risks at the household level. This gets further compounded during the extreme summer season. The relationship between this category of risks and the source risks is quite obvious from the field results. As the megacity struggles with the first layer risks, the emergence of new drivers like globalization, climate change, new urban middle class, and regional politics create fresh conditions for second layer risks. Besides influencing the first layer risks, these second layer risks bring elements of uncertainty and unpredictability to the system. Interventions in these risks are happening at different scales with varied outcomes*. (p.45)

The supply-demand gap has another interesting dimension. Since supply comes from outside, the shift in responsibility is quite easy. The city uses it as a potent weapon to exert pressure outside and shirk responsibility within. It sidelines the larger issues of equity, justice, right, geography, and culture. The pre-fixation of the postcolonial state with its immediate predecessor obscures the centuries-long historical traditions in city making and the centrality of water in it.

[5] Starred Question no. 187 dated 29/06/2009.

8.5 Holistic Water Governance

> *Successful management entails both 'hard' investment in solid and lasting infrastructure to provide water services over the long term – thus reducing risk – and 'soft' investment in capacity, science, data collection and analysis, and information about water, so that uncertainties are continuously reduced. It will also require investment in alternative and innovative forms of water service provision, including the restoration of water services provided by healthy ecosystems, which have thus far been largely ignored as entry points for water management.* (WWAP, 2012: p. 356)

The cities in the global South face the dual challenges of poor infrastructure to overcome the existing and future risks: *first,* maintaining the decaying water assets; and *second,* building new infrastructure and services (Cashman and Ashley, 2008). These management approaches are based on the vision of a 24 × 7 uniform supply of water. This vision gets its scientific credibility through the adoption of a fixed normative volume of H_2O needed for everyone. The normal yardstick for individual needs provides a powerful tool to pursue accumulation, extract more resources, and propagate the myth of scarcity. It produces three facts: (i) domestic water uses are identical in value and quality; (ii) domestic water needs are more (quantity-wise) for the users of modern technology; and (iii) domestic water needs are uniform and unaffected by the season. These facts armed the technocrats to negate the political negotiations.

Globally, three prominent concepts are promoted to redesign the urban water management strategy – integrated urban water management (IUWM), soft path, and water--sensitive cities. All three disregard the dominance of traditional engineering or hard approaches which focus on supply-side interventions. The buzzword 'sustainability' seems a common thread in these approaches as they believe in 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.[6] Another common factor is the increased attention on demand-side interventions. IUWM is driven by international organizations like the UN and World Bank, whereas the proponents of 'soft path' and 'water sensitive cities' are testing it in the cities of Canada and Australia respectively.

Anil Agarwal and Sunita Narain of the Centre for Science and Environment (CSE), Delhi edited a highly popular report titled 'Dying Wisdom: Rise, fall and potential of India's traditional water harvesting systems' (1997) which argues for the revival of local water harvesting systems and claims that this revival would not be an archaic return to the past. In Delhi, it campaigned for the popularization of rainwater harvesting, the revival of water bodies including the river Yamuna, and the conservation of the historical and cultural landscape of the city. Looking inside the city seemed attractive for three reasons: reducing (or limiting) external dependence;

[6] United Nations General Assembly (1987) *Report of the World Commission on Environment and Development: Our Common Future*. Transmitted to the General Assembly as an Annex to document A/42/427 - Development and International Co-operation: Environment. Retrieved on:16/08/2012.

reviving internal sources; and advocating increased engagement of the 'local' in overall water management.

Hosagrahar (2011) argues that the 'prevailing discourse on demand and supply of water obscures the loss and reinterpretation of features in the hydrological landscape through modernity and colonialism and the more recent trends in globalization and hypermodernity'. She feels that a 'view of modernity has framed contemporary approaches and interventions' (p.112). The need for a paradigm shift in urban water management has been noticed by the WWAP (2012) also.

> *There is, therefore, a need to replace the old ways of sector-based decision-making with a wider framework that considers the multiple facets of the development nexus, and the multiple risks and uncertainties, costs and benefits of every decision, in light of a long-term goal. In this regard, national governments have a major contribution to make by creating stronger, more collaborative, flexible institutions, adopting appropriate financing mechanisms to ensure the long-term viability of water services and infrastructure, and ensuring that water considerations are mainstreamed into everyday policy decisions as well as international governance processes. Water managers have a responsibility to continuously inform these processes and to raise awareness of the centrality of water in the development nexus.* (p.360)

However, it cautions against the application of historical understanding in current scenarios.

> *Knowledge in dealing with risks and uncertainties often comes from past experiences, observations and records. However, these are no longer adequate indicators of the risks and uncertainties faced by future water planners, managers, users and policy-makers, due to uncertainties generated by future changes in population growth and spatial distribution, water consumption patterns, socio-economic development, and climate variability and change. It is, therefore, crucial to understand the sources of uncertainty and learn how to analyse, internalize and cope with the risks that arise due to these uncertainties.* (p. 256)

It may be true in dealing with unknown uncertainties, but in cases of known uncertainties history and culture do offer opportunities to re-examine the path chosen to secure the water's future. As Hosagrahar (2011) comments in the case of Delhi:

> Studying the cultural landscapes of water through a historical perspective gives a window into alternative views, technologies, interpretations, and practices that worked well once. An opportunity to examine whether they can be modified to work well again. Such a cultural view of water management also allows us to reflect on transformations in its premises and as such, reframes discussions of water in megacities and our responses to it. (p.127)

Dealing with the multi-layered diverse risks of megacity water management demands a multi-pronged approach. However, if the ideology (singular and modernist vision of urban water) remains intact, the tools to achieve this ideology would continue to prevail over any radical change.

There is a strong case to bring a paradigm shift. History provides evidence; culture becomes the driver; science acts as an innovator, and politics lends support to displace the existing ideology of singular water first. Waters is not a mere cultural past, but it is very much visible in present. The practices of multiple waters are observable in the raw water portfolio (diverse sources including surface water, groundwater, and ranny (sic) of the Delhi Jal Board (government supplier of water); bottling industries (Hamlin, 2000); in household uses (Gyawali, 2010); and even in institutional handling (stormwater, groundwater, drainage, irrigation, etc.). For domestic water supply, the most compelling evidence comes from two sources: first, the arguments for a dual water supply system or use of recycled wastewater; and second, the evidence emerging from the household approach.

The consideration of multiple waters in the ideology opens up various opportunities to design strategies to manage some of the risks present like diversifying source portfolio to reduce external risks; overcoming the risk of institutional fragmentation; revitalizing the historical and cultural landscape to reconnect with local resources; delinking the essentiality from other needs of water; and bringing local (seasonality, ecology and politics) back into consideration.

The management of risks present in megacity water is an ongoing struggle for the state and the households. The state often relies on engineering solutions to reduce the risks. This engineering fixation has continued in the case of rainwater harvesting measures in the megacity of Delhi. Here, the technical design and its promotion are themselves becoming barriers to maximizing the potential of rainwater. Despite several initiatives to promote the harvesting of rainwater, Delhi has not seen much success in water management as risks continue to be present in the system, and this has left the households to devise strategies to cope with these risks. Drawing from tradition, the households rely on segregation, prioritization, and diversification to reduce the impact of these risks. For a household, water is not a singular and uniform element. It practices multiple forms of water. The distinction between the drinking/cooking water and the washing and other water uses in the household is a time-tested risk reduction strategy. The coping strategies are acting as safety valves in the overall scheme of megacity governance. These coping strategies may seem to be the result of the failure of the state's commitment to adequate universal supply, but these also offer opportunities for the state to redesign its water management system strategically.

Conservation of water is a preferred strategy to reduce risk and enhance water security. In the households, this has been traditionally practised. However, in a megacity, these practices depend upon the characteristic of habitation. The planned colonies, in comparison to the villages (rural as well as urban), are less inclined to follow certain practices like the use of clay pots as water infrastructure. The state in its approach needs to factor in this kind of spatial diversity of the megacity. This targeted approach will be more strategic, focused, and rewarding (in outcome).

8.6 Discussion

The uniform strategy of water provisioning has not seen much success in Delhi. The centralized management of water provisioning fails to look beyond the singular form of water. This has obscured the historical and cultural landscape of water in the city. There is no place for the neighbourhood and its practices in this approach. It led to the neglect of internal water and increased dependency on external water giving a false sense of security to the city. The change in this strategy is imperative in today's environment. This would require a two-pronged approach: the dispersion of the existing management structure and the adoption of the legal right of universal provisioning of the minimum threshold in domestic water. The dispersion of the existing management structure would entail the involvement of neighbourhood communities in the decision-making process, the conservation measures, and the revival of historical and cultural landscapes of water. The state needs to redesign its role as facilitator and regulator for the water provisioning in the megacity.

To sum up, the existing interventions to reduce risks in megacity water postulates to look beyond the engineering solutions, factor in the spatial diversity of the megacity, revisit the historical and cultural landscape of water and disperse of the management structure with the conferment of legal rights to water for the domestic provisioning. This multipronged approach will create conditions to address the multi-layered risks simultaneously.

8.7 Conclusion and Recommendations

In a more urbanized world, it is obvious that State has assumed the responsibility of harvesting and provisioning water to its inhabitants. Since the middle of the nineteenth century, in the belief of controlling water, the State started designing its water governance architecture ignoring the co-existential character of human societies of the past. Its devastating consequences are apparent in excessive extraction, scarcity, wastage, behavioural neglect, inequitable access and deprivation of certain habitations in the cities. It has also led to ignorance about seasonal variations of resources and availability, which has become more palpable in times of climate change. Indigenous wisdom about this essential element allows us to lessen these damages, as demonstrated in this paper. In conclusion, important recommendations are as follows:

One, the idea of control over water is flawed. Modern technology may provide a temporary sense of controlling nature. However, experience shows that instead of control, society must continue living harmoniously with nature. This would require revisiting the narratives of power and control over water. In urban setting, it needs to shift from dominance to co-existence.

Two, water governance by integration has been advocated to maximize utilization and reduce wastage (WWAP, 2009, 2012). This integration of compartments misses the obvious: the sum is more than the total of each component. A holistic understanding of water is essential to inform the approaches to water governance in urban areas. It is more than the integration.

Third, urban water management is confronted with multiple risks. Concerns about supply and demand, on both sides, exacerbate the risks experienced by the inhabitants. Cities must learn to do portfolio management of water risks. On the supply side, it needs to widen its source base using harvesting and conservation as key factors to enhance the availability of water. On-demand side, it needs to distinguish between essentiality and necessity, and design its policy instruments appropriately.

Fourth, seasonality in water in tropical countries is often ignored aspect. Cities in these areas have varied requirements and this needs to be factored into governance.

Fifth, conservation is not a dominant factor in current urban water governance. Provisioning by the State tempts inhabitants to become free riders. Reversing this behaviour would require the concerted efforts of every stakeholder.

Sixth, urban water institutions must ensure accessibility, availability, and affordability of quality water in reasonable quantity for every household. The right to assured water must be integral to the right to life.

Seventh, urban life requires the development and promotion of green spaces. Urban green spaces are not only the spaces for recreation but act as locations for absorption of rainwater, which helps in the recharging of groundwater. These green spaces need to be redesigned with treated water/wastewater.

Eighth, the urban water supply system works on norms of requirements. These are fixed mathematical articulations ignoring the needs evolved culturally in a particular location. Politically and technically fixed norms may sound appealing. However, it needs to be discarded because of its futility in water management in cities. Large cities ignoring their internal inequity and unmindful wastage keep projecting their demand at the cost of others. Norms must be culture and geography-specific for realistic assessment.

Ninth, indigenous water wisdom is inter-generational. Advocacy on water conservation needs to account for this. In urban centres, inter-generational understanding of water wisdom is being forgotten. The state in close collaboration with civil societies must acknowledge these aspects in their policy praxis for sustainable water management in urban areas.

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Chapter 9
Interactions Between Changing Climates and Land Uses: The Case of Urmia Lake, Iran

Mansour Ghanian, Omid M. Ghoochani, Latif Mohammadzadeh, Matthew Cotton, Gul Özerol, and John P. Tiefenbacher

Abstract Iran is experiencing rapid population growth coupled with the negative impacts of global warming and land-use change. These impacts pose significant challenges for water managers and planners trying to match supply and demand. The twin challenges of land-use management and planning for climate change are exemplified in the case of Lake Urmia—situated in a closed basin in northwestern Iran. The basin supports agriculture from water stored in several reservoirs. Lake Urmia was once the largest saltwater lake in the Middle East and North Africa. It has recently become an environmental concern due to shrinking by 80% within the last 30 years. The dropping water level is exacerbated by a combination of declining precipitation and land conversion practices. Water loss provokes severe socio-environmental consequences (including chronic health impacts, child mortality risks, and agricultural threats) that are similar in magnitude to those seen in the Kazakhstan–Uzbekistan Aral Sea disaster. This chapter explores the interactions

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between climate and land use, and reveals the difficulties faced by short-term land-use policies that favor urban expansion and agricultural productivity over long-term protection of ecosystems. Lessons from indigenous water management practices in Iran are drawn upon to assess the long-term social sustainability of common pool resource management in the region.

Keywords Climate change · Land-use change · Iran · Lake Urmia Basin · Water management · Wicked problems

9.1 Introduction

Environmental degradation of arid and semi-arid ecosystems is exacerbated by global warming and land-use change, both of which alter the provision of water and natural resource, resulting in thirst and hunger challenges that undermine progress toward Sustainable Development Goals (Ghanian et al., 2022; Winslow et al., 2004). This interconnected set of environmental challenges constitutes a *super-wicked* problem, based upon compounding positive feedbacks that reinforce changes in environmental systems from human activities (Ghanian et al., 2020; Eskandari-Damaneh et al., 2020). Urgent action is required to avoid a tipping point of non-reversible environmental harm, yet the people generating the changes are the same people seeking a solution. Land-use governance practices commonly discount long-range futures in a way that fails to address the core environmental challenges of water, climate, and food productivity within an ever-narrowing window of opportunity (Levin et al., 2012). In this chapter, we consider the intersection of two environmental policy domains—one concerning climate change adaptation and the other concerning land-use change and economic productivity. The reinforcing interactions of an ongoing global land grab for agriculture, increasing pressure on water resources in arid and semi-arid regions, global population increase, and economic growth, create a deepening vortex of environmental degradation in certain regions. This chapter explores the interactions between global heating-induced changes, land-use decision-making, and the role of indigenous knowledge at an environmentally sensitive site experiencing decline—the Lake Urmia Basin (LUB) in Iran, among the threatened saltwater lakes of the Middle East and North African (MENA) region. This assessment provides insight into the management of threatened lake ecosystems globally.

9.1.1 The Global Hunger Challenge

Global population is expected to grow from approximately seven to nine billion people by 2050 and will be a key challenge for sustainable development (Bene et al., 2015). Almost one billion people suffer malnourishment, primarily in Asia (578 million) and Sub-Saharan Africa (239 million). Alleviating chronic hunger is one of the biggest sustainable-development challenges (Dahimavy et al., 2015; Ghoochani et al., 2017a; Wheeler & Von Braun, 2013). Agricultural productivity and food distribution must outpace population growth to resolve hunger and malnutrition (Azadi et al., 2015). An additional 200 million extra tons of livestock products and 1 billion tons of cereals per annum are needed and the growing wealth of people in middle-income countries necessitates a 60–70% increase in annual agricultural output is required; such growth would be unprecedented in human history (Ghoochani et al., 2017b). The growth of agricultural capacity is vital for the improvement of standards of living and for the avoidance of the Malthusian trap of using food abundance to further population growth (Kögel & Prskawetz, 2001). The imperative for such agricultural growth and modernization is strongest in developing countries, where the challenge is not just to provide food but to make sure that distribution networks ensure food access and encourage food security (Abbasi et al., 2016) in line with Sustainable Development Goal #2—to end hunger, achieve food security, improve nutrition, and promote sustainable agriculture (Behera et al., 2019).

One person in 20 continues to be in danger of undernourishment in developing countries, irrespective of whether agricultural production doubles by 2050. This is equivalent to 370 million hungry people. Most of these people live in Sub-Saharan Africa and Central and Southern Asia (Dubois, 2011). The agricultural sector is the engine of social development and economic growth, particularly within the poorest regions, though sustainable agriculture is vital to ensure the long-term provision of ecosystem services like water quality, biodiversity, and carbon management (Powlson et al., 2011). The demand for food commonly prompts a shift toward the intensification of food systems (Garnett et al., 2013; Godfray & Garnett, 2014). However, expansion of agricultural land use is often a central cause of environmental degradation—commonly through deforestation (Barbier, 2004; Fuller et al., 2019). Economic globalization shrinks cropland availability and sometimes triggers land-cover conversion and deforestation under conditions of land scarcity, and few developing countries have managed a transition that simultaneously increases agricultural production and forest cover (Lambin & Meyfroidt, 2011; Zambrano-Monserrate et al., 2018). To maintain ecosystem services produced by forests and simultaneously remedy food scarcity, improvements to agriculture must be made through *sustainable* forms of intensification involving integrated assessments of natural resources and the drivers of food demand.

The twentieth century achieved agricultural intensification through high-yield crop varieties, new fertilization technologies, irrigation, genetic modification, and pesticide use. Collectively, these have contributed to enormous gains in food production, though they also altered ecologies and the patterns of resource availability with serious adverse consequences for local, regional, and global environmental quality and socio-economic impacts on vulnerable communities (Rasmussen et al., 2018). Cropping patterns and land management practices have an enormous effect on freshwater availability, biogeochemical cycles, and soil quality (Palatnik & Roson, 2009). Land use plays a very important role in methane generation, carbon cycling, and carbon storage (Azadi & Barati, 2013), strongly impacting atmospheric composition (World Bank, 2008). Land-cover and land-use change is a serious driver of global environmental change (See et al., 2015). The pursuit of food security is both subject to and the cause of environmental pressures and is a key challenge this century (Ghoochani et al., 2017b). Accelerated global warming confounds the prediction of climate change trends and coupled with the direct destruction of natural habitats threatens terrestrial biodiversity (Anderson et al., 2016) and agricultural productivity (Gornall et al., 2010). These will be acute challenges for sustainable development under the climates of the MENA region (Kaniewski et al., 2012; Sowers et al., 2011; Hameed et al., 2020), and in Iran in particular (Amiri & Eslamian, 2010; Mahdavi Damghani et al., 2019).

9.1.2 Anthropogenic Climate Change

Greenhouse gases are increasing in atmospheric concentration. Carbon dioxide (CO_2) levels have now exceeded the 400-ppm benchmark (the concentration is over 418 ppm in early 2022), and the global mean temperature has risen by 0.8 °C since the 1850s. The warming has been evidenced by three independent terrestrial and maritime temperature records (Pachauri et al., 2014). The globally averaged combined land and ocean surface temperature data as calculated by a linear trend reveal a warming of 0.85 °C [0.65–1.06 °C] between 1880 and 2012 (Wheeler & Von Braun, 2013). The interactive effects of carbon-based fuel use and land-use changes upon anthropogenic warming are described as a *super-wicked problem* (Levin et al., 2012) that has complex and interrelated impacts on both human and natural systems (Foley et al., 2005). Changing climates driven by anthropogenic warming of the atmosphere are bringing myriad socio-environmental impacts: including changes in rainfall patterns, reduced global snow and ice coverage (including glacial retreat), increased frequency and severity of weather events, rising sea levels, and ocean acidification (Wheeler & Von Braun, 2013). There will be disproportionately greater changes to spatial and temporal patterns of precipitation and temperature on land than over oceans, toward the poles than near the equator, and in arid regions more than humid regions (Rogelj et al., 2012).

Food productivity is consequently dependent upon agricultural resilience in the face of changing climates, both in the short and long terms (Ghoochani et al., 2018). Though some regions may benefit in the immediate future from longer growing seasons or a shift to more temperate climates, the influence that global warming will have on feed, fodder, or food production, on livestock health, and on the patterns of trade of food and food products will be profoundly negative (Wheeler & Reynolds, 2013). Impacts will vary with the degree of change in regional climates (i.e., the associated changes in precipitation and thermal patterns compounded by local and/or regional drivers of micro-climates). But changing climates disrupt both food production and food demands locally, where communities rely on local farmers' markets and their own food production (Wheeler & Von Braun, 2013). The net effect of global warming is probably going to weigh down or reverse any progress we have made toward a world without hunger.

9.1.3 Land Use Change

'Land-grab' concerns have been raised about acquisitions of large agricultural properties and resulting in the destruction of natural ecosystems and displacement of local communities (Teklemariam et al., 2015). Others have conceptualized transnational land acquisitions within the widely evolving global capitalist development framework, and the relationships among political economies working toward confronting the converging global crises in food, energy, financial capital, and global warming. Large portions of developing countries are cultivated by smallholders, often families based within indigenous communities. The International Fund for Agricultural Development—IFAD (2013) estimates that about two billion people in developing countries are small landholders and they produce about 70% of the developing world's food. This is, however, an increasingly precarious livelihood strategy (Murshed-e-Jahan & Pemsl, 2011) that returns low yields (Chamberlin et al., 2014). Under conditions of rapid population growth and urbanization, agricultural policymakers frequently seek external investment and trade agreements to meet domestic national and regional food demands (Kalamkar, 2009; Hallam, 2009; Lavers, 2012), and Iran is particularly harassed by external economic sanctions. Many smallholder farmers also suffer from uncertain legal rights and face the prospects of dispossession (Palmer et al., 2009). Unmitigated land-use instability is pushing the global agricultural sector to a tipping point for subsistence and smallholder farming societies (Anseeuw et al., 2012). Interrelated processes of economics and land conversion are also driving toward this tipping point (Azadi et al., 2011). Although land-use practices vary greatly internationally, their outcome is usually susceptible to land-grabbing. This universal problem—the acquisition of natural resources for immediate human needs—frequently occurs at the expense of the environment and this is often viewed to be a global tragedy of the commons (Dell'Angelo et al., 2017).

The magnitude, pace, and spatial reach of alterations of Earth's surface are unprecedented (Nunes & Rezende, 2016). Key aspects of the functions of environmental systems are severely impacted globally by changes of land covers and land uses (Lambin et al., 2001). We are seeing: declines in biodiversity globally; changing climates that are impacting locally, regionally, and globally; and degradation and desiccation of soils. These changes affect the capacities of biological systems to support human needs by altering and disabling ecosystem services (Chhabra et al., 2006), with knock-on impacts to livelihoods and economic development opportunities. Since 1850, about 6 million km^2 of forests and woodlands and 4.7 million km^2 of savannas, grasslands, and steppes have been converted due to the expansion of croplands around the world. Approximately 1.5 million km^2 of cropland have since been abandoned in formerly wooded areas and 0.6 million km^2 have since been abandoned in grassland environments (Lambin et al., 2001). Land-cover changes to short-term transitional conditions (such as forest succession under slash-and-burn cultivation) also are widespread (Agrawal et al., 2014) as are the most severe conversions of expanding cropland and pastoral land into pristine natural ecosystems (Power, 2010). From 1980 to 2000, concerns grew about environmental services and global biodiversity because approximately half of new agricultural lands of the tropics derived from intact forests, and another 28% came from disturbed forests (Gibbs et al., 2010). Rapid deforestation throughout the tropics, in turn, has global implications for sustainable development, global warming, and biodiversity conservation (Lasco, 2008) because of the alteration of precipitation and regional temperature patterns by land conversion and changes to transpiration rates.

9.1.4 The Interaction Between Land Use and Climate Change

Land-use and land-cover change is profoundly disturbing to terrestrial ecosystems, interacting with anthropogenic heating of the atmosphere which drive climates to change (Azadi & Barati, 2013; Lambin & Meyfroidt, 2011). This is specifically relevant to uncontrolled land conversion for agriculture (Backlund et al., 2008). This is principally driven by economic growth, increasing population density, and urbanization (Azadi et al., 2011) which make it almost certain to happen to many parts of the developing world (Putro et al., 2017). The trends, intensities, and drivers of agricultural land conversion vary by country, however. Land conversion has multiple driving factors operating over a variety of temporal and spatial scales, each with differentiated impacts on the human environment (Verburg et al., 2013; Bryan et al., 2016): these include the use and demands of natural resources; cultural, political, aesthetic and moral values; and economic and technological processes and policies. Managing the complexity of land conversion for agriculture requires the mixing of diverse stakeholder values through sustained engagement and policy construction to form appropriate strategies that will preserve and prevent conversion of agricultural lands to other uses (Löhr, 2010). Authorities throughout the developing world have used such measures to prevent conversion of agricultural land to other uses with varied success (Azadi et al., 2011).

The interaction between land-use decision-making and global-warming mitigation efforts is key. Rapid anthropogenic warming is driven by activities that produce greenhouse gases (principally carbon dioxide and methane) and from changes in the conditions of land covers that can also augment greenhouse gas emissions such as the drying of wetlands and peatlands (Vitousek et al., 1997) and the drying out of forests that increases their susceptibility to wildfires. Land-cover changes also affect local climates by changing surface energy and water balance. Humans have simultaneously transformed the hydrological cycle to produce freshwater for irrigation, industry, and domestic consumption (Cunha et al., 2015) which can alter the characteristics of wetlands and their capacities as carbon sinks. Furthermore, anthropogenic nutrient inputs to the biosphere from airborne and waterborne pollution and fertilizers exceed the natural capacities to absorb them and have widespread impacts on maritime, estuarine, and freshwater ecosystems (David & Lal, 2013). Land conversion also drives declining biodiversity through the destruction, modification, and fragmentation of habitats, the degradation of soil and water, and the overexploitation of native species (De Las Heras, 2014). Each type of land-cover change is tied to other secondary environmental impacts. Wetland drainage, for example, can affect biodiversity, trace gas emissions, soil, and hydrological balance. But the secondary impacts of land-cover changes are difficult to differentiate from natural variation. Climatic change and water flows are a case in point (Meyer & Turner, 1992). Environmental changes of either kind become global changes in either of two ways: either through top-down impacts as the global effect of net GHG emissions causes warming that influences local conditions, precipitation patterns, sea-level rise, salinity intrusion, or bottom-up impacts wherein drying due to warming interacts with micro-climatic conditions, and land types are altered by broader macro-trends in environmental change. The latter generates an accumulation of localized land-use changes that sum to global significance (Pachauri et al., 2014). Land-use change contributes to both kinds of global environmental change. It can cause global systemic changes through trace-gas accumulation and generates local cumulative impacts like soil degradation, biodiversity loss, and hydrological change that have broader regional-national-international scale interactions with global climate systems. It is the interaction between the macro-and micro-scale effects that yield global environmental impacts with negative outcomes for humans and natural systems.

9.1.5 Climate and Land Use Change in Iran

Like many other developing countries, Iran's climates and land uses are both changing rapidly. These changes pose significant challenges for water managers and planners working to match supply and demand (Barati et al., 2018). Iran is 29.2% arid, 20.1% semi-arid, 35.5% hyper-arid, 5% Mediterranean, and 10% wet. Water and environmental management are among the foremost challenges for policy-makers (Jowkar et al., 2016). The population of Iran has increased rapidly since 1950, reaching approximately 75 million by 2011. It is projected to exceed 100 million by 2050. This growth has increased resource scarcity within the semi-arid regions of Iran. Water is particularly scarce due to the high levels of consumption in petrochemical industries, for agriculture, and domestic use. Drought frequency has increased and has been exacerbated by changing climates.

Changing climates and land uses are the principal environmental challenges Iran faces (Tahbaz, 2016). Their impacts on hydrological and bio-geological functions impact the behavior of the terrestrial components, and rapid growth increases the severity of impacts from anthropogenic global warming (Stephenson et al., 2010; Mahdavi Damghani et al., 2019; Karimi et al., 2018). The primary impacts are decreased snowpack, earlier snowmelt, altered patterns of precipitation including watershed desiccation, increased winter precipitation that causes flooding, drought, and higher summer and lower winter temperatures. When these exogenous factors are augmented by rising water demand, it becomes increasingly difficult for authorities to plan for and meet future water needs. Historically, annual rainfall in Iran has been approximately 250 mm, less than one-third of the global average (860 mm). Sparse precipitation combines with erratic rainfall patterns (Abbasi et al., 2016) that significantly increase flood risk in populated areas (Taherei Ghazvinei et al., 2016). Despite low average annual rainfall, peak-flood intensity continues to increase (Panahi et al., 2010). Analysis of daily rainfall confirms that extreme events occur across the country, and areas with impermeable surfaces are very likely to flood in the wake of extreme rainfall (Darabi et al., 2020).

While changing climates impact the stability and productivity of farmland, the acreage of farmland in Iran has expanded by more than 900% (from 2.6 to 24.5 million ha) and natural forests, rangelands, and bare lands have decreased. Forests have shrunk by about 6.6 million ha between the 1950s and the 1990s (Bahrami et al., 2010) and more is predicted to occur in the 2020s and 2030s as forests are consumed for residential areas, agricultural lands, and grassland for animal production (Joorabian Shooshtari et al., 2020). The projection for 2030 indicates that agricultural land will be converted to urban uses, will be lost to salinization of soils, and will be fragmented to support infrastructure. Flooding has increased substantially in Iran while freshwater reserves have diminished (Abbaspour et al., 2009; Darabi et al., 2020). Natural resource stocks, ecosystem services, and resource demands are increasingly imbalanced. Iran is therefore exemplifying the super-wicked interaction between natural resource management decision-making, agricultural land productivity, food security, water quality and supply, forest cover, and wetland biodiversity under conditions of increasing aridity, more frequent and more widespread droughts, and increasing flood risk.

9.2 The Case of the LUB

The LUB is an example of how changing land uses and global warming interact in an environmentally threatened ecosystem. Lake Urmia is located between the Iranian provinces of East Azerbaijan and West Azerbaijan and has a catchment area of 51,876 km^2 (Hassanzadeh et al., 2012b). The LUB contains fertile land that is used for agriculture supported by several reservoirs. Seventy-six million people live within a radius of 500 km of the LUB. The LUB has 12 seasonal rivers and 39 streams, and 11 sub-basins with 17 main rivers (Hasemi, 2011). Its continental climate has temperatures that range between -20 and 0 °C during the winter months and can rise to 40 °C in summer (Eimanifar & Mohebbi, 2007). These are predicted to increase by the end of the twenty-first century (Doulabian et al., 2021). Lake Urmia was once the biggest saltwater lake within the MENA region. However, its water level has been declining continuously since the 1990s, having shrunk by some 80% (Faramarzi, 2012; Shadkam et al., 2016; Balkanlou et al., 2020). The depth of

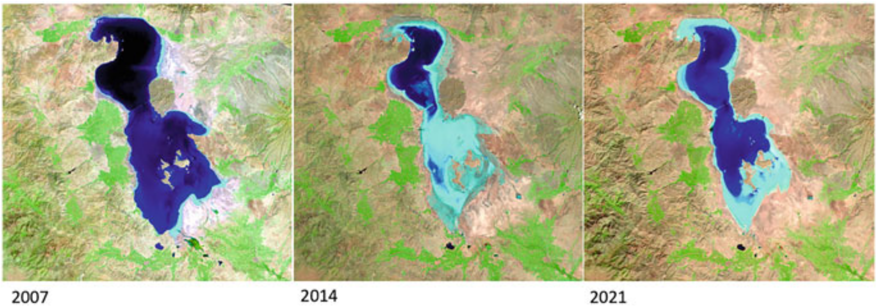

Fig. 9.1 The changing water levels of Lake Urmia from 2007 to 2021. Source: USDA Foreign Agricultural Service (2021)

the lake had declined to 1271.58 m in 2008 from its most recent record of depth at 1277.80 m in 1994. Salinity has also increased (Hassanzadeh et al., 2012a). Since 2017 there has been an observable increase in water level and a relative improvement in Lake Urmia's condition, but controversy remains over whether this has been due to active restoration or due to temporary increases in rainfall in the basin (Nikraftar et al., 2021). Longer-term observable conditions like increased salinity from 205 to 338 g/l due to evaporation and reduced inflow indicate degradation (Faramarzi, 2012; Mohammadi et al., 2019). Ghale et al. (2017) showed that salts and salination of soils have increased dramatically from 1995 to 2014, and over 5000 km^2 of Lake Urmia's water area was converted to salt pans and/or highly saline soils significantly impacting the lake's biodiversity, ecosystem services, and usefulness for irrigation. Desertification and salinization are not limited to the increasingly exposed lake bottom. Though hectares of irrigated lands have more than doubled during the studied period, soil salinity has also increased within the vicinity of Lake Urmia (Fig. 9.1).

The lake's decline is driven by multiple factors. Most significant are the destruction of Zagros forests and Iranian government water policies that have consistently diverted water from the LUB to politically-connected agricultural land users. As Henareh Khalyani et al. (2014) show, this process of water system governance exacerbates existing social inequity, particularly to indigenous peoples, and prompts further deforestation, creating a vicious circle of land and water degradation. Responsibility rests partially with the commercial agricultural sector and resource over-exploitation by farmers (Pouladi et al., 2019, 2020; Abadi et al., 2018; Sadeghi et al., 2020; Shojaei-Miandoragh et al., 2020). It is notable that unlike in other regions of Iran, where indigenous knowledge practices of water management provide adaptive capacity in the face of drought, farmers in the LUB have little historical experience or memory of water scarcity (Azizzadeh & Javan, 2018; Amirataee et al., 2018). Unlike community-based water sharing practice inherent to indigenous communities in Iran (Ghorbani et al., 2021), historically, the farmers in the LUB region used the techniques of water supply and distribution based on the continuous availability of sufficient water resources. Only by refashioning water governance through organized indigenous collaboration can water resources be equitably and sustainably shared (Azarnivand & Banihabib, 2015).

Studies of farmers' perception of the LUB water crisis have found changing cultivation patterns, the expansion of profitable cultivation, overproduction at the expense of subsistence-indigenous needs, and disregard for land and water resources potential, leading to water depletion (Abbaszadeh et al., 2020). Cultivation patterns are perceived as a supra-regional process: national economic goals shape crop cultivation practices. Whereas independent indigenous farmers would cultivate diverse crops according to the needs and local market for produce, contemporary farming practices are driven by national agricultural policy of the Iranian Government. The changing scale of agricultural management from indigenous knowledge and local governance to national policy is a core aspect of this crisis. Farmers in the LUB have taken collective action to adapt to climate change in recent years; such as 'the increased desire for cultivation of cash crops'; 'using more fertilizers and pesticides'; 'cultivating multi-crops'; 'renting their lands to others'; 'replacement of agriculture and horticulture by animal husbandry'; and 'sale of land and migration to urban areas' (Ghanian & Mohaamdzadeh, 2019). However, analysis of the structure of social relations of local farmers showed their low desire to reduce their water consumption through individual actions. In fact, farmers' ambiguity and distrust of the usefulness and effectiveness of their action to protect water resources is the result of three factors. First, the wide radius of the population involved and affecting the catchment area of Lake Urmia and the lack of a collective consensus based on public respect at the expense of personal interests. Second, the wide radius of the population involved and affecting the catchment area of Lake Urmia and the lack of a collective consensus based on public respect at the expense of personal interests. Third, is distrust of the major water resources management institutions of the basin and their lack of seriousness and support, and consequently failures of individual impact. The reality of the region shows that the shrinkage of the lake has led to acute water scarcity for surrounding settlements (Fathian et al., 2014). Ghale et al. (2017) revealed that drought, environmental degradation, and increases of agricultural activities were the most significant drivers of the shrinking of the lake and have caused severe socio-environmental consequences including infant mortality, chronic malnutrition, and diminishing profits for farmers. This is very similar in scale and scope to the disaster connected to the depletion of the Aral Sea (Shadkam et al., 2016)—a similar endorheic basin located between Uzbekistan and Kazakhstan.

The impacts of land use and climate change in the Urmia basin are of interest to scholars who are examining a diverse array of environmental drivers (Ghale et al., 2017, 2018; Shadkam et al., 2016; Balkanlou et al., 2020; Hassanzadeh et al., 2012b). The average temperature and mean maximum temperature in the southern basin of Lake Urmia increased by 1.8 °C and 3.5 °C, respectively, over the last three decades (Ghanian & Mohaamdzadeh, 2019). Mean minimum temperature, mean precipitation, and humidity have decreased by 1.3 °C, 10.3 mm, and 5% over the same period. Ghodousi et al. (2014) showed that the volume of Lake Urmia has decreased by 51% and the actual evapotranspiration rate increased by 13%, with the rate of water loss accelerating in recent years. They predicted increasing frequency droughts that will intensify the shrinking volume despite recent signs of rising levels (Mirgol et al., 2021). These trends will change the ecological matrix of the lake region. Areas of dense grass, sparse grass, and woodlands have declined sharply in the southern part of the basin. Forests have diminished to only 5% of the region. Growing pasturelands and diminishing soil cover are similarly problematic. By the year 2027, the intensification of irrigated agriculture is expected to grow by nearly 9000 ha and rain-fed agriculture is expected to grow by 1000 ha, further threatening the region's biodiversity. Shakeri (2021) reports that the land-use change and water-resource challenges emerging in the basin are exacerbated by increased residential land use (increasing 40% over 20 years), creating multiple and compound threats to ecological stability.

The considerable expansion of salt pans to the south and west of Lake Urmia may have further consequences like intrusion of salts into aquifers and salt storms that will yield social consequences like those experienced around the Aral Sea. Within the last decade, most of the land around Lake Urmia Lake has been rendered unusable; causing serious problems for northwestern Iran's agriculture and industrial productivity (Ghale et al., 2017). The increasing stress from droughts, dams, environmental degradation, and rapid growth of agriculture in the basin have created a state of perpetual environmental crisis and the socio-ecological system is rapidly losing resilience (Fathian et al. (2014). Yet agricultural and water plans don't seem to be sufficiently robust to counter the negative impacts of the interaction between climate and land-use change on residential development, ecosystem services, or biodiversity (Shadkam et al., 2016). Managing these complex interactive effects requires an integrated sustainable land-use management approach that draws upon indigenous and other forms of community knowledge, beyond the agricultural productivity gains asserted through national-scale land-use policy.

Within land-use policy networks in Iran, the controversy has centered upon the urban fringes (the spaces where agricultural land meets urban and residential development). This is also referred to as the urban hinterland. Policy debate around settlements within the LUB focuses on whether agricultural land in the fringe should be maintained, expanded, or converted to other uses. This debate may be regarded as either pro-rural or pro-urban policy perspectives. The pro-rural viewpoint sees conversion of land to urban uses as having negative impacts: reducing agricultural jobs, destroying prime agricultural land, displacing indigenous peoples and livelihoods, and wasting investments that have been made on irrigation infrastructure. This change could affect agricultural production and threaten national/regional food security. Pro-ruralists conclude that agriculture should be protected and expanded to increase food production. Pro-urbanists, however, argue that land conversion could be a logical consequence of urban growth. Reduced food production, they argue, could be solved by agricultural intensification and improved technologies for food production. Land conversion, in their view, is not a threat, but an opportunity for agricultural innovation. The result of this debate is that the solution to the super-wicked problem for sustainable ecology and water management is stymied by a framing conflict created by the competing visions for social development, land productivity, and technology. In both cases, land-use policy ignores the long-term risks that land conversion will have on the ecological system in favor of the immediate goals of fulfilling acute human needs. Without agreement on the core goals of a sustainable management strategy, there will be no consensus upon an answer and environmental degradation will accelerate to the detriment of all in the region.

9.3 Discussion

The gradual drying of Lake Urmia and interactions between climate change and land-use change have created significant regional socio-environmental challenges that include the destruction of agricultural lands and pastures, inadequate potable water, deteriorating air quality, and increased migration away from communities near the lake. Land-use change and climate change generate substantial negative impacts on biodiversity and rural livelihoods within the LUB though there is little research into the interaction of these two drivers. Their combined effects compound one another and make current adaptive solutions and conservation management strategies insufficient to sustainably manage the ecosystem services of the basin.

This chapter finds that the evidence of droughts, decreasing precipitation, and increasing temperature collectively demonstrates that the climates of the LUB are changing (Balkanlou et al., 2020). Its interaction with land-use change presents significant challenges for local and provincial planning authorities and national natural resource managers. Focusing only on environmental matters like greenhouse gas emissions reduction is not enough. The poor levels of environmental monitoring and regulation, the failures of agricultural and land management stakeholders to follow scientifically based rules, the inappropriate enforcement of protections for biological resources, and the weak coordination within the Iranian state together promote adverse socio-environmental outcomes. From the farmers' point of view, with the collapse of traditional irrigation systems and the disappearance of local sovereignty, both water resource reserves have been destroyed, and social capital and the most fundamental ethics have been infiltrated. A practice that seeks to maximize individual profit and gain regardless of the possibility of future resource availability and severely undermines local governance, and ultimately the outcome of all these were water crisis conditions over the past few decades. Although farmers use their strategies in the absence of a legitimate governance system to manage the status quo and try to establish individual or collective order on a micro-kinship-neighborhood scale, the results are counterproductive in two ways. Consequences that will intensify the crisis in the form of conflict and divergence will lead to the withdrawal and transfer of agricultural lands, and or as a group that will try to overcome the current crisis with resistance and hope. Stronger focus on policies that build community resilience includes changing to knowledge and attitudinal perspectives amongst farmer-stakeholders to longer-term views that support pro-environmental agricultural practices and that minimize their vulnerabilities through education and awareness. They can improve adaptation and overall climate literacy in the face of these threats (Mileř & Sládek, 2011). However, following the Islamic revolution in 1987, Iran has been deeply affected by multilateral (UN) and unilateral (USA) international economic sanctions, reducing the socio-economic and political capacities of national and regional authorities to plan for a sustainable future. They are forced to simply strive to extract food and water and to manage land in the LUB to meet short-term needs at the cost of longer-term ecosystem stability.

International best practices for land-use planning and climate-change response in the USA and China involve operational and integrative approaches premised on extensive financial and research support. In the USA, this includes integration of satellite-based remote sensing with ground-based observational networks, and multi-agency coordination (between the Department of Energy, Environmental Protection Agency, and Department of Agriculture, among others) using integrative analysis of comprehensive scientific and ecological information to form coherent policy (Wang et al., 2016). In China, the Organization of Environmental Protection (in coordination with 30 other government agencies) provides extensive financial and research support to prevent the degradation of pastures and other productive lands, as well as for climate dynamics and land-use modeling efforts from which global socio-economic development planning is based. Though these exemplars provide a basis from which to understand best practices, the smaller pool of resources for environmental monitoring in Iran, the lack of integration across government departments, and the lack of political will toward sustainable planning remain key barriers to the sustainable management of the LUB.

9.4 Conclusions

Land-use change is intertwined with changing climates as both are consequences of and promoters of increasing global warming (Dale, 1997). Building dams for electricity, water storage, or irrigation water is land-use change that affects hydrologic processes and spawns other direct impacts upon regional and global atmospheric conditions (Taherei Ghazvinei et al., 2016). Other land-cover changes like deforestation, road construction, and agricultural cultivation on steep slopes produce similar local-to-global impacts (Santika et al., 2017). Yet a changing climate is often considered to be a factor driving land-use and land-cover changes (Marshall et al., 2018). As many have demonstrated, climate change has prompted land-use changes; there is a positive feedback for both of these facets of environmental change (Peters et al., 2019; Hohmann et al., 2018). The importance of this interaction and the role of the aquatic ecosystems (wetlands, mudflats, natural and artificial basins, lagoons, ponds, and swamps) become increasingly significant over time as we collectively undermine the ecosystem services that support human development. These challenges are most acute in lake systems and other wetland habitats as these delicate socio-ecological systems rapidly lose their resilience to multiple interacting changes

(Faramarzi, 2012). Modern land-use practices and policies in Iran and beyond focus too strongly upon increasing the short-term supply of material goods to meet acute (often local) human needs and undermine the fundamental ecosystem services that support regional to global needs over the longer term. Land-use policies that emphasize either urban (construction) or rural (agricultural) land allocation have an enormous impact on ecosystem sustainability and this is a global issue that reaches far beyond local decision-makers and indigenous communities (Delattre et al., 2015). Confronting the worldwide environmental challenges of land use would require assessing and managing inherent trade-offs between meeting and maintaining the capacity of ecosystems and the immediate human needs for goods and services well into the future.

The LUB is an important and valuable ecosystem; one that is deeply significant to local, national, and international environmental protection communities. We need a new *integrative* management approach (e.g., Esmaeilnezhad et al., 2021) to address the challenges of the basin to reach sustainable water use and ensure conservation of the lake ecosystem. A new strategy must be *holistic* in its approach to understanding the interaction of climate and land-use change: it must have the capacity to mediate competing land--use perspectives against long-term ecosystem-service provision, changes in agricultural capacity, and changes resulting from long-term climate change, and should aim to directly halt and reverse ongoing processes of degradation. Consequently, policymakers must improve their understanding of the water resources system and its different components within the basin by striving to understand the socio-hydrological elements of the lake system (Pouladi et al., 2021). Lessons from indigenous knowledge practices elsewhere in Iran provide particular insight. Water sharing and long-term management practices within indigenous Iranian communities have shown long-term sustainability across multi-generational timeframes (Ghorbani et al., 2021), primarily because water resources are managed within socially prescribed limits to meet local agricultural needs without exceeding the carrying capacity of the local common pool resource (Hosseini et al., 2011). Learning from such cases can assist in the development of new water management plans. The most recent plan to rescue the lake involves rapidly decreasing irrigation water use by 40% (Shadkam et al., 2016). This will create, however, social and economic pressure for the residents that depend on water access for sustainable livelihoods. The LUB is gaining increased public scrutiny, with civilian dialogue on the potential environmental threat and the unwanted economic, social, and cultural consequences of new management plans on the area's inhabitants. An integrated approach to land-water use planning and climate change adaptation that learns from indigenous knowledge elsewhere in Iran would improve agricultural development in the region and reduce the desiccation of this hyper-saline lake. But the approach must be one that all stakeholder groups, including agricultural water users, can agree with.

Finding a balance between what is needed for both settlements and regional or national food systems and for longer-term ecosystem stability is critical for the long-run sustainability of water resources. Prediction of water-balance components could be a valuable component of water supply analysis and watershed management, and it could help to prevent land degradation, to estimate water availability for irrigation, to enhance food security, or to calculate the amount of groundwater withdrawal that would be sustainable. While international assistance remains an important aspect of future environmental management policy and practice, Iranians, as those who live with developing economies, must lead regional restoration of Lake Urmia and provide their insights into the management of other major fresh and saltwater bodies. In fact, without a pragmatic action plan, the country faces severe water stress that is increasing the already considerable problem of hunger within the country. Land use, climate change, water management, and human development policy cannot be separated into discrete problems for policy formation or planning. Any sustainable long-term management plan must be based on a strong assessment of the interactions of land-use change and climate change and their effects on natural resource availability and resilience, and on the stability of ecosystem services. The allocation of agricultural and urban land uses must be accomplished in ways that reduce long-term risks by placing basin restoration at the heart of future planning in a way that indigenous approaches to water management have done for centuries, if there is to be a concerted effort to maintain and increase the recent gains in water availability in the LUB.

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Chapter 10
Indigenous Water Governance Systems in a Post-colonial State: Insights from Zimbabwe

Manase Kudzai Chiweshe

Abstract This chapter traces the evolution of indigenous water governance system in a post-colonial space in Zimbabwe. It argues that the advent of colonial water tenurial systems created multiple and often conflicting systems of governing water. These conflicts have led to adverse effects especially for rural communities who are often excluded by top-down approaches that do not value indigenous systems. We however argue that indigenous water governance systems continue to operate outside or parallel to formal state systems. This chapter explores the nature and internal dynamics of these systems in contemporary rural Zimbabwe whilst noting how policy makers can influence the strengthening of indigenous systems. It also explores opportunities of the integration of indigenous and formal water governance systems to enhance water access and equity. The chapter is based on a review of literature that highlights emerging debates related to how indigenous water governance systems are operating in post-colonial Zimbabwe. The study found that indigenous systems are resilient, adaptable and continue to be more influential than formal or state institutions. This highlights the need for government to provide a policy framework that supports a holistic and complimentary water governance systems.

Keywords Water governance · Indigenous knowledge · Water values, Zimbabwe

10.1 Introduction

Water is generally defined by communities as belonging to God, making it accessible to all. No one is supposed to claim water as their own but white farmers and black commercial farmers at present have successfully fenced off water from neighbouring smallholder farmers showing how class plays an important role in access and control

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of water resources. In principle, water belongs to everyone but in practice there is a mediating form of social control that exclude and include individuals based on various factors and processes. Nemarundwe (2003) notes that for the communities in the Romwe Catchment in southern Zimbabwe, 'water is life' (*mvura hupenyu*). The importance of water is thus steeped in the everyday belief that it belongs to God who has provided it freely for all to use. In 1998 discussions in parliament even concluded that,

> Water is a public resource. It is a gift from God. None of us here are rainmakers, and that includes commercial farmers. The rainmaker is God. He provides His people and that water forms part of the hydrological cycle. (Zimbabwe Parliamentary Debates, pp. 1562–63; Derman et al., 2007: 257)

This belief system is at the heart of indigenous water governance systems that ensured equity for all. Nemarundwe and Kozanayi (2010: 194) highlight that indigenous water management systems are localised "institutional arrangements" which are intractably associated with indigenous myths and customs, and therefore, offer more room for often marginalised groups to participate in water provision, as compared to government-regulated water policies. These localised arrangements operate adjacent and often in conflict with more formalised government-initiated policies.

10.1.1 Indigenous Water Governance Systems

Across the world, various communities have historically developed localised systems of water management. These indigenous water governance systems are based on the lived experiences of communities built through generations. Lssozi (2012) argues that across Africa, people have developed rich environmental cultures which are contained in myths, taboos, stories, proverbs, and beliefs and through symbols and rituals. Management of water is thus based on shared ecological ethics that function to ensure good practices. Obiora and Emeka (2015) show how the Igbo in Nigeria utilise taboos associated with rivers and forests to safeguard the resources from pollution and exploitation. In Africa, the belief in ancestral spirits is core to the idea of conserving resources such as water bodies. Wilson (1989) argues that ancestral spirits are believed to be living in the forests, special trees, caves and water bodies. Bernard (2003: 149) concludes that,

> Among many of the Southern African indigenous people (Khoisan- and Bantu-speaking people) there exists a set of complex beliefs regarding water, river systems, and riparian zones. The spirit world is regarded as the ultimate source of such life-sustaining resources. Water is the essence of both spiritual and physical life, and the spirit world is regarded as the ultimate source of such life-sustaining powers. Integral to such beliefs are various zoomorphic spirit manifestations, primarily the snake and the mermaid, who reside in or beyond the water and who interact with humans in a variety of ways. The rivers, wetlands, and the sea are the dwelling places of such manifestations and are of fundamental importance to many of the African healing traditions and their practitioners.

Governance of water is thus intricately linked to religious practices and belief systems. Across the dry regions of such as Morocco, communities have developed a system called *Qanat* which is a traditional water-extracting and transporting technique. Behailu et al. (2016: 3) note that '*Qanat* is a technique of developing an underground network and has been developed for the transportation of water from hillside deep mother-wells to plain areas for domestic and irrigation purposes. The underground network can substantially reduce evaporation.' In semi-arid regions of sub-Saharan Africa, communities utilise digging pits to harvest rainwater as a means of water conservation (Nkomwaa et al., 2014). All these examples highlight the rich knowledge utilised by local communities in water governance and management. Local systems and knowledge remain an integral part of everyday life for rural communities.

10.2 Theorising Indigenous Water Governance Systems

The paper utilises the concept of indigenous knowledge systems (IKS) to explore how water management has evolved in local communities in Zimbabwe. Indigenous knowledge systems are a body of knowledge, or bodies of knowledge of the indigenous people of geographical areas that they have survived on for a very long time. It refers to the understandings, skills and philosophies developed by societies with long histories of interaction with their natural surroundings (Mapara, 2009). For rural and indigenous peoples, local knowledge informs decision-making about fundamental aspects of day-to-day life (Emeagwali, 2003). This knowledge is integral to a cultural complex that also encompasses language, systems of classification, resource use practices, social interactions, ritual, and spirituality (Nyota & Mapara, 2007). International Council for Science (ICSU) has provided a detailed definition of IKS, arguing that,

> Traditional knowledge is a cumulative body of knowledge, know-how, practices and representations maintained and developed by peoples with extended histories of interaction with the natural environment. These sophisticated sets of understandings, interpretations and meanings are part and parcel of a cultural complex that encompasses language, naming and classification systems, resource use practices, spirituality and worldview. (ICSU, 2002)

IKS is used in this chapter to centre the importance of indigenous water management systems in the cosmology of communities in Zimbabwe. This IKS is utilised in harmony with the natural and spiritual world. These traditional or cultural practices are ingeniously designed to address local ecological limitations by maintaining a sustainable utilisation and protection of commonly shared natural resources.

IKS related to the environment is built over time by people who live with and around natural resources and observe the activities around them (Mugambiwa, 2018). People thus develop IKS through observation and adaption to changes or challenges in ways that foster protecting the environment for the benefit of all. This has 'enabled indigenous people to learn and to observe how various natural artefacts from animals, birds, and plants change, interact and behave over a period of time' (Mugambiwa & Makhubele, 2021: 2045) and to use this information to adapt to any changes. IKS is thus an important component of local communities and as such it is even recognised in the Zimbabwean constitution. Section 33 of the Zimbabwean Constitution calls for measures to preserve and protect indigenous knowledge systems possessed by local communities. The importance of IKS is thus recognised in the supreme law of the country.

10.3 Research Methodology

The chapter is based on exploratory desk-based research conducted to highlight the emerging patterns from the literature on indigenous water governance systems in Zimbabwe. According to Wolcott (1990) desk research involves a summary, collection and synthesis of existing research rather than primary research where data is collected from a research subject. Desk research determines what is known already and what new data is required to inform research design. Desk research involves gathering information and analysing information already available in print and published on the internet, internal services and government publications. The study concentrated on electronic databases including Google Scholar, EBSCOHost, Researchgate and university websites to collect literature that focused on indigenous water management systems. The articles were purposively sampled with a specific focus on work published in journals and book chapters that included work from anytime period if it focused on indigenous water governance systems in Zimbabwe. The selected articles were analysed using thematic analysis. Thematic analysis is a process that involves searching through data to identify any recurrent patterns.

10.4 Findings and Discussion

10.4.1 History of Indigenous Water Governance Systems in Zimbabwe

Indigenous water governance systems have a long history in Zimbabwean communities. Traditional systems of resource management are steeped in the histography of communities because it is intertwined in the socio-cultural and religious systems. Mapara (2009) provides a detailed outline of how pre-colonial communities in Zimbabwe were involved in utilising various indigenous knowledge systems in managing water resources. He argues:

> Wetlands were also well managed. The indigenous people used them for growing rice and other crops like yams and bananas. Ranger comments on how the indigenous people who were domiciled around the Matopos (Matombo) used wetlands for agricultural purposes prior to the arrival of white colonialists. He observes that the Matopos vleis are dry from

> May to July and from August to October, 'water begins to run from the rocks'. These vleis become waterlogged in summer. Under the Mwali rotation, the local people grazed their cattle in these wetlands in the three dry months of the year. (Mapara, 2009: 148)

Duri and Mapara (2007) also highlight practices such as *chinjiri* (terraces) which were used to minimise the effects of erosion that resulted from run-off water. All these practices highlight a holistic system of managing water resources in traditional communities. Among the Karanga, 'if one defecates in a water source, he or she will be struck by diarrhoea which will only stop when the offender has consulted a traditional healer and payment to appease the ancestors is done' (Makamure & Chimininge, 2015: 12). Environmental management was linked to the ancestors (*vadzimu*) who are understood to be the custodians of nature. The ancestral spirits were central in ensuring adherence to the norms and rules related to the utilisation of common pool resources. Shoko and Naidu (2018: 86) conclude that 'The local community, therefore, conserves water by adhering to local myths. Disregarding the regulations is tantamount to committing structural violence to nature and other humans, because the *chitubu* [spring] may dry up, leaving the community with limited water supply options.'

10.4.2 Nature of Indigenous Water Governance Systems

Mugambiwa (2021) highlights that traditional or indigenous resource governance systems in rural Zimbabwe including water are centred around the role of the traditional leader. At the local level, traditional leaders called *sabhuku* (village head) are critical in ensuring the management of water and common pool water sources. Chigwata (2016: 78) indicates that 'The Traditional Leaders Act also assigns to chiefs the responsibility to supervise headmen and village heads; oversee the collection of levies, taxes, rates and charges payable to rural local authorities and conserve the environment and natural resources.' Water governance roles are thus subsumed under the role to conserve the environment and natural resources. Shoko and Shoko (2013) further argue that these traditional leaders are an important source for indigenous knowledge which has been utilised by communities to manage resources such as water. Traditional leaders are thus a critical part of indigenous water governance systems through instituting and implementing various ritual and traditional norms, beliefs and performances (Marango, 2011). Dolsak and Ostrom (2003) argue that common pool regimes are sustainable when rules are created by a resource management group and regulated by them. In traditional communities, these rules were often steeped in the mysterious and religious belief systems.

The use of mythological and religious belief systems is an important part of the indigenous water governance systems. Myths are utilised as systems to govern access and ensure sustainable utilisation of water resources. The belief in the supernatural leads to specific rules and moral codes that govern water and other natural resources. Among the Shona, for example, they have taboos (*zviera*) to govern fair use of resources. Tatira (2000) argues that

> . . .Shona people often use *zviera* (taboos) as one of the ways of teaching young members of their society. The Shona had, and still have, unique ways of transmitting social values which are crucial to the development of their society. *Zviera*, among other practices, encourage conformity to societal expectations on correct human behavior in the environment.

The taboos are thus an important mechanism to guide against misuse of resources. These taboos come in a variety of forms and are largely contextual in nature. Communities around Zimbabwe have traditionally utilised various beliefs as mechanisms to foster sustainable use of water resources. For example,

> The Ndebele community observes nature and uses it to regulate human behaviour. Hydronyms are a case whereby dangerous aquatic animals are used to name pools as a deterrent to would-be abusers of water resources. For example, *Sengwenya* i.e. pool of the crocodile. The crocodile is a danger to humans and livestock, the pool has limited human and animal activity and the water is always clean and clear. (Ndlovu et al., 2022: 3)

Among the Shona people, there are taboos (*zviera*) related to water bodies such as springs (*zvitubu, zvisipiti*) or wells (*matsime*). As Mabvurira et al. (2021: 115) notes, "water bodies/wetlands are sacred because they are the abode of animals associated with spirits. Metal and clay containers which have been used for cooking may not be used to fetch water from certain water bodies. Water spirits/mermaids and pythons are considered guardians of wetlands. Appropriate behavior and observance of obligations and rites are important and required to maintain social harmony, longevity, and contentment of spirits." Table 10.1 outlines the many water-related myths, beliefs and norms.

10.4.2.1 Contemporary Dynamics of Indigenous Water Governance Systems

Indigenous water governance systems have continued to evolve and remain an important part of the everyday cosmology of rural Zimbabwean communities. The norms and customs have changed to match the increased modernisation which has also penetrated rural spaces. Whilst there is evidence of communities losing a lot of their traditional customs, there are also instances where many traditional norms have been appropriated to respond to unique challenges of a modern world. In terms of water management among the Shona, Shoko and Naidu (2018: 87) note that

> . . .community members are prohibited from laundering on the riverbanks, or in the rivers, because soap contaminates water, which leads to the death of the living organisms in the rivers. The community is aware that human life can be destroyed by ecological disasters—therefore, it becomes necessary that they seek to maintain a balance in ecosystem in order to ensure sustainable livelihoods.

The modern use of soaps and detergents can lead to pollution of water sources especially those used for drinking. Thus, communities are prohibited to do laundry on the riverbanks. Prohibitions also include banning of building or living on

Table 10.1 Water related myths, beliefs and norms

Indigenous belief/myth	Meaning	Use
Marambotemwa	Prohibition of cutting trees in certain areas	Vegetative cover prevents soil erosion and sedimentation of water sources thereby ensuring sustainable environmental use (Mhaka, 2015)
Njuzu (water spirit)	Ancestors are believed to manifest their presence at sacred water bodies through *njuzu*	Protection of certain water sources (*madziva anoyera*) by regulating who, how and when water is retrieved or utilised (Mahohoma, 2020)
Ubuntu/unhu	Self-censored behaviour that conforms to the communal spirit of sharing and caring for each other	Promote (Shoko & Naidu, 2018)
Zvirehwa (myths)	People are forbidden from plucking off the reeds surrounding the *chitubu*. Metal tins are also prohibited, and only plastic buckets are used to abstract water.	The local community, therefore, conserves water by adhering to local myths. Breaking these regulations, it is believed, will cause the fountain to dry (Shoko & Naidu, 2018)
Ukawetera mumvura, unorwara nehozhwe	If you urinate in a water source, you will suffer from bilharzias	The fear of contracting a disease is used as deterrent for those who may be tempted to urinate in water sources thereby polluting them (Chemhura & Masaka, 2010)

riverbanks. Machoko (2013: 287) adds that 'The concept of water spirits is still there among a small number of traditional Zimbabweans like diviners and water spirit mediums (*majukwa*) who still have the knowledge of the inner workings of water spirits.' There are still communities and people that practice and follow the traditional belief systems that regulate water resource use. Among the Ndau in Zimbabwe, water bodies are revered, ritualised and governed by taboos that relate to the *njuzu* (mermaid) water spirit. These beliefs have continued to shape community practices and remain integral part of managing water resources.

10.4.2.2 Indigenous Water Governance Systems-Formal Water Governance Systems Nexus

Zimbabwe possesses a dual (formal and traditional/informal) water management system that led to complexity and competition at local levels. At the formal level, Department of Water Development oversees policymaking while a semi-government authority, i.e. Zimbabwe National Water Authority (ZINWA) oversees operational aspects of water management (*Manzungu*). The country is divided into seven hydrological units, presided over by a catchment council, which is democratically elected. Under them are sub-catchments, which are based on major tributaries or sections of rivers in the area. The latter are mandated to collect water-related fees.

ZINWA also collect water fees especially for use of water in government dams (Kujinga, 2002). This formal system is often experienced as punitive and exclusionary for local communities. This has led to local communities, subverting the formal and utilising traditional systems which are more responsive to their everyday needs. As Nemarundwe and Kozanayi (2010: 195) argue, customary activities, 'have a habit of overcoming the government tenure measures in water arrangements.' Communities revert to what is known, responsive and relevant to their needs. In rural spaces, people grasp local or traditional rules better than the formal government regulations and most of the time respect the former (Rurai, 2007).

What is clear is how local people are often averse to formal water governance systems. The formal and traditional systems need to be complimentary and not antagonistic to ensure a holistic system of water management. Water is a common pool resource that requires joint management and decision making as neither the state, private sector nor the local communities can effectively manage water alone (Meinzen-Dick et al., 2006; Baland & Platteau, 1996). Policy makers need to be innovative and provide ways of integrating the dominant state-driven and the community-based common pool systems. Water governance will benefit from a system that enhances complementarity of both systems. Maposa and Mhaka (2013: 25) argue that

> The inclusion of aspects of Shona culture in the management of water and other natural resources will help the perception of the local Shona that any programme which engages IKS would be more acceptable, and people may cooperate so readily. This helps in avoiding the usually hated "top-down" or paternalistic approach to policy making and implementation in rural development.

The dominant top-down approaches are bound to fail if there is no consideration to the views, experiences and wishes of local communities. It is important for policy makers to revitalise and mainstream traditional systems of water sharing, and preservation to ensure sustainable water use.

Across all natural resources, the governance structures in rural Zimbabwe are characterised by friction between the state and indigenous institutions. The post-colonial government has done little to address this friction and it has affected traditional common property regime. Formal structure tends to demean, marginalise and subjugate the traditional natural resources management systems. Zinhiva and Chitakara (2017: 36) highlight that

> The indigenous people fought for their freedoms and rights, which culminated in political independence from former colonial masters. However, the post-colonial governments have inherited and perpetuated the colonial natural resource governance systems. They have maintained, empowered, and cosmetically restructured the same statutory bodies like Environmental Management Agency [EMA], Zimbabwe National Water Authority [ZINWA] etc. to exclusively manage natural resources on both state and communal land. These statutory bodies are manned by professionally trained natural resource managers who largely utilize western scientific knowledge and little or no local traditional ecological knowledge. All too often, the state and traditional institutions have competed and conflicted (but collaborated) because their sources of legitimacy differ (state versus customary). They operate without clearly defined mandates and articulated processes…This has left the local people and their communities even weaker and confused.

The state needs to provide a clear framework that ensures the mainstreaming of indigenous water governance structures in a manner that allows for complimentary existence of the two systems. Localised understanding of water management remains informal and operating in competition with formal structures in a manner that is neither sustainable nor helpful in efforts to protect water resources.

10.4.2.3 Compatibility of the Two Systems in Contemporary Zimbabwe

Mtisi (2011) argues that Zimbabwe's water policy is built on the concept of "Integrated Water Resources Management" which emphasises four main principles namely: management of water based on hydrological boundaries, decentralisation of water management, stakeholder participation and representation in water management processes and treatment of water as an economic good. Decentralisation must include the recognition of traditional water governance systems. In most cases, this excludes customary systems and focuses on the participation of district-level local government structures. Decentralisation must recognise the need to mainstream traditional norms and values. Biswas (2004: 152) further argues that any system that seeks an integrated water resources management system must have 'all legal and regulatory frameworks relating to water, not only directly from the water sector, but also from other sectors that have implications on the water sector.' Excluding indigenous systems will only lead to the ineffective implementation and practice of the formal system.

In Zimbabwe, traditional systems have, however, largely operated outside formal state processes and are often seen as inferior. In water management, this has meant formal institutions such as ZINWA sorely making decisions around water without local input. There is a lack of clarity around the roles of traditional leaders, local government institutions and government parastatals in terms of control and implementation of policies at the grassroots. For Ncube (2011: 89),

> This confusion at the local administrative levels was characterized by a lack of clarity on roles and functions between the traditional institutions of chief, headman and village head, and the elected leadership of village development committees (VIDCOs) and ward development committees (WADCOs) in land matters.

Compatibility of the two water governance systems is possible if there is a political will to decentralise decision making to grassroot decisions. As Chibememe et al. (2014: 31) notes, 'To avoid conflict between the modern and traditional institutions and ensure effective local institutional function, there is a need to integrate traditional management concerns into natural resource law.'

10.4.2.4 Gendered Dimensions of Indigenous Water Systems

Zimbabwe is dominated by patriarchial communities in which women are often excluded from public institutions including water governance structures. This is more so in indigenous water institutions which are steeped in patriarchial cultural systems. Any discussion on promoting traditional or indigenous systems needs a clear nuance in terms of how this does not promote and entrench already existing gender inequalities. Patriarchy is a gendered power system: a network of social, political, and economic relationships through which men dominate and control female labour, reproduction and sexuality as well as define women's status, privileges and rights in a society (Chakona, 2012). In terms of indigenous water governance systems, women have historically been underrepresented yet still play a critical role within households, especially given their role in domestic water use. Water resource use and governance is largely under the control of men with women excluded from decision-making processes. Mollinga (2008) further argues that neither traditional nor formal institutions recognise women's knowledge and experience in regulating and managing water resource infrastructure.

In precolonial communities, women played integral parts in the socio-religious systems that determined resource management. In this vein, Schmidt (1992: 91) concludes,

> However, during the pre-colonial period, there was no clear distinction between the political and religious domains. If women assumed such important roles as spirit mediums key mediators in local disputes who were also consulted about disasters such as drought and famine. . .the nature of their involvement in public life was clearly political.

Rutsate (2016) further argues that there were a special group of women rain mediums who were sworn to virginity and working at shrines known as *mbonga* and in any case beer brewed for rain-asking ceremonies was the responsibility of post-menopausal elderly women. This highlights that the exclusion of women from water management systems emerges out of colonial period which distorted the nature of gender balance in African communities. Ranger (2003: 86) notes that 'despite the dominance of patriarchy in Zimbabwean land ownership, inheritance, politics and ritual; women mediums, priestesses and prophets still play a major role in ecological religion.' Women's roles in the ecological systems have continued within the post-colonial state in many parts of rural areas. In Chimanimani, elderly women are still responsible for preparing *doro remakoto* (beer for rain-asking ceremonies).

10.5 Conclusions

Indigenous water governance systems remain influential across many parts of rural Zimbabwe. Whilst many cultural systems are slowly eroding, indigenous water governance systems have remained resilient across rural communities. The threads of traditional institutions have remained largely intact despite the historical impositions both by the colonial and post-colonial governments. The government must respect the resilience and adaptive capacities of traditional institutions that have evolved over time and are still functional in the present day. Communities are innovative and have developed various ways of responding to challenges they face including those that relate to water. Political will on the part of the government is required to fully mainstream traditional water-related institutions through decentralisation, capacity building and changing laws. This chapter has outlined the nature and types of indigenous water management norms, values, and institutions. It has shown the historical marginalisation of these institutions and knowledges at the expense of foreign, centralised, and imposed forms of governance. The chapter concludes that there is scope to develop a complimentary decentralised system that respects and promotes indigenous water governance systems.

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Chapter 11
Benefits of Reviving Indigenous Water Conservation Practices for Drought Resilience in Red and Lateritic Zones of West Bengal, India

Sabita Roy, Rahi Soren, and Sugata Hazra

Abstract Water conservation practices have a fundamental role in facilitating irrigation and groundwater recharge in drought-prone regions. The present research aimed to determine benefits of indigenous water conservation (IWC) practices—tanks, dug wells, and ditches—in Kashipur and Chhatna blocks of Purulia and Bankura districts belonging to the red and lateritic zones (RLZ) of West Bengal, India. The household survey and focus group discussions were conducted on a total of 460 households (Kashipur, 150, and Chhatna, 310), which were selected by utilizing a stratified sampling method that covered 36 villages of the blocks. The analysis revealed that IWC structures along with the promotion of scientific cropping practices have provided supplementary water supply for micro-irrigation, increased cropping intensity, crop variability and rotation, and benefitted crop production—especially in drought and drought-like situations. As a result, income from agriculture has enhanced. Livestock ownership and income from livestock also improved due to increased water and feed availability supported by IWC structures. In all the study villages, additional water supply led to the adoption of nutrition gardening and revival of indigenous crops. This, in turn, ensured food and nutrition security and improvement in vegetable and fruit consumption and also led to a reduction in hunger days. The fundamental impacts of the IWC structures with scientific cropping techniques including the promotion of double cropping, nutrition gardening, indigenous crops, animal husbandry, and backyard fishery in ditches emerged as potential livelihood options. The present study suggests increasing community participation in the implementation of these structures, adoption of mixed cropping and multi-cropping practices, and up-scaling these multi-stakeholder approaches can continue to secure livelihoods and drought resilience in the RLZ, paving pathways for the adaptation of the marginalized communities to climate change.

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Keywords Indigenous water conservation, Crop intensity · Food security · Drought resilience · Livelihood diversity · Hunger days

11.1 Introduction

The adverse effects of climate change and global warming on agriculture have been recognized globally. In India, high dependence on rainfed agriculture and excessive pressure on natural resources make it highly vulnerable to climatic extreme (Kumar et al., 2020; Venkateswarlu & Singh, 2015; Khan et al., 2009). Climate change is leading to an increase in the frequency and intensity of droughts, heat stress, and more evaporation (IPCC, 2021; Chauhan et al., 2014) which negatively affects the crop production and food security in India (Singh et al., 2012; Rao et al., 2015). Thus, sustaining crop production in the rainfed farming system is essential to maintain India's food security (Kumar et al., 2020). Warming-induced frequent droughts in monsoon season are common in red and lateritic zone (RLZ) often resulting in severe crop loss and food shortages (Mishra et al., 2022), and the most severe impacts are felt among the small and marginal farmers. The occurrence of crop failure is on the increase as the frequency and intensity of droughts have been raised in the RLZ (Bhunia et al., 2020; Palchaudhuri & Biswas, 2020). Farmers understand the uncertainties of rainfall and associated production risk and try to manage it by implementing indigenous water conservation structures.

Water conservation structures have been executed widely for infield water storage all over the world. Water conservation practices among the indigenous population of the United States have been recorded for at least 1500 years (Pretty & Shah, 1997). Traditional water conservation practices in the sub-humid undulating terrain area were to excavate land to store excess rainfall (Mitiku et al., 2006; Mihret et al., 2020). Water conservation structures constructed thousands of years ago are known from the Babylonia, Israel, Tunisia, China, and also the United States (Frasier, 1980; Boers & Ben-Asher, 1982; Li, 2000; Ouessar et al., 2004). Such structures have received renewed consideration to increase crop yield since the prolonged drought conditions in sub-Saharan Africa, Ethiopia (Critchley et al., 1991; Pretty & Shah, 1997; Prinz & Singh, 2000; Kunze, 2000; Ouessar et al., 2004). Though traditional water conservation practices have been prevalent dating back to 4500 BC, the agricultural revolution of the late 1990s in India has brought it in again into focus (Sivanappan, 1997; Rockstrom, 2002; SIWI, 2001).

The indigenous water conservation (IWC) structures have increased the amount of water stored by retaining rain and reduced surface losses, so that water can be used where and when it is needed (UNEP, 1997). The IWC structures implicate the storage and usage of rainwater for domestic, agricultural, and other livelihood activities (Ngigi et al., 2006; Jebamalar & Ravikumar, 2011). Therefore, IWC structures have been considered as an effective adaptation strategy against drought and climate variability (Wolka et al., 2018).

Previous studies concluded that farmers have received benefit from IWC structures through run-off retention, thereby improving water availability to crops in different countries of the world such as semi-arid region of Zimbabwe (Nyagumbo et al., 2019) and humid uplands of Ethiopia (Mekonnen, 2021; Mihret et al., 2020; Mekuriaw et al., 2018; Adimassu et al., 2017), China (Jia et al., 2019; Jiang et al., 2019), Africa (Wolka et al., 2018), and Kenya (Ngetich et al., 2014).

Climate change and associated recurring monsoon drought have resulted in frequent crop failure in most small and marginal farming in Purulia and Bankura of West Bengal, India (Bhunia et al., 2020; Roy & Hazra, 2020). Agriculture in this region is predominantly dependent on rainfall, and primarily a single crop is cultivated which makes it vulnerable to drought and drought-like situations. Recently, higher rise in temperatures led to higher evaporation which affected the agriculture production and water resource sectors of the region (Roy et al., 2020). Since 1990, the RLZ has been experiencing frequent severe droughts for a short period (Mishra & Desai, 2005) with reduction of around 24% Kharif (monsoon) crop production (Pandey, 2012). Incidents of drought frequency and intensity have also been increased (Bhunia et al., 2020). The tribal communities dominate the population in the villages of Kashipur (Purulia) and Chhatna (Bankura) with high rate of poverty (Mishra et al., 2022) and irrigation deficiency restricting agricultural and socioeconomic improvement (Palchaudhuri & Biswas, 2020; Pant & Verma, 2010). It is essential to popularize and adopt water conservation practices that can reduce the vulnerability of marginal farmers who cultivate in upland areas in the drought-prone RLZ. The water conservation practices are considered one of the key strategies to sustain crop production in prospect of growing water shortages and deteriorating soil health to fight the increasing incidence of drought and desertification and also to moderate the negative impacts of climate change and variability.

In India, IWC structures have been considered as supplementary irrigation sources which can possibly sustain crop production during drought conditions (Pani et al., 2021; Kumar et al., 2020; Pender & Kerr, 1998; Kerr & Sanghi, 1992). The IWC structures provided additional water supply and enhanced crop yield in Sikkim (Mishra & Rai, 2014; Mishra et al., 2019), Sone river catchment (Goel & Kumar, 2005), Andhra Pradesh (Kumar, 2016), Karnataka (Naveena et al., 2019), Gujarat (Pande et al., 2011), Madhya Pradesh (Malik et al., 2014), and Odisha (Sahoo et al., 2017).

To stabilize the production and reduce the probabilities of crop failures during dry spells, IWC structures have been provided with significant positive changes in the RLZ of West Bengal (Croke et al., 2012). The production of fish and carp in IWC structures has created alternative livelihood options and enhanced economic conditions in drought-prone RLZ region (Mishra et al., 2021, 2022). The indigenous people of the region have adopted various IWC practices such as happa, pond, well, pitcher watering system, drip watering system, etc. to cope with drought in RLZ. These structures supported micro-irrigation during drought conditions (Bauri et al., 2020). Small in-field IWC structure has facilitated groundwater recharge and increased soil moisture leading to higher crop production and intensity in drought-prone Bankura district of West Bengal, India (Pani & Mishra, 2021).

However, while the benefit using large-scale water bodies on fishing yields has been evaluated, overall benefits of IWC structures on the improvement of agriculture and drought risk reduction have not been evaluated so far. Therefore, the current research chapter focuses on the benefits of indigenous water conservation practices on the profile of agriculture, income, nutrition, food security, and livelihood diversification in smallholder farming villages of Kashipur and Chhatna blocks of Purulia and Bankura. The study evaluated the role of indigenous water conservation practices in improving food and nutrition security and drought-resilient farming through increasing water availability.

11.2 Study Area

The present study was conducted at 36 villages of Kashipur (17 villages) and Chhatna (19 villages) blocks (Table 11.1) of Purulia and Bankura, which are part of the RLZ, West Bengal (Roy et al., 2020). Kashipur and Chhatna blocks are situated between 23°26′,54″N to 23°21′26″N latitude, 86°34′20″E to 86°49′50″E longitude, and 23°27′8″N to 23°18′2″N latitude, 86°49′27″E to 87° 0′34″E, respectively (Fig. 11.1). Kashipur covers an area of about 434 km^2 with elevation varying from 88 to 228 m above mean sea level. Chhatna covers 449 km^2 area, and its elevation varies between 63 and 199 m above mean sea level. Thus, compared to Chhatna, Kashipur is at a higher elevation, and its topography is steeper, which results in a relatively higher risk of drought. The major landscape of these blocks is characterized by undulating terrain topography. Around 30% of the area have slopes in the range of above 6° and are prone to drought. The annual average rainfall is 1300 mm. The annual mean minimum temperature is 10 °C, whereas the annual mean maximum temperature is 45 °C (Roy et al., 2020). The non-perennial Dwarakeswar is the principal river in the area and follows the master slope toward the southeast. The soil is mainly red sandy to red and yellow loam (NBSS and LUP, 2006) with fewer nutrients and less water-holding capacity. Livelihoods of the community predominantly depend on agriculture. About 60% of the cultivators are marginal, and 30% are small farmers. Recurring drought is common in the study area which suffered a severe drought in the year 2015 (Roy & Hazra, 2020). In response to the water scant condition, indigenous water conservation and scientific agricultural practices were popularized and employed by a non-governmental organization (DRCSC) in the study area to reduce drought impact. In the area, traditional water conservation practices such as pond, dug well, and ditch or farm pond have commonly been observed.

Table 11.1 Distribution of sample household over the study villages

Block	Village	No. of sample household
Kashipur	Jagannathdi	4
	Lari	5
	Jamkiri	5
	Jibanpur	12
	Bodma	22
	Jorthol	5
	Kashidi	6
	Sunra	10
	Seja	5
	Lajhna	3
	Ranjandi	25
	Tilabani	4
	Bhatin	4
	Chaka	3
	Pabra Pahari	13
	Ichamara	4
	Lara	20
Chhatna	Saluni	7
	Besara	8
	Enari	14
	Kalipur	27
	Jhunka	22
	Hausibad	23
	Majhidi	3
	Kendua	12
	Penchasimul	17
	Shirpura	9
	Jirra Kelai	29
	Jai Nagar	14
	Dumur Kundi	11
	Benagoria	21
	Ghoshergan	32
	Kharbana	24
	Hans Pahari	15
	Dumdumi	14
	Shuara Bakra	8

11.3 Materials and Methods

11.3.1 Sampling Method and Data Collection

The present research applies a semi-structured questionnaire and focus group discussions for data collection. The household survey was conducted to collect primary

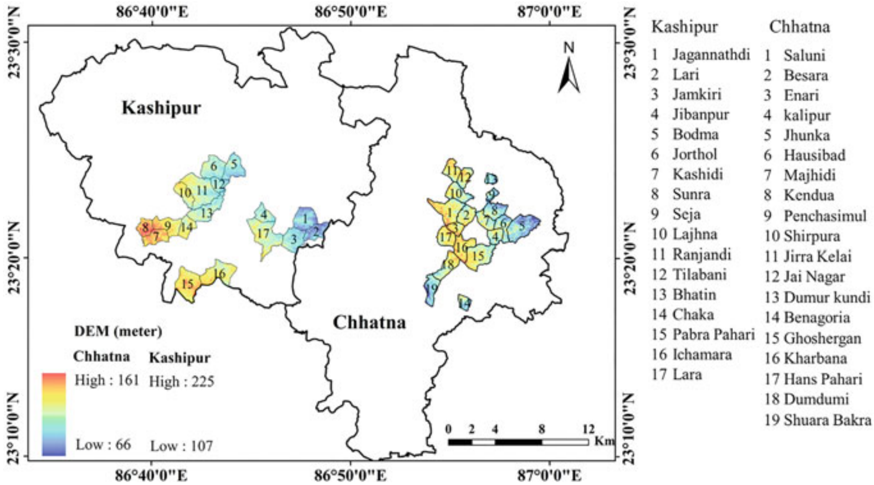

Fig. 11.1 Location of the study area

data on the socioeconomic profile of the 460 sample households (Table 11.1). The detailed information on their age, educational status, agricultural land holding, source of drinking water, major source of income, and access to banking facility, electricity, and sanitation were collected. The stratified random sampling technique was employed for selecting sample households in the villages. In each community development block, villages were recognized and selected based on the percentage of tribal population who are mostly small and marginal farmers. Furthermore, in each village, households who have water conservation structures such as pond, dug well, and ditch on their agricultural land (adopters) were chosen.

Sample size was computed by the equation (Cochran, 1977; Adjimoti & Kwadzo, 2018):

$$n = z^2 \times p(1 - p)/m^2$$

where n is the required sample size, z refers to the confidence level, p is the estimated extent of farmers in the area, and m denotes the margin of error.

In the present study, the confidence level of 95% with the standard value of 1.96 was used, and the margin of error (m) is 5% (Adjimoti & Kwadzo, 2018). The tribal small and marginal farmer households in the villages represent 54% ($p = 0.54$) of the total household in the villages. Therefore, $n = 3.8416*87.04 = 381$.

The sample size was increased by 20% to account for contingencies such as recording error or non-response. $382*1.20 = 459$.

11.3.2 Household Survey

A pre-tested questionnaire consisting of open-ended questions and multiple choices was used to collect data from the sample households with their prior consent. The issues addressed in the questionnaire contained basic socioeconomic characteristics, intensity of drought impact, types of indigenous water conservation structures, reasons for selecting and implementing the indigenous water conservation structures, and identified advantages of these indigenous water conservation structures on agricultural, income, livestock, and food security. The questionnaire has been used to collect data for both before (2015) and after (2021) the adaptation of the indigenous water conservation practices. The questioner has been attached as a supplementary material in the annexure.

11.3.3 Focus Group Discussions

The checklist-guided discussions with focus group members, both men and women, concentrated on the effects of drought on the past and present indigenous water conservation activities. Specifically, the effects of indigenous water conservation structures on reducing crop failure and improving crop yield, income, food, and water supply during dry spell were discussed. Additionally, discussions were held with the members of the implementing organization (DRCSC) and experts to triangulate the data collected using questionnaire and focus group discussions. Consequences of conversations with agricultural and natural resource specialists and focus group members helped to substantiate the individual interviews.

11.3.4 Data Analyses

The present study assesses the comparison of incremental changes on past and present adaptation and is extensively utilized for impact evaluation. The collected data were compared using percentages and average and by employing the one-way ANOVA using SPSS version 20. The present research studies the impacts of indigenous water conservation structures on agriculture, livestock ownership, and food supply by comparing changes on past and present adaptation for a period of 6 years, from 2015 to 2021. To determine the impacts on agriculture, it assesses changes in cropping intensification and crop yield (Malik et al., 2014). The study thus examines the impacts of indigenous water conservation structures on livestock by analyzing changes in the livestock ownership for 6 years (Kumar et al., 2016). Lastly, the impacts of indigenous water conservation structures on food security were analyzed by tracking the hunger days for 6 years (Tesfamariam et al., 2018).

11.4 Results and Discussion

11.4.1 Socioeconomic Attributes

Rainfed agriculture is the main livelihood of the villages, as above 77% of the total working people employed as cultivators or as agricultural laborers. Most of the respondents belonged from indigenous (scheduled tribe) as well as scheduled caste backgrounds. A higher percentage of adopter of IWCs were heads of households within the age range between 20 and 50 years (Table 11.2). This indicates that mainly younger persons are engaged in construction and repairing of labor-intensive indigenous water conservation structures. The education level of the majority of respondents is low (upper primary to secondary). The respondents had a small farmland area which consisted of lands having higher slope (known as Baid and Kanali) (Table 11.2). This, on the one hand, can motivate respondents to build the indigenous water conservation structures on sloping land for improving or maintaining the productivity in a small area. On the other hand, since the IWC structures occupy cultivable areas, these are not easily adapted by farmers. Source of drinking water for the majority of respondents is tube well. A large proportion of respondents have electricity and banking facilities. In both administrative blocks, more than 85% of respondents perceived frequent moderate to severe drought and associate crop failure which was also confirmed by the focus group discussants. Therefore, indigenous water conservation practices are highly persuasive in the present drought-prone villages. Village-wise intervention of IWC structures from 2015 to 2021 has been shown in Table 11.3, Figs. 11.2, and 11.3.

Most of the respondents used their own labor for the construction of indigenous water conservation structures. In addition, availability of government and non-government support and advisory service might have contributed to the indigenous water conservation structures which helped to promote scientific agricultural practices like mixed cropping and multi-cropping, nutrition gardening, and animal husbandry and backyard fisheries with the help of the IWCs.

11.4.2 Perceived Benefits of Indigenous Water Conservation Structures

In both administrative blocks, the majority of respondents perceived lifesaving irrigation positively affected agriculture during the recent drought-like conditions (2019). The focus group discussants also agreed on the role of indigenous water conservation structures in reducing drought impact and improving crop yields.

Table 11.2 Principal socioeconomic profiles of the respondents in villages of Kashipur and Chhatna blocks

Household socioeconomic characteristics			Chhatna (%) $n = 310$	Kashipur (%) $n = 150$
Cast structure	Scheduled tribes (ST)		58	85
	Scheduled castes (SC)		14	7
	Other backward castes (OBC)		7	7
	General category (GEN)		21	1
Age composition	<18 years	M	16	15
		F	13	14
	19–35 years	M	16	18
		F	17	17
	35–59 years	M	15	14
		F	13	13
	>60 years	M	4	4
		F	6	5
Educational status (%)	Primary	M	9	7
		F	10	7
	Upper primary	M	18	20
		F	16	15
	Secondary	M	14	14
		F	9	13
	Higher secondary	M	9	10
		F	6	6
	Undergraduate	M	6	5
		F	2	4
Average land holding size (hectare)	Pediment (Tnar)		0.27	0.15
	Upper mid terrace (Baid)		0.35	0.29
	Lower mid terrace (Kanali)		0.28	0.20
	Lower terrace (Bohal)		0.22	0.11
Source of drinking water (%)	Tube well		68	86
	Dug well		5	14
	Tap water		27	1
Main source of lighting (%)	Electricity		92	94
	Kerosene		8	6
Number of households having latrine facility (%)			40	57
Total number of households availing banking services (%)			90	85

Table 11.3 Village-specific interventions of indigenous water conservation structures from 2015 to 2021

	Village	Ditch	Pond	Well
Kashipur	Jagannathdi	13	10	1
	Lari	6	3	
	Jamkiri	5	3	
	Jibanpur	14	5	
	Bodma	3	13	
	Jorthol	2	32	
	Kashidi	9	8	1
	Sunra	6	5	
	Seja	28	1	3
	Lajhna		4	
	Ranjandi	10	26	12
	Tilabani	1	8	
	Bhatin	9	18	
	Chaka	7	8	2
	Pabra Pahari	28	13	1
	Ichamara	1	12	
	Lara	6	8	
Chhatna	Saluni	12	6	2
	Besara	1	8	2
	Enari	2	2	
	Kalipur	6	2	2
	Jhunka	6	8	5
	Hausibad	5	2	4
	Majhidi	2	3	3
	Kendua	3	5	1
	Penchasimul	2	3	1
	Shirpura	8	8	
	Jirra Kelai	7	4	7
	Jai Nagar	8	6	2
	Dumur Kundi		1	
	Benagoria	1	14	
	Ghoshergan	20	4	9
	Kharbana	3	4	6
	Hans Pahari	14	7	6
	Dumdumi		3	
	Shuara Bakra	1		1

11.4.3 Impact on Agriculture

11.4.3.1 Crop Intensification

General agriculture practice in the study villages is of cultivating one crop in a year, during the monsoon (Kharif crop). After implementation of indigenous water

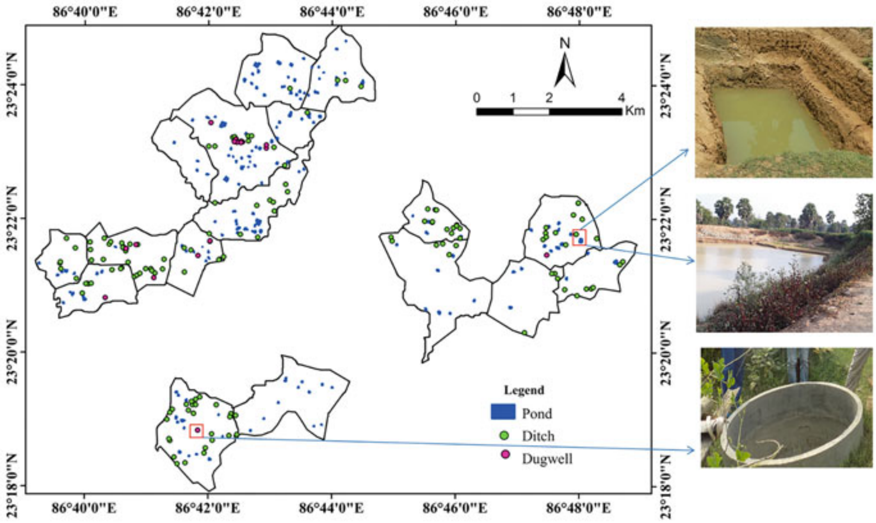

Fig. 11.2 Village-wise location of IWC structures in Kashipur

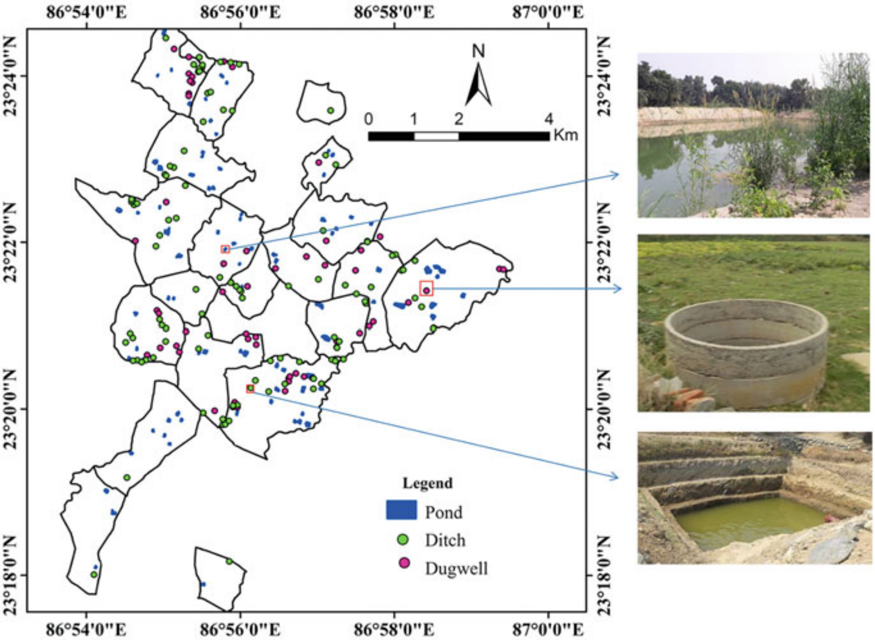

Fig. 11.3 Village-wise location of IWC structures in Chhatna

Table 11.4 Changes in double cropping practicing after IWC structure implementation

Kashipur	Percentage of people practicing double cropping		Chhatna	Percentage of people practicing double cropping	
	2015	2021		2015	2021
Jagannathdi	27	55	Saluni	0	63
Lari	25	55	Besara	3	63
Jamkiri	0	54	Enari	0	67
Jibanpur	13	55	Kalipur	3	63
Bodma	36	62	Jhunka	18	84
Jorthol	30	60	Hausibad	0	65
Kashidi	0	56	Majhidi	0	67
Sunra	0	50	Kendua	17	83
Seja	22	60	Penchasimul	13	82
Lajhna	16	60	Shirpura	1	66
Ranjandi	14	88	Jirra Kelai	1	80
Tilabani	26	50	Jai Nagar	0	80
Bhatin	0	60	Dumur Kundi	0	44
Chaka	0	60	Benagoria	10	65
Pabra Pahari	0	70	Ghoshergan	3	75
Ichamara	0	55	Kharbana	6	85
Lara	12	50	Hans Pahari	8	75
			Dumdumi	0	71
			Shuara Bakra	18	80

conservation structures, farmers cultivated two crops in a year, one during the monsoon (Kharif crop) and other during the winter (Rabi crop). Before adaptation, only 10–20% of the respondents in 10 villages (Table 11.4) practiced double cropping. But after adaptation, above 50% and 70% of the respondents in all villages of Kashipur and Chhatna, respectively, have been cultivating twice a year. About 67 % of surveyed households have access to at least one-time irrigation supply from indigenous water conservation structures during drought conditions. After indigenous water conservation structures were excavated, average cropping intensity has increased from 15% in 2015 to above 60% in 2021. The difference in the average cropping intensities, obtained between the before (2015) and after adaptation (2021), is statistically significant at 5% significance level (p-values are 0.00063 and 0.00025 for Kashipur and Chhatna, respectively). Indigenous water conservation structures have facilitated additional water availability for irrigation which has supported crop intensification.

Utilization of the supplementary water available through indigenous water conservation structures has increased the crop diversity. Responses to the survey reveal that a majority of the respondents cultivate multiple crops during the two crop cycles over a year. The average varieties of crops cultivated over agricultural land in two cropping seasons have also increased from two in 2015 to five in 2021. The findings were statistically significant at 5% significance level (p-values are 0.0163 and

0.00034 for Kashipur and Chhatna, respectively) (Table 11.7). After digging the water conservation structures, the sample households are cultivating around five varieties of crops on more than 5 ha of agricultural land. Currently, the majority of sample households cultivated two cropping seasons annually; the varieties like paddy and vegetables (okra, ridge gourd, etc.) are farmed in the Kharif (monsoon) season, while mustard, peanut, and lentils are grown in the Rabi (winter) season.

The considerable improvement in the cropping intensity and crop diversity cultivated were also found in several other studies on the various water conservation structures such as in India (Pani & Mishra, 2021; Deora & Nanore, 2019; Malik et al., 2014; Sur et al., 2001) and abroad, e.g., Ethiopia (Wolka et al., 2018) and Africa (Adjimoti & Kwadzo, 2018).

11.4.3.2 Increase in Crop Yield

An increased crop production is one of the indicators of the impact of water conservation structures (Bouma et al., 2016; Wolka et al., 2018). Therefore, the present study evaluates crop production across the before (2015) and after (2021) adaptation. Rice is the primary crop in this area. The average rice production has been increased from 1200 kg/ha to 1600 kg/ha within this time interval. The statistical analysis using one-way ANOVA, comparing crop yields after and before adaptation, indicates that the difference in average crop yields is statistically significant at 5% significance level with p-values 0.00023 and 0.0202 for Kashipur and Chhatna, respectively (Table 11.7).

Studies on various water conservation structures such as the farm ponds, 30 ft. X 40 ft. ditches along slope, nala bund, and check dam could also found increase in the crop yields (Wolka et al., 2018; Deora & Nanore, 2019). It was revealed from focus group discussions that the additional water availability in the wells and ditches has also facilitated micro-irrigation during drought conditions and reduction of crop failure (Kumar et al., 2016; Malik et al., 2014).

11.4.4 Increase in Livestock Ownership

After IWC implementation, the number of sample households having livestock has increased from 52 to 75% (Table 11.5). The respondents have also reported that the variety of livestock like cow, pig, sheep, goat, chicken, and duck has increased. Animal husbandry not only improved the income for the households but also secured their nutrition intake at no additional expense and contributed to drought risk reduction during monthly or seasonal droughts. The difference between the percentage of livestock ownership households before and after adaptation is statistically significant at 5% significance level ($p = 0.003$ and 0.00014) (Table 11.7). Sample households stated that the rice has been primarily used as a livestock feed by a considerable portion, and the analysis on crop production revealed that after

Table 11.5 Changes in crop variation, income, production, and livestock ownership after IWC structure implementation

Village	Change (%)				
Kashipur	No. of crop varieties	Livestock ownership	Poultry	Agricultural production	Income
Jagannathdi	8	33	4	6	30
Lari	3	40	4	16	23
Jamkiri	40	25	13	17	8
Jibanpur	5	98	15	8	40
Bodma	25	21	8	22	25
Jorthol	7	31	60	25	18
Kashidi	40	4	4	35	28
Sunra	20	6	58	23	70
Seja	15	78	60	19	95
Lajhna	5	3	19	57	46
Ranjandi	5	85	19	70	92
Tilabani	5	70	37	15	23
Bhatin	40	51	57	18	11
Chaka	20	10	8	24	57
Pabra Pahari	50	95	52	57	85
Ichamara	40	96	72	27	44
Lara	10	95	80	11	55
Chhatna	No. of crop varieties	Livestock ownership	Poultry	Agricultural production	Income
Saluni	40	96	71	41	46
Besara	3	91	85	17	17
Enari	50	75	63	87	84
Kalipur	10	89	72	24	26
Jhunka	25	14	2	11	16
Hausibad	50	39	40	26	14
Majhidi	30	49	33	19	19
Kendua	12	4	25	25	35
Penchasimul	25	6	17	35	29
Shirpura	10	80	79	31	25
Jirra Kelai	10	69	79	12	26
Jai Nagar	50	63	75	28	25
Dumur Kundi	20	90	89	36	18
Benagoria	13	25	78	2	28
Ghoshergan	7	43	27	31	40
Kharbana	2	83	46	12	18
Hans Pahari	10	49	33	46	35
Dumdumi	50	50	81	39	21
Shuara Bakra	24	57	17	25	12

adaptation, rice production has increased significantly. Therefore, the availability of livestock feed has been raised. The IWC subtly associates with the drinking water availability for the livestock. IWCs have been advantageous to ensure feed and water availability for livestock. Similar findings were reported in the earlier studies (Deora & Nanore, 2019; Renganayaki & Elango, 2013; Sur et al., 2001).

11.4.5 Introduce Nutrition Gardening and Increase in Indigenous Crop Cultivation

Water conservation structures have been found to be helpful in introducing nutrition gardening and enhancing indigenous crop cultivation. The introduction of nutrition gardens, where a variety of vegetables, leafy vegetables, and fruits are being grown for household consumption, has helped to ensure food and nutrition security for 83% of beneficiaries in 2021 (Table 11.6). The revival of indigenous crops like okra, wild potato, and pigeon pea has helped to secure household subsistence during adverse climatic conditions and achieve nutritional security.

11.4.6 Increase in Food Security

After adaptation, crop yield has been increased, and the nutrition garden provided vegetable supply throughout the year. Consequently, the number of hunger days has decreased. The average number of hunger days has decreased around 68% and 71% respondents in Kashipur and Chhatna, respectively (Table 11.6). They attributed their enhanced food security to a range of initiatives which yielded interlinked benefits for them. The introduction of improved water supply at the appropriate levels using dug wells and ditches and promotion of double or triple cropping with improved water supply for micro-irrigation, indigenous crop revival, nutrition gardening, and fishing significantly have improved food and nutrition security of the beneficiaries and reduced the need to purchase food for daily consumption. The previous studies on the farm ponds also find a similar increase in food security (Adjimoti & Kwadzo, 2018). These studies have shown that crop intensification, crop diversification, indigenous crop cultivation, and nutrition gardening have a positive effect on households' food security status.

11.4.7 Increased Income and Livelihood Diversification

Water conservation structures have been supportive to increased income and livelihood diversification in the study area. The increase in income is one of the most

Table 11.6 Percentage of respondents involved in nutrition gardening and fishing and who experienced food security after adaptation

		% of people who experienced reduction of hunger days (by 2–3 months)	% of people having backyard fishery	% of people having nutrition garden
Kashipur	Jagannathdi	85	60	85
	Lari	84	60	80
	Jamkiri	89	75	80
	Jibanpur	81	66	83
	Bodma	86	52	60
	Jorthol	75	20	80
	Kashidi	76	25	83
	Sunra	79	80	98
	Seja	82	75	85
	Lajhna	72	80	95
	Ranjandi	74	72	92
	Tilabani	76	75	75
	Bhatin	69	75	75
	Chaka	83	65	98
	Pabra Pahari	82	76	98
	Ichamara	83	77	85
	Lara	86	80	70
Chhatna	Saluni	72	65	87
	Besara	65	65	87
	Enari	68	0	78
	Kalipur	75	35	71
	Jhunka	78	75	81
	Hausibad	69	65	86
	Majhidi	67	35	67
	Kendua	71	83	75
	Penchasimul	73	58	94
	Shirpura	73	55	77
	Jirra Kelai	71	50	95
	Jai Nagar	72	50	95
	Dumur Kundi	75	0	80
	Benagoria	69	0	80
	Ghoshergan	70	55	95
	Kharbana	69	65	79
	Hans Pahari	71	60	93
	Dumdumi	73	42	85
	Shuara Bakra	68	60	85

frequently recorded indicators of the impact of water conservation structures (Bouma et al., 2016). Therefore, this analysis compared the income before and after adaptation. Diversification of livelihoods, utilizing the additional water available through water conservation structures, has been found to result in a definite increase in the net agricultural, livestock, and nutrition garden returns. The average annual income from agriculture has increased from 15,000 INR to 20,000 INR in Kashipur and from 17,000 INR to 24,000 INR in Chhatna. The difference in the average annual income from agriculture, obtained after adaptation, is statistically significant at 5% significance level ($p = 0.02$) (Table 11.7). Responses to the questionnaire indicate that the majority of respondent households cultivate multiple crops during the two crop cycles over a year and the crop yield has increased. Consequently, income from agriculture has enhanced. The construction of community ponds and ditches enabled the beneficiaries to practice group-based aquaculture, while increasing the depth of existing ponds caused improved returns from fishing. After adaptation, around 50% and 65% sample households have started practicing fishing in Kashipur and Chhatna, respectively (Table 11.6). Rearing livestock like hen, duck, fowl, sheep, goat, pig, and cow supplied milk, eggs, and meat for household consumption and sale, supplementing income and nutrition during periods of drought and water stress. A variety of vegetables like green and red spinach, grown in the nutrition garden, and the revival of old crops like lady's finger and wild potato have promoted the consumption of a wider variety of nutrients and reduced expenditure during dry spell. Accordingly, after adaptation, fishing, nutrition gardens, and animal husbandry have produced interlinked advantages for the respondents and emerged as potential livelihood options. Similar results have been found in other studies in different regions like Purulia (Roy et al., 2022), Maharashtra (Deora & Nanore, 2019), Karnataka (Kumar et al., 2021), Zimbabwe (Nyagumbo et al., 2019), and Africa (Lasage & Verburg, 2015). These studies have concluded that IWC structures have resulted in significant increase in income, crop intensity, livestock, and livelihood which have been able to cope with drought (Malik et al., 2014; Sur et al., 2001).

11.5 Conclusions

Various indigenous water conservation structures such as ponds, dug wells, and ditches were adopted for drought along with scientific farming practices. Benefits of reviving indigenous water conservation practices for drought resilience were analyzed based on primary data acquired by the household survey. Farmers were selecting and implementing IWC structures depending on the local land characteristics. Ditches and dug wells were widely implemented in the blocks because they required a small area and were cost-effective. In both administrative blocks, the respondents perceived fundamental benefits of these IWC structures including lifesaving irrigation during drought conditions and reduced crop failure. In this regard, the IWC structures were recognized to positively contribute to agricultural

Table 11.7 Results of the ANOVA

Kashipur $n = 150$	Average		Variance		F	p-value	F crit
	Before	After	Before	After			
Crop intensification	20.06	58.82	388.43	82.28	62.78	0.00063	4.49
No. of crops	2.29	5.18	1.72	1.53	87.71	0.01637	4.49
Livestock ownership	52.82	75.82	306.53	56.28	31.71	0.00375	4.49
Poultry	62.29	80.76	121.85	46.57	32.79	0.00312	4.49
Production	1559.6	1910.55	373,355.69	397,016.65	72.45	0.00023	4.49
Income	17,508.72	24,202	65,793,700.79	66,051,135.75	73.29	0.00024	4.49
Chhatna $n = 310$							
Crop intensification	5.32	71.47	44.34	108.37	44.55	0.00025	4.11
No. of crops	2.53	5.58	2.49	1.15	48.75	0.00034	4.11
Livestock ownership	40.37	80.89	76.36	97.10	79.90	0.00014	4.11
Poultry	36.74	74.58	56.43	235.92	93.07	0.00016	4.11
Production	1247.05	1558.74	157,026.50	155,625.03	5.90	0.020223	4.11
Income	15,740.37	19,771.07	15,111,948.15	17,454,204.16	9.48	0.003964	4.11

Significantly different at $p < 0.05$, degree of freedom is 16 for Kashipur and 36 for Chhatna production, income, food security, and livelihood. IWC structures have ensured micro-irrigation and supported farmers in increasing their agricultural cropping intensity, crop diversity, and crop production for the majority of crops. Livestock rearing has also obtained a raise after IWS structure excavation, through increase in ownership and additional feed and water availability for livestock. The benefits of these interventions were reflected in income enhancement, food security, more nutrition intake, livelihood diversification, reduction in hunger days, and improved purchasing power. For the implementation of IWC structures, less requirement of land acquisition makes it more useful for small and marginal farmers. It has been concluded that IWC structures have the potential to intensify agriculture and provide food security and livelihood options in the drought-prone villages of the RLZ. Hence, these can be an effective strategy for drought adaptation. The present study provides insights for decision-makers by highlighting the impacts of a low-cost small water conservation structure in drought-prone undulating terrains. These practices can further be replicated in the drought-prone areas of India and the world to facilitate potential solutions of water shortages in the smallholder farming.

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Chapter 12
Local Knowledge on Water Use and Water-Related Ecosystem Services in Lowland, Midland, and Upland Villages in Mindanao, Philippines

Elson Ian Nyl Ebreo Galang, Alexandra Jewel Rosas, and Paoloregel Samonte

Abstract We explore local knowledge on water in lowland, midland, and upland villages in the Libungan-Alamada Watershed in Mindanao, Philippines. Specifically, we investigated local knowledge on water use and other natural benefits derived by the villages from their water sources (i.e., river and spring) or water-related ecosystem services (WES). We implemented a two-stage participatory exercise in each village that engaged diverse residents to collaboratively identify how they use water and other WES they obtain from their water sources. Results of our participatory exercise indicate the richness of local knowledge on water, reflecting that their water sources do not only supply water for domestic and agricultural use but also WES that shape the very social-ecological dynamics of their village. Villagers' local knowledge captures how the water sources are a complex biome of several water-dependent ecological units (e.g., trees and shrubs that form riparian forest strips) that all contribute natural benefits for subsistence, livelihood, and cultural identities of each village. We found similarities in local knowledge across all villages, especially on traditional WES that have intergenerationally supported the basic needs (e.g., food) of their village. More importantly, we found several unique local knowledge for each village, demonstrating place-based specificity of local knowledge based on biophysical (i.e., elevation) and socio-cultural variations.

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In particular, we found local knowledge among Indigenous communities in the upland village to mirror their traditional heritage. We discuss that our findings can strengthen the need for engagement, recognition, and documentation of local knowledge for more sustainable, resilient, and equitable water management.

Keywords Upland · Watershed · River · Indigenous · Participatory

12.1 Introduction

Water sources provide various benefits to local communities including water supply for domestic and agricultural use, as well as other natural benefits or water-related ecosystem services (WES) (Gao et al., 2017; Sahle et al., 2019; Shaad et al., 2022). WES are natural benefits that are generated because of the unique ecosystem structures, compositions, and functions (i.e., biomes) that are closely dependent on water sources, especially in freshwater sources such as rivers, lakes, and springs (Chang & Bonnette, 2016; Pettinotti et al., 2018). WES can be the provision of the very supply of water, other provisioning services or material benefits such as meat from the animals in the water source, regulating services or ecological function benefits such as the erosion mitigation of riparian forests, cultural services or non-material benefits such as the recreational value of water sources, and supporting services or benefits that support the generation of other benefits (e.g., photosynthesis) (Millennium Ecosystem Assessment, 2005; Brauman et al., 2007).

Sustainable, resilient, and equitable water management should therefore consider not only the water supply in water sources but also other WES these provide. Understanding local knowledge on water, especially WES, can serve as a significant first step to having more holistic perspectives that can better guide more comprehensive and inclusive water management actions and decisions (Kanyama-Phiri et al., 2017; Ramirez et al., 2019; Cebrián-Piqueras et al., 2020; Moore & Nesterova, 2020). Local knowledge is the knowledge held by a specific group of people about their local ecosystems and has been generated as local communities interact with their natural environment (Olsson & Folke, 2001; Raymond et al., 2010; UNESCO, 2021). Water management that effectively considers local knowledge is better understood, accepted, perceived as fair, and legitimized by communities (Titilola, 1990; Kozar et al., 2020; Cebrián-Piqueras et al., 2020).

It is under this rationale that we explore local knowledge on WES among three elevation distinct villages—lowland, midland, and upland—in a watershed in Mindanao Islands, Philippines. Analyzing the variances of local knowledge on WES across different elevations provides a more nuanced understanding of how biophysical factors influence WES perception and the consequent knowledge this articulated perception reproduces. In this research undertaking, we thus ask the following research questions:

(a) How does each village use water? What are the other natural benefits or WES does each village acquire from water sources?

(b) How does varying elevation, including related socio-cultural factors, influence local knowledge on water use and WES?

By answering these questions, we aim to expand our understanding of water sources as suppliers of WES while providing empirical information on similarities and differences in local knowledge across distinct villages. Comparing villages will provide key insights on how we can further engage local knowledge in informing water management, specifically how we can consider synergies and trade-offs in actions and decisions from one place to another. Our study likewise contributes to the limited comparative literature documenting local knowledge that are relevant and useful for water management (Camacho et al., 2015; Landicho et al., 2021).

12.2 Methodology

12.2.1 Case Study

We use the Libungan-Alamada Watershed (7°19′40.2″N, 124°30′57.4″E) in Cotabato Province, Mindanao, Philippines, as our case study. The whole Watershed is around 52,000 ha, which serves as the primary source of water supply for domestic and agricultural use of 6 municipalities in the province or around 142,000 families. Two of these municipalities have villages that are directly living within the Watershed. The Watershed is also a government-designated production-protection site, which means that villages that are directly within it are legally allowed to implement sustainable forms of agriculture. In particular, the Watershed has been characterized as an "agroforestry landscape" because most of the families on the site practice different forms of agroforestry systems (i.e., integration of perennials in crop and/or livestock production) (Neyra-Cabatac et al., 2012; Galang & Vaughter, 2020). Water supply of the Watershed originates from two major water sources: (1) the river and its tributaries and (2) springs.

To answer our research questions and implement our methods, we selected three elevation-distinct but adjacent villages in the Municipality of Libungan. The Municipality is one of the two municipalities whose several of its villages are directly living in the Watershed. These three villages we explored are the following:

Ulamian (Lowland Village) This village is in the lower, plain-to-hilly lands portion of the Watershed. Families mostly practice bi-annual cash crop-based agroforestry systems (i.e., two harvest cycles in a year). Among the most common agroforestry system practices is the integration of rice production with fruit trees (e.g., coconuts) as shelterbelts. It also has a strong poultry and swine industry, as well as a relatively well-built dirt road networks that allow better transportation in and out of the village. Thus, many families also rely on non-agricultural sources of income such as employment in government and market sectors, entrepreneurial activities, and service offerings in the nearby urban centers. Accessible and efficient transportation is a crucial factor that explains why among the three case study villages, Ulamian has the best access to social services usually found in urban centers, especially educational and health centers. The village likewise has access to processed tap water.

Demapaco (Midland Village) This village is in the middle, sloping-hilly lands portion of the Watershed. Families mostly practice multi-story farming of fruit trees (e.g., mangoes) integrated with irregular cash crop farming (i.e., vegetables and corn). Multi-story farms are also important spaces for small-scale ruminant production (i.e., goats and beef cattle). Unlike the lower village, families here are much less involved in non-agricultural sources of income. It is interesting to note that this community has a high percentage of families with at least one overseas Filipino workers (OFW) member or someone who works and remits money from abroad. Remittances from OFWs play a critical role in ensuring more reliable cash in-flow for the families, compensating for the irregular income from multi-story farming and cash cropping. Like the lowland village, this village also has access to processed tap water.

Sinapangan (Upland Village) This village is in the upper, plateau-like portion of the Watershed. The village has one of the highest population proportions of *Erumanen ne Menuvu* in the whole of the Watershed. The *Menuvu* is an Indigenous group in Southern Philippines, and the *Erumanen ne Menuvu* is a particular Indigenous *Menuvu* subgroup that has traditionally inhabited that Watershed (Neyra-Cabatac et al., 2012). Families mostly practice slash-and-burn agriculture and cash crop-based agroforestry farming (i.e., upland varieties of rice, corn, and beans with perennial legumes). Livestock production, especially of small ruminants (e.g., goats), is also present. Hunting wild meat and gathering wild vegetables in the rich hilly forests of the village are important sources of food for their subsistence. The village relies on income from tourism-related services as the village serves as the entry to the Watershed's hiking trail. Indigenous peoples sell souvenir items, serve as local hike guides, and prepare/sell local delicacies to tourists. Unlike the lower villages, this village has the least transportation network, which is only accessible through one main dirt road that only big trucks or single motorcycles can pass through. During the rainy season, the roads can be completely impassable to vehicles, and the village only becomes accessible by walking. Among the three, this village is the only one with no access to processed tap water.

12.2.2 Participatory Exercise to Scope Local Knowledge

We have implemented a participatory exercise in each of the three villages that aimed to solicit their local knowledge on water and WES. Specifically, our exercise identified the water use and other WES that each village obtains from the river and springs within their village. We invited 15–21 diverse residents of each village to participate in the exercise, including representatives from local farming associations, women's groups, elderly and youth organizations, and community councils. Each participant was carefully co-selected with village leaders to represent as much diversity of local knowledge. Meanwhile, all village exercises were spaced 1 day apart during the rainy season (i.e., August) to reduce seasonality bias that might affect local knowledge of water (Buhyoff & Wellman, 1979). Each exercise lasted for around 3 h, all held in the mornings. Described below are the key activities of the exercise.

Water Source-Specific Water Use and WES Participants were placed into subgroups, such that each subgroup is assigned a specific water source (either the village's river or spring). The differentiation between river and spring is associated with their potential varying biomes. Water in rivers flows continuously downstream, while water in springs is confined within a particular space. Prior to the exercise, we took photos of these two water sources as located in their village (i.e., each village has distinct sets of photos). We provided these photos to each subgroup to help facilitate their thinking process. Termed as "photo-elicitation," photographs can serve as better stimuli and guidance for respondents than oral or written discussions alone (Harper, 2002). Each subgroup was then given 30–45 min to discuss and list down, in their respective village languages (i.e., each village speaks a distinct language), the various water uses and other WES they know from the water source, through either their own experience or personal observation of other villagers.

Village Consensus of Water Use and WES Each subgroup then presented their preliminary list of water use and other WES from river/spring to the rest of the group. After the presentation, we facilitated an open group discussion to ask for comments and further additions of water use and/or WES that were not captured in the preliminary lists. Once everyone agreed that we have exhausted all possible answers, we then finalized the list of water use and WES for each water source. Before we ended the exercise, all participants were asked to check and verbally validate the results that we just co-produced, which is a process also termed as transactional validity (Caretta & Pérez, 2019). We, as the facilitators, took a passive role all throughout the process to ensure that the lists solely reflect the local knowledge held by the participants.

12.2.3 Analyzing the Outputs of Participatory Exercise

We aggregated the water use and WES identified for the river and spring in each village because we wanted to consider both water sources as a single unit of analysis to represent our case. We then cleaned out the aggregated list in each village to remove close duplicates or fused highly related ones. We also translated all entries into English, closely coordinating with local experts to review and confirm our translations. Using the framework of the Millennium Ecosystem Assessment (2005), we categorized and counted the water use and WES from each aggregated list as provisioning (i.e., material benefits), regulating (i.e., non-material benefits that support ecosystem functions), or cultural (i.e., non-material benefits that support socio-cultural functions) ES. All identified water uses for drinking, domestic, or agricultural purposes were classified as provisioning WES because these are tangible and direct benefits obtained by the village (Sahle et al., 2019).

12.2.4 Probing Exercise Results

We conducted follow-up interviews with select participants to gather more information that would substantiate the results of our exercise. We have also reviewed relevant reports and other documents, as well as conducted observations of the villages.

12.3 Results

12.3.1 Understanding Water Sources as a Complex Biome

Results of our participatory exercise show that local knowledge is tied not only with water use for various purposes but also with other WES that benefit the villages. Specifically, local knowledge on WES spans provisioning (Fig. 12.1), regulating (Fig. 12.2), and cultural (Fig. 12.3) dimensions associated with various ecological units of the water sources (i.e., rivers/springs). These ecological units closely interact in both structure and function to depend on these water sources, forming a vibrant river/spring biome. These components include:

(a) Trees such as native timber trees (e.g., *Ficus* sp.) and some fruit trees which form thin strips of riparian forests
(b) Perennial shrubs and grasses (e.g., *Bambusa* sp.)
(c) Fish (e.g., *Ambassis* sp.) and other water-based animals such as reptiles, mollusks, and amphibians
(d) Small rodents, avian, and other air- and land-based animals that depend on the ecological dynamics provided by the river and spring

These ecological units can be unique in these water sources, especially that many of these are dependent on water supply. For example, some flora can only be found in areas where there is continuous supply of water. Some animal species mainly thrive in the ecological food web that directly consumes water-based animals (Pettinotti et al., 2018; Sahle et al., 2019). These biomes do provide not only material benefits or provisioning services (e.g., tree branches as fuelwood) but also non-material or regulating/cultural services. For example, villagers know that trees and their canopies improve the overall microclimate in their watershed. Our results feature the complexity of local knowledge on water among local villagers—capturing not only the usage of water supply per se but also the benefits that the whole river/spring biomes provide for their subsistence, livelihoods, and wellbeing. We

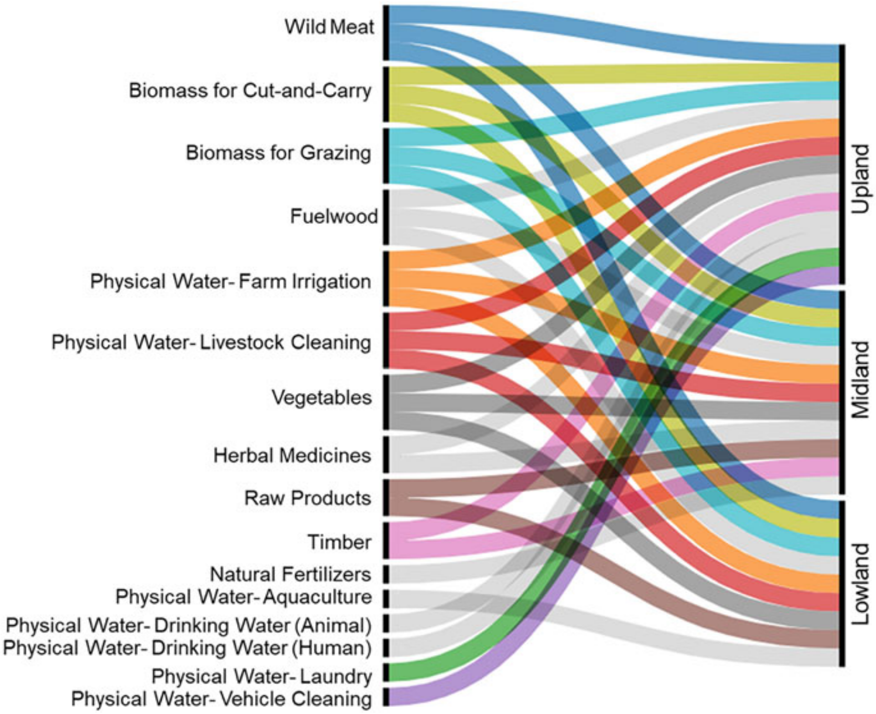

Fig. 12.1 Provisioning WES known by each village

further discuss local knowledge on these WES in the succeeding cross-cutting and case-specific results.

12.3.2 Cross-Cutting Local Knowledge on Water Use and WES

Despite differences in elevation, our results show how there are several similarities across local knowledge on water use and WES. Similarities are particularly evident in local knowledge on provisioning services including wild meat from the animals, cut-and-carry/grazing biomass for livestock feedstuff from trees and perennial shrubs/grasses, fuelwood from fallen branches of trees, and vegetables that are mostly native plants growing beside the rivers (e.g., *Diplazium* sp.). This group of provisioning services is also what Galang and Vaughter (2020) termed as "traditional ES" or the WES that translate as basic needs that rural communities require to persist intergenerationally. This echoed during follow-up interviews in which villagers mentioned how "nature," in this context the rivers/spring biomes, are essential for their wellbeing since they were children. How their parents and/or grandparents

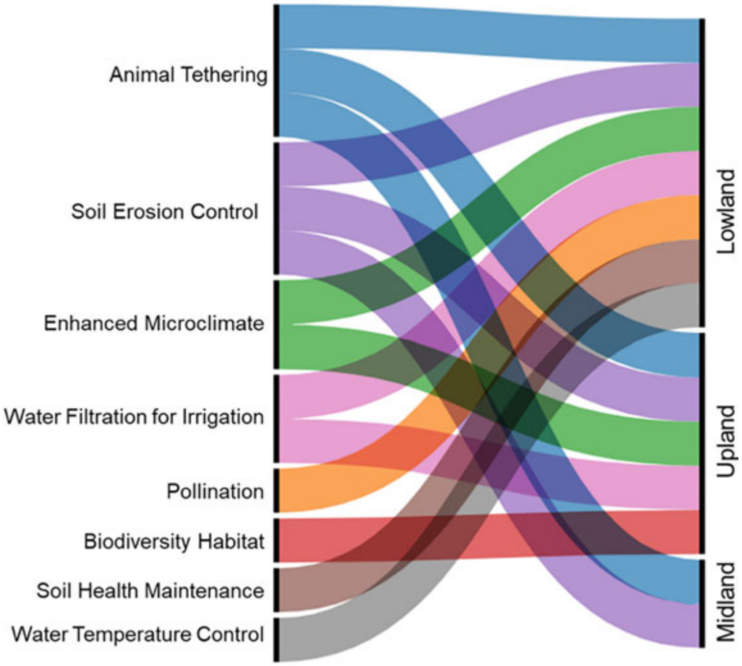

Fig. 12.2 Regulating WES known by each village

operated their daily lives for subsistence, as far as villagers can remember, has been greatly influenced by the availability and access to natural resources, including those obtained from water sources. Eventually, such local knowledge on how to utilize trees, shrubs, and grasses around water sources has been transferred intergenerationally from the elderly to young ones.

Water use for farm irrigation and livestock cleaning is also common across the three villages, reflecting their dependence on crop farming and livestock raising livelihoods. Villagers use the water for their crops and for livestock purposes, including directly washing them as in the case of large ruminants (e.g., cattle) or washing the animal pens for smaller livestock (e.g., swine). Also related to livestock production is the cross-cutting local knowledge on regulating service of trees for animal tethering. The combined effects of the canopies of trees and the cooling effect from the water source provide an ideal place for animals to be tethered onto (Calub, 2003). Villagers shared in the follow-up interviews that livestock raising requires them to spend more than half of their daylight life in the water sources to keep an eye on their livestock. For them, it is essential that their livestock grazes in cool areas to maximize their growth and development, hence higher cash returns when sold.

Another cross-cutting regulating service is soil erosion control by perennial shrubs and grasses. Villagers discussed with us that the extensive rooting of shrubs and grasses keeps soil beside water sources intact. Villagers explain that most of

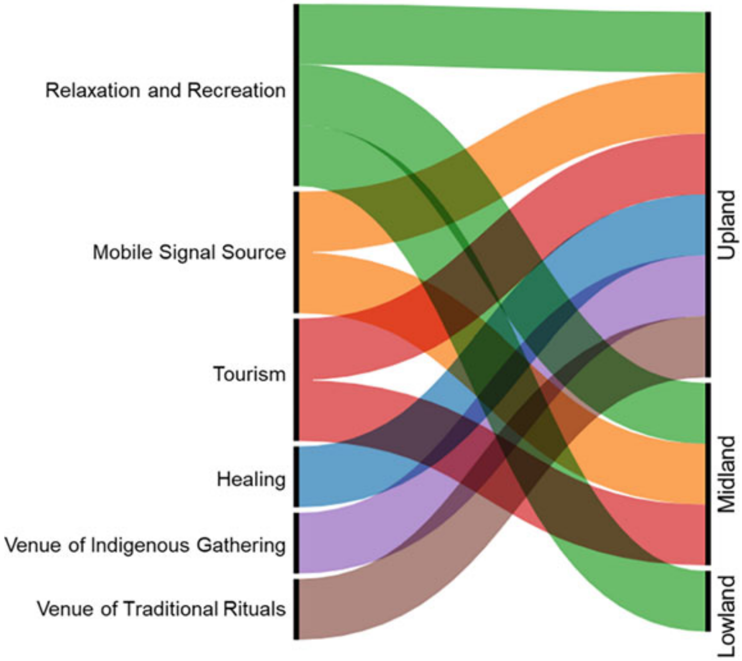

Fig. 12.3 Cultural WES known by each village

them do not let their livestock graze on grasses beside the water source because they know that these are important to avoid eroding soils.

Among the three, local knowledge on cultural WES is the least similar with only relaxation and recreational value of the water sources being common across the villages. Rivers and springs are important for swimming and strolling with friends and/or families, especially during the summer. It was also identified as an ideal site for family gatherings, picnics, and special occasions (e.g., birthdays). Our follow-up interviews further showed that for the villagers, "being with the water" (e.g., swimming, standing beside it, looking at it) can be very therapeutic both physically and mentally. It was not our intention in this study to capture individual differences among participants; however, we observed that there are very apparent distinct differences on the idea of the recreational value of water sources. A major example for this in our case study is how our youth participants have credited water sources as a site for courtship. Young couples in the villages usually walk through and spend time beside rivers or springs.

12.3.3 Specific Case of the Lowland Village

Local knowledge among lowland villagers centers on regulating services provided by the water sources. They associate trees and shrubs along the river with the ecological regulatory benefits that help their cash crop-based farming. Because most farming families divert the water from the rivers to irrigate their farms, they attribute the trees and shrubs along the river to keep the water cool, filtered from trash and other pollutants, and cleaned from eroding soil. All these regulating services assure that the quality of water supply that enters their farms is optimal for their cash crops. Villagers share that this is significant during the summer when increased water temperature could cause damage to crops, especially affecting the germination of crop seeds. In our follow-up interviews, the villagers also shared that these regulating services reduce the anticipated labor efforts and expenses for cropland preparation because they do not have to remove eroded soil, trash, and other pollutants for the next farming cycle.

In addition to these, they also know that trees and shrubs are important habitat for pollinators of their crops. Villagers recognize, for example, that many pollinating insects (e.g., bees) live among the flora around water sources. Another unique regulating service in this village that is also related to crop farming is soil health maintenance or good health of soil in croplands. Villagers understand that the water diverted from the river to irrigate their croplands contains soil organic matter that is rich in nutrients for their croplands.

Lowland villagers also have a unique local knowledge of water use for aquaculture production. Some of them practice small-scale pond-fish farming (esp. *Oreochromis* sp.) in which small ponds are created beside rivers. Small earthen canals connect the river to divert water into the ponds. Our field observations also tell us that the ponds are being used by some villagers for duck production. Among the three, the lowland villagers associate water sources with the least cultural WES or only for their recreational value. A specific interesting theme on the recreational value of water that we heard during the exercise is how water sources were closely associated by participants as a “children’s playground” which included activities such as paper boat raising.

12.3.4 Specific Case of the Upland Village

Upland village’s local knowledge highlights their subsistence and cultural dependence on water sources. This can be attributed to their high Indigenous peoples population whose lives and livelihoods have traditionally relied on their surrounding environment. This human-nature interdependence is particularly apparent as the upland villagers have the most local knowledge on water use and provisioning WES. Unlike the lowland and midland villagers who depend on processed tap water for drinking, this village directly obtains drinking water (for human and animal) from the water sources, especially from springs. In our interviews, villagers share that it is an essential part of their daily lives to go fetch drinking water. Our further probing shows that this is mostly an activity done twice a day, dawn and dusk, by young members of the household. The dependence on springs as drinking water source is further exacerbated by the fact that they are the only village in our case study that have no access to processed tap water, which is the drinking water source for the other villages.

Important water uses also include laundry and vehicle cleaning, with the latter becoming important during rainy season when dirt roads become extremely muddy. As trivial as it may sound, upland villagers value this water use for vehicle cleaning because owning a vehicle, mostly motorcycles, required them to save up for years before owning one. Having these vehicles, for them, is their only way to have better access in urban centers, especially if they want to send their children for further education or access more advanced health care for severe illnesses. Hence, the contribution of water to the maintenance of the vehicles against wear and tear has been an important local knowledge theme for the village.

These daily interactions with water sources can also explain why upland villagers have unique local knowledge on the role of water sources as biodiversity habitat or as a physical space hosting varied animals and plants. In our exercise, villagers particularly pointed out that there are some avian species that they observe to be present only in their village and not with other villages when they go downstream. An Indigenous participant has also shared how their traditional oral stories and epics are tied to the diversity of flora and fauna of nature, including creatures that dwell in rivers and springs.

Upland villagers also have local knowledge of timber value of some trees along the water sources. In our observations, most of the houses in the village are all made of wood. They emphasized, however, that their community does not allow cutting of timber trees for commercial selling as that goes against their tribal agreements. Cutting of timber trees along water sources will only be allowed upon consensus of the tribe.

Another major local knowledge for them concerns herbal medicines from the trees, shrubs, and grasses. This local knowledge is a major source of cultural pride for the Indigenous peoples, sharing that their great ancestors have left them the “legacy to heal.” Probed further about the intergenerational knowledge transfer about herbal medicines, villagers share that when they were children, their parents would already teach them the medicinal value of every plant species from nature. Until now, they have made sure that their children and grandchildren are knowledgeable about this. Coupled with the poor transportation network, many of the villagers have minimally availed or accessed health services from the urban centers—further reinforcing the necessity to use available resources even for health purpose.

The healing value of water is also a unique local knowledge of cultural service among upland villagers. Upland villagers believe that water from the river and spring has healing properties for physical illnesses. Villagers would go to the river/spring to take “healing baths” or praying for cure/treatment while in the water. Related to this is their local knowledge of the water sources as important sites of Indigenous gatherings, especially those that involve life decisions (e.g., weddings). Indigenous villagers shared how water is the embodiment of the flow of life and that rivers/springs are their "portals to life." It is also in this purview that several traditional rituals are done along the water source. Rituals are also implemented for cutting timber trees, requiring animal sacrifices to appease any elementals living in those trees.

They informed us that parts of the water sources, especially some springs in more thickly forested part of the watershed, are restricted for non-Indigenous peoples as these are sacred, housing certain water gods and other elementals that bless/curse them. One of the villagers say that their gods decide whether there would be water for them in the coming planting cycle.

12.3.5 Specific Case of the Midland Village

The pattern of local knowledge among midland villagers is less apparent, which may be credited to the village being located in between lowland and upland villages. It is the only village that has no distinct local knowledge on both water use and across all WES categories. An exemption to this is their unique local knowledge on the natural fertilizer value of fallen tree parts, especially leguminous trees present in the riparian strips (e.g., *Leucaena* sp.). Villagers share that they would collect branches, leaves, or fruits from the trees and use them as natural fertilizer for their home gardens. In our observations, numerous families in the midland village practice home gardens mostly to augment the less regular harvests that they acquire from their multi-story farms. There were also mentions of community-development activities that introduced participants on organic agriculture, which could be a factor on the emergence of this local knowledge in the village.

However, midland villagers share more local knowledge with upland villagers than those with the lowland. For example, the local knowledge of the herbal medicinal value of plants around the water sources is also present. Various propositions can explain the prevalence of such local knowledge including knowledge exchange with Indigenous upland villagers through simple interactions, transactions (e.g., trading), or even intermarriage.

As in the case of upland village, local knowledge on the role of river/spring as an important source of mobile signal is also highlighted in midland village. Villagers explained that they would go to the river/spring to call/text or connect to the mobile internet because it is a relatively open area, hence receiving better mobile signal connection. Another shared local knowledge on the cultural service is the role of the water sources for tourism. While tourism for upland villagers is associated with the waterfall in one of its springs that serves as a popular stopover among watershed hikers, midland villagers' tourism is associated more with the river. A community resort was once present (dilapidated just before this study was conducted) in the village.

12.4 Discussion

12.4.1 Engaging Local Knowledge on Water Management

Our results highlight how local knowledge captures the complexity of water sources not only for water uses but also for other WES that shape the social-ecological dynamics of the villages. Such validates that the water sources are whole ecosystems that should be valued not only for the water that they provide but to also consider the other benefits that the community derives from it. Hence, our study further reinforces the need to engage and mainstream local knowledge in any decisions and actions in water management.

Sustainable and equitable management of natural resources, including water sources, requires that diverse local actors are genuinely included in the agenda planning and implementation (Kozar et al., 2020). Usual scientific approaches (e.g., remote sensing, modelling) that inform water management should be coupled with participatory approaches that can integrate local knowledge (Ramirez et al., 2019). Lack of local knowledge inputs in policy processes can fail to capture the complex nature of water sources, mostly focusing only on the supply capacities of water sources and very minimally including other WES (Palomo, 2017). Actions and decisions that fail to address the holistic nature of water sources can result in significant trade-offs that may jeopardize the wellbeing of the villages that depend on these WES. Hence, integrating local knowledge in these policy processes improves the credibility, saliency, legitimacy, social acceptance, and relevance of decisions and actions made (Bennett, 2016). Integrating local knowledge can allow for better co-management of programs and co-ownership of outcomes—better guiding the conservation, sustainability, and resilience of natural resources (Cebrián-Piqueras et al., 2020).

Local knowledge can also reflect the desires and interests of local actors (Paing et al., 2022). Engaging and mainstreaming local knowledge is essential for watersheds that have villages living directly within them. These watershed-located villages have high and direct stakes in maintaining the watershed's ecological capacity to provide water and other benefits not only for them but also to other villages outside the watershed. It is imperative that watershed-located villages, such as those in our case study, be actively part of the policy processes to ensure that their interests in provisioning, regulating, and cultural benefits are not compromised while addressing the interests of surrounding villages for regular supply of water. For example, policies that aim to ban animal grazing around water sources for the intention of protecting tree saplings will greatly affect livestock livelihoods, which is a significant economic activity for all villages.

Our results have also highlighted the rich local knowledge among Indigenous peoples of our upland village case. We can treat such local knowledge as "traditional knowledge" which has been culturally accumulated by the *Erumanen ne Menuvu* for millennia of living with their nature, including the water sources. Proactively accounting such traditional knowledge in water management can protect the cultural identity and legacies of the Indigenous peoples (Nelson et al., 2019).

Engaging local knowledge is central to Integrated Water Resources Management (IWRM), which is a popular holistic management approach that promotes coordinated efforts in the development and management of water, land, and related resources. IWRM hopes to maximize equitable social and economic welfare without compromising the sustainability of critical ecosystems such as watersheds (WWAP et al., 2009). The Philippines has already been applying IWRM through the Integrated River Basin Management (IRBM) approach and operationalized through River Basin Offices (RBOs). Our case study, the Libungan-Alamada Watershed, is also oversight by an RBO; however, the lack of documentation by the local RBO for the specific portion of the watershed has hindered us from further exploring the roles and influences of the RBO in engaging diverse knowledge. Nonetheless, the experiences of other RBOs confirm the benefits of engaging inter-sectoral, interagency, and public participation coupled with strong policy, regulatory, and institutional frameworks in the success of water resources management. However, there remains the challenge of accounting for the traditional knowledge of Indigenous peoples (Almaden, 2017).

12.4.2 Recognizing Differences in Local Knowledge Toward Water and the Factors Shaping Them

Our study highlights that local knowledge on water is place-based, meaning that knowledge is highly dependent on context of the place. We showed how differences in elevation can serve as an underlying factor that shapes land use (i.e., agricultural systems), socio-cultural dynamics (i.e., access to social services), and community priorities (i.e., subsistence and livelihoods). In turn, all these factors were key to the local knowledge each village has. Thus, while our case study villages are in the same watershed, we found several local knowledge on water use and WES that are unique to each elevation distinct village. Our results, thus, provide empirical proof for the need to tailor water management plans to the biophysical and socio-cultural specificities of the place.

Our findings support current understanding of local knowledge as one that evolves and adapts through time, being strongly knitted with the beliefs and practices of the place (Cassin & Ochoa-Tocachi, 2021). Local knowledge on WES is closely linked to proximity and relative access to water source, as well as socioeconomic and cultural factors of the place (Chang & Bonnette, 2016; Ramirez et al., 2019). Place-based specificity of knowledge strongly justifies our earlier discussion for the need for diverse local actors to be involved in water management, especially to closely consider the impacts of actions and decisions across scales. Recognizing the differences in local knowledge in each place could provide important insights into the potential synergies and trade-offs of actions in decisions from one place to another. This is important in water sources, especially rivers like in our case study, because of its transboundary nature. Issues in upland villages, for example, also have repercussions among lowland villages. Or lowland villages may benefit from good management among upland villages. This cross-scalar interdependence is exhibited in our case study where in the upland villagers' strong cultural ties with nature have sustainably managed their river, directly benefiting not only their community but also the villages downstream.

The need to consider cross-scalar interdependence is also essential for situations where there are villages that are living directly within critical landscapes such as a watershed. Our case study villages, for example, have essential roles to become environmental stewards to maintain the ecological integrity of the watershed to supply water and deliver other WES (e.g., flood mitigation) to the tens of thousands of families living outside the landscape. Trade-offs and synergies of water management actions and decisions in a single village will not only be limited to its adjacent villages but can have rippling effects in larger social-ecological systems. Hence, looking at differences in local knowledge across varying villages can be a practical step that can dissect such cross-scalar interdependencies within and outside the watershed.

Moreover, the differences in elevation and other biophysical aspects are closely intertwined with the differences in socio-cultural contexts. In other words, local knowledge on ES is a social representation of how communities connect with and understand with their natural environment (Nelson et al., 2019; Cebrián-Piqueras et al., 2020). For example, local knowledge in our upland village case study is strongly influenced by the cultural identity and traditional heritage of its long-standing inhabitants, the *Erumanen ne Menuvu.* Local knowledge of nature among Indigenous communities, particularly that which relates to water, has been attributed to their ways of life that aim to maintain harmony with nature. Such local knowledge on nature shapes their ethics, ceremonies, and norms and even customary governance structures (e.g., who can access sacred parts of the water sources) (Magni, 2017; Moore & Nesterova, 2020; Sangha et al., 2018). This shows how it is important to understand local knowledge on water as a product not just of biophysical differences but of variations in the very social-ecological dynamics of the place.

12.4.3 Continually Documenting Local Knowledge on Water

Our study strengthens the need to document the rich local knowledge on water, both its use and the related WES that water sources provide. Documentation has two main contributions: (1) protecting local knowledge and the community identity tied with it and (2) sensing changes in the social-ecological state of water sources.

First, we have shown in and discussed from our findings the place-based specificity of local knowledge, showcasing how they represent the social-ecological interrelationships in the communities. As major changes in societies and lifestyles interrupt the retention of local ecological knowledge (LEK) (Aswani et al., 2018), documenting local knowledge has been increasingly recognized as a way to guarantee the social, cultural, and economic interests of Indigenous peoples and local communities (WIPO, 2017). Thus, protecting local knowledge is also a way to protect this community identity including the social ties and cultural heritage. This is particularly important for communities with Indigenous cultures, such as our upland village case, that has a long intergenerational transmission of local and Indigenous knowledge. In the Philippines, protecting local knowledge is upheld by the 1987 Philippine Constitution and institutionalized by the Indigenous Peoples Rights Act (Republic Act No. 8371), which both recognize, protect, and promote the rights of Indigenous cultural communities/Indigenous peoples.

Second, documenting local knowledge can be a simple yet effective approach to sense the changes in the social-ecological state of water sources. Specifically, LEK can detect extreme events and record significant changes (Moller et al., 2004). Ramirez et al. (2019) proved that local knowledge on watershed landscapes is evidence-based and complements scientific knowledge (e.g., satellite imageries and fragmentation analyses) to address and understand landscape changes and declining quality of ES. Systematic monitoring using advanced tools and techniques can be costly for these villages. Documentation, through community-based methods such as our participatory exercise, can serve as an alternative while capturing more nuanced perspectives on the state of water resources. Changes in local knowledge on water use and WES, either loss or gain, across repeated documentation can signal that there might be significant social-ecological changes in water sources that are worthy of further investigation. While our study did not explicitly assess changes in local knowledge, our probing with the villagers tells us that they have not recently encountered some previously known WES, thus having only a few villagers who have local knowledge about them. A big example of this from our case study was the practice of betel nut-chewing, a practice of combining and wrapping areca nut with betel leaf as a form of stimulant among rural communities. We were informed that areca nut plants were abundant around springs in the watershed in the early days. However, the loss of areca nuts because of various factors including illegal felling have also resulted to the loss of the practice, thus also the loss of local knowledge.

Finally, the significance of local knowledge on predicting changes in the social-ecological state of water resources becomes more instrumental considering the increasing pressures from climate change impacts and other emerging environmental challenges, which threaten the integrity of water sources to provide WES. Based on Chang and Bonnette's (2016) review, climate change impacts on the distribution and quality of water at spatial and temporal scales will affect provisioning, regulating, and cultural WES relative to the extent of changes and adaptive capacity of the ecosystem and local community. In complement, documenting the trends in local knowledge and practices on WES may provide evidence of how local communities manage water resources over time (Quevedo et al., 2021; Cassin & Ochoa-Tocachi, 2021).

12.5 Conclusions

We show the richness of local knowledge of both water use and WES among three villages of a watershed in the Philippines. Understanding local knowledge showed us that the water sources in the villages provide more than just water for domestic or agricultural use. In fact, exploring local knowledge tells us that the WES that are generated by the complex interaction of various ecological units (e.g., trees and shrubs in riparian strips, flora, and fauna) closely rely on water sources. These WES do not only support subsistence and livelihoods of the village but also contribute to the shaping of the villages' culture and way of living. We found similarities of local knowledge across the three villages, especially on traditional WES that have provided basic needs and allowed persistence of the villages. We also found differences in local knowledge, many of which represent the unique water use and WES that each village obtains from water sources. We find that this unique local knowledge is grounded in existing differences not only in the biophysical aspect (i.e., elevation) but also from inherent socio-cultural variations across the villages.

We discuss that such rich local knowledge should be actively engaged in water management, especially when designing and implementing actions and decisions. Engagement captures the complexity of these water sources not just in supplying water but in rendering other benefits. This should be coupled with recognition of place-based specificity of local knowledge. Understanding the differences in local knowledge across places, as driven by both biophysical and socio-cultural variations, can help water managers explore the potential trade-offs and synergies that actions/decisions can have across places. Finally, we discuss the importance of the documentation of such local knowledge to protect the cultural heritage of the villages, especially those inhabited by Indigenous communities. Documentation can also provide the community with a better sense of the social-ecological changes in their water sources.

Our study's findings are empirical contributions on how we should tap local knowledge in understanding the complexity of water resources. The recognition and application of local knowledge remain paramount in designing and implementing place-based water-related interventions, activities, and programs suited to the context of the community they aim to cater to. Further, our study's participatory approach can be adopted by water managers to address our call for more active engagement, recognition, and documentation of local knowledge for more sustainable and equitable water management. Ultimately, such participatory approach lends voice to communities in forging development within their own terms, placing their needs and desires front and center. This has become more crucial than ever given the urgency of environmental challenges these communities face—from climate change, biodiversity loss, to land desertification—that threatens not only the very supply of water but to the very wellbeing of humanity.

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Chapter 13
Indigenous Knowledge, Practices, and Transformation of Drinking Water Management System: Evidence from *Munda* Community of Bangladesh

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Abstract This study investigates indigenous knowledge, practices, and transformation of the water management system of the *Munda* community of Satkhira Upazila, Bangladesh. Using a qualitative approach, this study aimed primarily at the overall water-related knowledge, practices, and problems of the *Munda* community people. In this purpose, data were collected between February and March 2022 from 13 individuals using 12 in-depth interviews (IDIs) and a single key informant interview (KII) from *Burigoalini* of Satkhira district in the southwestern region of Bangladesh. This study used both thematic and narrative analysis to interpret the qualitative data. Findings explored that the *Munda* community—one of the ethnic groups residing adjacent to the Sundarbans mangrove forest (SMF)—is exceptionally marginalized as a community lacking knowledge concerning water contamination and the water purification process and benefits of the latter. Although a colossal transformation of the water management system has been made over the years, the only reliable source of potable water is rainwater harvesting. However, the way they collect rainwater is not proper and healthy because they mostly use alum and natural filters to purify the water. Consequently, the prevalence of waterborne diseases is very high among them. Furthermore, this study found that poverty also hinders them from managing water on their initiative. This study recommends that the government of Bangladesh and non-government organizations (NGOs) need to collaborate on improving ethnic community-centric water infrastructure to support rainwater harvesting to ensure their access to safe drinking water.

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Keywords *Munda* · Bangladesh · Water management · Indigenous knowledge and practice

13.1 Introduction

Over the years, the freshwater sources across the globe are shrinking (Boretti & Rosa, 2019) due to a wide range of exogenous environmental issues, including climate change, an increase of water pollutants both in-ground and surface levels, as well as endogenous human activities, such as unplanned and overuse of existing water resources (Schewe et al., 2014; von der Porten, 2013). Consequently, a paradigm shift in water management has been taking place, driving it away from a centralized system to a more local or regional level, assuring community participation in both developing infrastructures, and distributing water without compromising climate adaptation plans and indigenous agricultural practices (Jackson, 2018; Ghorbani et al., 2021; Sanz et al., 2019).

Indeed, an emphasis on water management through local participation, accommodating the local needs and aspirations with indigenous knowledge and practices, could widen the possibilities of effective and sustainable management of water resources in both developed and developing countries (Nguyen & Ross, 2017; Schmidt, 2014). The integration of indigenous knowledge and practices in managing water not only makes sure of sustainable usage of these depleting resources but also protects traditional ways of life and livelihood (Juanwen et al., 2012; Gautam et al., 2018; McGregor, 2008, 2012; Wilson & Inkster, 2018). Moreover, it ensures sustainable usage of water for irrigation and construction and implements climate adaptation strategies for remote communities (Codjoe et al., 2014; Gautam et al., 2018).

There is, however, no denial of the fact that indigenous people worldwide are experiencing a scarcity of water within their ancestral ground, largely because of global environmental change as well as intensified resource extraction due to growing population and economy (Hartwig et al., 2022; Prieto, 2022; Wilson & Inkster, 2018). Like other countries, the indigenous people in Bangladesh, especially in the southwestern region, are experiencing a similar dilemma. One of the unheard aboriginal communities of Bangladesh is the *Munda*, and they are highly exposed to natural calamities because of their settlement in the southwestern areas (Sharmeen, 2015; Roy, 2018). The safe drinking water supply in that particular area is seriously affected by salinity intrusion, heat waves, and flooding (Roy, 2018). The scarcity of freshwater in the past pushed them to practice special water fetching and purification practices. Moreover, their knowledge, cultural norms, values, and practices are also associated with water management. The indigenous *Munda* community's water management practices, cultural values, and knowledge are almost untouched in the existing literature. Against this backdrop, this study aims to study the drinking water management, practices, and knowledge of the indigenous *Munda* community of Satkhira Shyamnagar Upazila, located in the southwestern part of Bangladesh.

13.2 Indigenous Water Knowledge and Practice: The World Perspectives

A number of literature studied the indigenous people's water management, knowledge, values, and practices from different countries and context perspectives (Bayly, 1999; Megersa et al., 2014; Muller, 2012; McGregor, 2008, 2012). The literature argues that the global supply of freshwater is insufficient against the global demand, and it is evident that in many regions of the globe, freshwater supply is not sufficient to serve the drinking water purpose (Muller, 2012). Therefore, the world is facing a heightened level of the water crisis, and this scenario is also common among indigenous communities worldwide (Lucier et al., 2020; Hall et al., 2021).

McGregor (2008) studied the aboriginal people of the first nation, where water was identified as a "life-giving" force that has significance at spiritual, national, societal, and personal levels. In this community, water is viewed as precious. According to traditional knowledge and beliefs, water should be respected; hence, they should keep the water clean. They also believe that water is the blood of the globe and provides medicines for survival. In addition, women are the sole ones responsible for fetching, protecting, and cleaning water which is culturally embedded, and there exists a special connection between water and "life-giver" women. Wilson and Inkster (2018) explored the ontologies of water from the lexicon of kinship using the theme of "respecting water." Among the indigenous communities of the first nation, water is treated as a "relative" and "living entity." This view is often contested with the view of water as a "resource" that can be managed, owned, and utilized. In Canada, for survival, the people of indigenous communities apply their traditional knowledge (TK) to purify water, and they also care for water (McGregor, 2012).

Hartwig et al. (2022) explored southeastern Australia's aboriginal people's water experiences by adapting the tripartite justice framework and settler colony theory. The study identifies that water colonialism brings injustice and less economic gains to the aboriginal people. In this country, the water source of the aboriginal people is usually rock holes, clay dams, rainwater harvest, and so on (Bayly, 1999). In the same context, Hall et al. (2021) argued that several factors challenge the drinking water supply, and findings suggest that for safe water delivery, appropriate infrastructures, including place, people, monitoring, and technical support, need to be developed. Likewise, in the indigenous communities of Ontario, Canada, the people used to drink the worst-quality drinking water and, hence, experience deteriorated health outcomes. This study also identified the risky behaviors due to knowledge gaps in the community people (Lucier et al., 2020). Similarly, Bradford et al. (2016) argued that many indigenous communities use below-standard quality drinking water in Canada than non-indigenous people. However, the media coverage of the Canadian indigenous community and water quality is quite limited, and a difference in water quality is observed between indigenous and non-indigenous communities (Lam et al., 2017). Therefore, Bradford et al. (2016) suggested more research to formulate policies for better-quality water supply among the indigenous communities. McGregor (2012) recommended that for access to resources, including water, the indigenous people should be given access to the national territory and way of life and collaboration is essential between traditional knowledge and western science.

In south-central British Columbia, a relationship between the freshwater ecosystem and culture is observed (Blackstock, 2001). This study also identified the spiritual aspects of purifying water-stressed by elderly people, which is contested by western science. Watts (2012) argued that indigenous histories, knowledge, and biogeography are undervalued in water management. Hence, the study shedded light on indigenous knowledge, practice, and values in water management of the indigenous community in the Ngukurr region. Similarly, Megersa et al. (2014) studied the use of indigenous plant species in purifying drinking water which is less expensive than piped water. The study found that plant species are quite useful in purifying water which can be used on a complementary basis at the household level. In contrast to scientific technologies, aboriginal rights demand recognition in Canada in terms of water governance and protection. Also, the older people hold traditional knowledge in water governance and protection; this knowledge works in a more holistic approach (McGregor, 2014). However, while experimenting with water purification at the indigenous household level, Olannye et al. (2017) found that the indigenous water treatment method is unprotective and therefore recommended the inclusion of flexible and affordable techniques to upgrade indigenous water treatment practices.

Berry et al. (2017) unpacked the nexus between histories of water use and management of the indigenous people from the lexicon of power, cultural practices, and colonialization. According to the indigenous community's values, preferences, customs, and livelihood, the community stressed more on governing and controlling water management. Woodward et al. (2012) argued that in the Northern Territory of Daly River, ecological knowledge can be useful to understand water management activities. Gautam et al. (2018) analyzed the efficiency of indigenous water management practices in the context of Nepal and found that the indigenous system is efficient and rational while harvesting water. Similarly, Gondo and Kolawole (2019) explored water governance from the context of the Okavango Delta of Botswana, and findings suggested that the water management decision at the household level is influenced by gender, culture, age, income, and education. In addition, Bayly (1999) added that for survival, the indigenous traditional knowledge, stylish mapping, and oral instructions are necessary to identify the available water supply source in a particular region.

13.3 Materials and Methods

13.3.1 Research Design

The study was exploratory in nature, in which an attempt was made to gain indigenous knowledge, practices, and transformation of the water management system of the *Munda* community. Hence, the qualitative approach was used as it was the most suitable way of comprehending the issue (Creswell & Creswell, 2017) from *Munda* people's perspectives. Primarily, *Munda*'s perception of "the quality of water and the problems they faced" and "how they distinguished pure and contaminated water" were focused on; and later, "the role of government organizations (GOs) and NGOs in water administration and preventive measures to play down the breach between organizations and community individuals" was investigated. Based on this purpose, the qualitative methods assisted in apprehending the meaningful and logical explanation of the problems faced by the targeted population in their particular social settings (Berg & Lune, 2017). This approach also enables understanding the change in *Munda* people's water administration framework over 50 years.

13.3.2 Study Subjects

Since the study focused on the overall water-related problems faced by the *Munda* community and the administration system maintained by both the *Munda* community and GOs and NGOs, the sample of the study came from two major groups (see Table 13.1). However, to conduct the study in the first group, in the *Munda* community population, two-step sampling procedure was used to determine the

Table 13.1 Description of the participants of IDIs and KII

Sl.	Participants	Age	Sex	Occupation	Ethnicity	Method of data collection
1	Participant 1	45	Female	Farming	*Munda*	IDI
2	Participant 2	22	Female	Farming	*Munda*	IDI
3	Participant 3	30	Male	Farming	*Munda*	IDI
4	Participant 4	45	Male	Farming	*Munda*	IDI
5	Participant 5	50	Female	Farming	*Munda*	IDI
6	Participant 6	30	Female	Farming	*Munda*	IDI
7	Participant 7	50	Female	Farming	*Munda*	IDI
8	Participant 8	55	Male	Farming	*Munda*	IDI
9	Participant 9	48	Female	Farming	*Munda*	IDI
10	Participant 10	35	Male	Farming	*Munda*	IDI
11	Participant 11	63	Male	Farming	*Munda*	IDI
12	Participant 12	65	Female	Farming	*Munda*	IDI
13	Participant 13	36	Male	NGO officer	*Munda*	KII

Note: *IDI stands for* in-depth interview, *KII* indicates key informant interview sample. In the first phase, purposeful sampling was used to select the first participants, as the investigators took the constraints of the field data collection into their consideration (Emmel, 2013), and accordingly, it also helped to seek the reliable information from the field. In the next step, the rest of the 11 participants from the *Munda* community was selected by using homogenous sampling as this procedure is helpful to describe specific subgroup in-depth (Patton, 2002). This sampling procedure also enabled the investigators to distinguish the *Munda* community from other communities living in the same locality. For the second group, data were collected from NGO worker, where the critical case sampling method was utilized because it is very useful in exploratory qualitative research where a small number of cases or a single instance is viewed as decisive in clarifying the problem of investigation (Patton, 2002). In both cases, the verbal consent from the participants was confirmed before tape recording the entire interview. In this regard, after conducting ten interviews, the data reached at the saturated level regarding the study theme produced from secondary literature. Considering the sample size of the study selected by the homogenous sampling method, Guest et al. (2012) contended that a sample size of 6–12 participants per group is adequate for many forms of qualitative research.

13.3.3 Interview Outline

For this study, an unstructured interview guideline was developed by going through relevant literature because unstructured interviews allow to realize the views of the *Munda* community regarding the issue of investigation from their social settings (Bryman, 2012). Apart from this, this method also enabled the investigators to look back in detail across the *Munda* community's water management system from their life course. To fix the errors before the final phase of data collection, a couple of in-depth interviews were conducted to justify the contents of the interview guideline.

13.3.4 Data Collection

Though it was difficult to conduct face-to-face (FTF) interviews during this pandemic, however maintaining the World Health Organization (WHO) recommended guidelines, data were collected from the *Munda* community by conducting IDIs that took place in face-to-face interaction with the participants, because FTF enables the investigators to gather extra information from the social settings where the interview took place (Opdenakker, 2006). Besides, the KII was conducted with the NGO official to know about *Munda* community's knowledge and practice regarding water management, accordingly, the role of GOs and NGOs in water management administration for the *Munda* community. This method guides the study to comprehend qualitative and rich detail about the topics of investigation in a particular social setting (Cossham & Johanson, 2019).

The interviews were conducted in *Bangla*, and data collection took place between February and March 2022. On average, the duration of a single IDI was 35–50 min. Each interview was recorded with prior permission from the participants, and the recordings were kept strictly confidential as part of the ethics of the study. The participants were given the option to withdraw from the research at any time without providing a reason. During the interview session, the investigators were careful and followed the rule of unrestricted acceptance, attentive listening, and explanation to affirm the authenticity of the data and avoid the appearance of favoritism in the results. Seventy percent of all codes were identified after the sixth interview; however, the initial thematical saturation point was reached after taking the tenth interview but continued to take another four interviews to validate the theme generation. After the 13th interview, data collection was discontinued.

13.3.5 Data Analysis

Immediately after taking the interviews, the recorded verbatim was converted into written words and then translated into English. After that, NVivo 12 pro software was used to produce codes and transform the verbatim into classified themes. After managing all the classified verbatim, thematic analysis and narratives were used for data analysis. By concentrating on how the topic is presented and the frequency of its recurrence, the investigators related the analysis to external factors. Furthermore, every relevant issue in the initial analysis was included based on mutual consent among all the authors after each interview. Meanwhile, any discrepancies discovered during the interviews were resolved or eliminated after rigorous deliberation and deconstruction.

13.3.6 Ethical Issues

The Khulna University Ethical Clearance Committee (Protocol No. KUECC-2022/02/07) examined and authorized this work. Informed permission was obtained verbally from each participant, and the recordings of those conversations are available upon request. This is also certified that no academic misconduct, such as manipulation of data or misrepresentation, had occurred.

13.4 Results

This section provides the evidence of knowledge, belief, and practices of water management within an indigenous community (*Munda*) and the story of transformation in their water management system.

The information offered in this chapter provides a first-hand account of the participants' experiences regarding water filtering systems, as well as the problems they face before and prospects of getting services regarding water management in the future. The following themes were generated from the gathered data.

Theme 1: Brief undocumented history of *Munda* community (KII informant)
Theme 2: Perception of the quality of water and its problems
Theme 3: Separations of water quality—Pure (distilled) vs. contaminated
Theme 4: Change of water administration framework over the last 50 years
Theme 5: Possible role of GOs and NGOs in water administration and preventive measures to play down the breach between organizations and community individuals

13.4.1 Theme 1: *Brief Undocumented History of Munda Community in Bangladesh (Narrated by Head of* **Munda** *Community)*

This theme represents the scenario of *the Munda* community of Bangladesh. The informant, who is also the head of the *Munda* community in our study location, narrated the undocumented history of the *Munda* arrival in Bangladesh and their culture, tradition, occupation, and language. This theme is comprised of the data provided by the KII informant. This study tried to document the oral history (undocumented) of the *Munda* community as an ethnic group of Bangladesh, because of a significant gap in official and academic literature, and there are no official as well as historical records about the arrival of the *Munda* people in southwest Bangladesh. Traditional myths, tales, and songs, which are still widely disseminated in the actual communities, contribute a little to providing detailed information about their origin and early history.

According to the information given by the head of *Munda* community from our study location, the *Mundas* are a Sundarbans mangrove ecological zone ethnic community. The *Munda* people, who originated in India, arrived in Bangladesh around 300 years ago and have remained ever since. According to some estimates, based on information gathered by non-government organizations, the country has 212 *Munda* families. According to local estimates, 1163 *Munda* live in scattered villages in the Koyra and Dumuria Upazilas of Khulna district, as well as Shyamnagar, Debhata, and Tala Upazilas of Satkhira district, all of which are located within the Sundarbans. The Sundarbans ecosystem appears to suit the *Munda*'s indigenous ways of life and cultural traits.

*Munda*s are the followers of *Sanatan* (Hindu) religion. In November, they perform Shyama and *Kali* pujas and *Ashadi* and *Bhadu* pujas in July and September, respectively. *Poush-parbon* is also a harvesting ceremonial that they observe in January. However, unlike Hindus, they are not caste-bound. *Mundas* are well recognized for their peaceful character. Their homes are made of thatch. They are incredibly welcoming, and it is customary for them to entertain visitors.

The head of the *Munda* community further addressed about the structure and occupation of the community. For each community in a specific territory, a *montri* (minister) is appointed. With the use of *mondols* (village leaders), *montri* settles tribal disputes. The Sundarbans' depleting forest, animal, and aquatic resources are being stressed by an influx of Bengalis from other places. *Munda*s are noted for their hard work as laborers, particularly in removing forests and cutting dirt. They are of medium stature, stocky build, and dark skin. They arrived as seasonal workers at first, but as the demand for their services grew, more of them arrived. However, the community head also explained that as the jungles and woodlands shrank due to population pressures, clearing, and urbanization, they discovered that their customary employment was no longer economically viable. Alternative occupations such as agriculture, fishing, van driving, small companies, and jobs used to help them live.

Overall, the *Munda*s had no written language in the past. For this, the Roman script and regional scripts are now employed. Many *Munda* is bilingual and communicates with one another in Hindi, Sadri, or other regional languages. Accordingly, regarding their language the head of the community explained that:

> Our main language is Mundari. But because there is no written alphabet, this language is lost. Moreover, the language we speak within ourselves is the Sadri language.

13.4.2 Theme 2: Perception of the Quality of Water and Its Problems

The *Munda* community has suffered from scarcity of safe drinking water and a lack of hygiene and knowledge about clean water. The only source of drinking water takes them to travel a long distance where they could collect or buy safe and drinkable water. Although a group of *Munda* community were found supported by local NGOs, who have provided them some source of purified water, however, it is not enough for the whole community.

The *Munda* community is a very marginalized community. Hence, their knowledge level lacks many facts. They mostly have insufficient knowledge about clean water. They do not know the difference between contaminated water and clean water and its benefits. According to them, the clean water is characterized by being odorless, white, and transparent. From the field investigation, we found that they use only clean water for their drinking, and for other purposes, they rely on unhygienic pond water and other contaminated sources. Consequently, this resulted in inflammatory conditions, eye infections, and kidney damage. However, speaking with them reveals that they rely on unclean water for cooking, bathing, and other stuff. In these regards, one participant stated that:

> Excessive saltiness, human and animal wastage, leaves of large trees, natural disaster (flood), fish cultivation, fertilizer, and pesticides are the major cause behind water quality problem in our locality.

Besides, findings from the qualitative investigation showed that the community of *Munda* has suffered from the super cyclone *Amphan* and the cruelest damage it has made is by washing away several embankments near their homes. As a result, saltwater flowed into their drinkable water sources, and they kept living with severe water crises thereafter.

Moreover, *Munda* people considered water as unsafe when it contains germs, worms, or toxic chemicals. Germs and worms, such as whipworm, hookworm, and roundworm, are responsible for a variety of serious illnesses. Germs and worms are found in human and animal waste (urine and feces) and can cause severe and long-term illnesses when there are no effective ways of disposal of human and animal wastes, water supplies are not protected and kept clean, and there is insufficient water to wash.

Some of the illnesses, such as cholera, spread quickly and kill many people. Other germ- and worm-related illnesses can cause years of illness and lead to other health problems such as dehydration, infections, anemia (low blood count), and malnutrition. Diarrhea is the most common sickness from germ and worms. For the provision of these speeches, the researcher made a discourse with the KII participant (Participant 13). The discourse is stated below:

> **Researcher:** What kind of policy guidelines do you have about clean water? How can the quantity and quality of clean water be improved?
>
> **Participant 13:** There is a need to do various experiments on the source from which we currently get water. Firstly, for the reason that the amount of arsenic in the water needs to be quantified by various minerals. Secondly, to make arrangements for the people, especially for the poor and marginalized people who cannot afford to buy their water to drink.

Their knowledge of clean water is very limited, and they have no idea whether it is clean or edible. Since they have only one water source, they have no choice but to drink from that source. An NGO in the area called “Rupantar” has provided water to only 20 families. Apart from that, many more residents in that village have no chance to get clean water, and they have to buy water with their own money. The financial condition of the people in the area is so bad that they cannot buy water now and then. They do not even know if the water is good for their health or not.

13.4.3 Theme 3: Separations of Water Quality: Pure (Distilled) vs. Contaminated

As the previous theme showed the perception of the *Munda* community toward the quality of water and its problems, this theme provides the information regarding their way of water separation. One of the in-depth interviewees (Participant 2) apprehends the thoughts of many ($n = 5$), stating that:

> . . . to differentiate between pure water and contaminated water, I kept water (both pure and contaminated) at first in the glass. The filth of pure water sits at the bottom of the container, from which it is easy to drink water from above except for the bottom. But the filth of contaminated water floats in the container.

To support this statement, another in-depth interviewee (Participant 4) further added that:

> . . . we use clean sand, broken pieces of bricks, cotton clothes to purify water. Sometimes we used alum for ponds water purification. Nowadays there is the availability of water purification medicines and improved filters.

The *Munda* community did not have access to water, so they filtered water manually. For this process, at first, they used clean clothes to filter; sometimes, they used charcoal; then they put playground sand on top of the charcoal layer and then the layer of paver sand, also known as polymeric sand; and eventually, they used gravel or small rock.

In addition, filtered water is beneficial for health. Filtered water tastes better because the filters remove the chlorine and bacteria that cause tap water to taste flat or chemical. Although water filters remove minerals that are harmful to health, minerals necessary to keep in the water are not removed. Essentially, a water filter provided the same healthy minerals as bottled water at a fraction of the cost. Water filters also remove bacteria that can cause stomach upsets, keeping everyone healthy. Table 13.2 shows how the access to safe drinking water has changed over a period of 50 years among the *Munda* community.

Table 13.2 Glimpse of transformation over the last 50 years

Earlier times					Recent times				
Access to pure drinking water	Sources of water (drinking)		Storage of water		Access to pure drinking water	Sources of water (drinking)		Storage of water	
Modified	Pond	✓	Plastic bottle	–	Direct	Pond	–	Plastic bottle	✓
	Rain	✓	Tank	–		Rain	✓	Tank	✓
	Filtered	–	Pitcher (mud)	✓		Filtered	✓	Pitcher (steel)	✓

13.4.4 Theme 4: Change of Water Administration Framework over the Last 50 Years

According to the explanation given by our informants, there is an ongoing discussion about how the availability of water varies significantly throughout the year, as the rainy season brings massive amounts of water and summer brings drought. Because the infrastructure cannot handle the onslaught of water during the monsoon season, the water is not saved for the dry months. Over 80% of available water is used for agriculture.

Our informants from the *Munda* community argued that the Bengalis have little control over how much water they receive from these sources. The rising salinity of the water, which is caused by a variety of factors, exacerbates the problem. One of these factors is the construction of the Farakka Barrage in India, a structure that diverts water from the Ganges to irrigate Indian soil. This reduces the flow of the Ganges, causing salinity to rise. Salinity is also rising as a result of a large number of shrimp farms in various bodies of freshwater. Climate change has also resulted in rising sea levels, which are stealing precious water from freshwater river deltas. This increase in salinity has an impact on the soil and the quality of the groundwater.

Consequently, the Bangladesh government is attempting to improve infrastructure to increase rainwater harvesting and access to safe drinking water. Contaminated wells have been marked to keep people away, but the painted markers are fading, and over 100,000 safe water points have been established. In addition, new arsenic treatment technologies are being researched. To coordinate with this idea, the all-in-depth interviewees ($n = 13$) stated that:

> 50 years back, at that time, our ancestors brought water from a long-distance away. In the past, there was non-availability of alum and purification tablets. Rather water pollution was seen rarely. The soil was kept in the ground from where the water was taken. Besides, our parents used to drink the pond's water. At that time river water, and pond water was not polluted. They reserved it on the pitcher. Even 2years before we used pond water for drinking and we used to drink direct water after straining with clean cotton cloths. But after the storm, it cannot be drunk anymore because the water is salty. Overall, it can be said that rainwater, river, pond, and canal water were the sources of water 50 years back.

Even a few years ago, there was no clean water system in their area. Their only reliable source of water was rain, pond water, river water, and sometimes even water that had accumulated in the soil due to land cultivation. They thought the water was clean enough for them to drink. Although the rainwater was the purest, the way they collected rainwater was not healthy. They then used alum and natural filters to purify the water. There were a lot of waterborne diseases that were high in those days due to their lack of knowledge about the amount of arsenic and minerals found in water.

13.4.5 Theme 5: Possible Role of GOs and NGOs in Water Administration and Preventive Measures to Play Down the Breach Between Organizations and Community Individuals

The majority of our informants agreed upon the fact that there is no tradition in our countries of open and transparent information about environmental contamination issues and their links to health problems. The water right is predicated on the right to be informed. To make an informed decision about which water to drink, consumers must have access to current information about water quality and other aspects of drinking water. Non-government organizations (NGOs) play an essential role in increasing public access to accurate information about local issues, such as drinking water quality and water-related health risks.

NGOs host seminars and workshops for communities and local governments on water issues, multi-stakeholder debates on water supply and sanitation sector development and technical solutions needed to improve situations, and public hearings on water and sanitation action plans at the local and national levels. NGOs develop and disseminate a variety of educational and information materials on various water and health issues to the public.

Incidentally, in-depth interviewers ($n = 13$) and KII participants throw some recommendations to minimize the breach between organizations and community people. Those were stated below:

Participant 1: A lot of people around us have problems with water. If they are provided with water, it will be helpful.

Participant 2: We have filters here, but it would be better if we could do it everywhere because many people don't have such facilities. They will suffer less.

Participant 3: Providing good water, arranging tube wells, filtering.

Participant 6: No. It would be better if we have deep tube wells. So that we can use good water for the house.

Participant 9: I will suggest increasing our self-awareness so that we can properly manage our filter.

Participant 10: I am satisfied with this filter. If this project quantity could raise, it will be more helpful for everyone.

Participant 11: We have to be conscious of cleanliness. We should try to maintain the environment of the pond's surroundings as we use its water for other purposes.

However, most of the locals say that there is a usable source of water provided by NGOs, not everyone has access to it, so not everyone gets clean water. The number of *Mundari* tribes living in the same area is close to 3000. And, only 20 families have the benefit of a water filter. Most claim that there should be usable tube wells for everyone in every area which will have many benefits and there will be no need to buy water to drink. Buying and drinking water all year round is risky and expensive. It is very difficult to bring water in drums or pitchers on muddy roads during the rainy season, and rainwater is not enough to drink all year round. Considering their financial situation, they cannot manage water on their own initiative, and they are completely dependent on government and non-government organizations. They do not know the value and benefits of filtered water and have no choice but to drink it.

13.5 Discussion

13.5.1 Theme 1: *Brief Undocumented History of Munda Community in Bangladesh (Narrated by Head of* **Munda** *Community)*

In literature, *Munda* is defined as a “wealthy man” or “head person of the village” (Standing, 1973). A *Munda* person prefers to define himself as “man” (Standing, 1973; Sharmeen, 2015). Considering the origin of the indigenous *Munda* community, this study found that the *Munda* community is a Bengali tenant; however, this community is not a part of the Bengali nation. The findings also reveal that the *Munda* community people came to the Sundarbans adjacent areas of Satkhira from Ranchi, India. Before migration from Ranchi to Shyamnagar, Satkhira, the original *Munda* community was settled in Azamgarh, Uttar Pradesh (Roy, 1912). Historically, the migration process continued, and after the ages, a part of *the Munda* community people settled in the southwestern part of Bangladesh. The *Munda* people have their own language, *Mundari*; however, due to the unwritten alphabet, the current generation of *the Munda* community uses *the Sadri* language. It is well known that language is the medium of communication and means of culture and, most crucially, it is the identity of any community (Sahoo, 2013). As the original language is almost lost due to the lack of an alphabet, the *Munda* community of the study area is suffering from that identity crisis. Hence, they urge the preservation of their mother tongue using GO and NGO support.

The *Munda* community usually prefers to reside in a community in the study area. However, in other places such as Koyra and Dumuria, they live in different villages. The study found that they were primarily dependent on farming and forest-based resources; however, these livelihood strategies are currently in crisis for several reasons, and it is similar to the findings of Roy (2018). The *Adivasi Munda* community has its traditional livelihood strategies including cutting trees, honey collection, and fish and crab catching from the Sundarbans adjacent areas (Roy, 2018). The Sundarbans mangrove forest and its characteristics have an immense influence on their culture, livelihood, and way of life. Siddiq et al. (2018) also observed identical findings in his study with *Munda* community. However, the livelihood crisis emerged in the current period due to several reasons, such as no entitlement to land and inability to pay rent; therefore, they become a victim in many instances. Moreover, due to population pressure, clearing of forests, and urbanization, woodlands are being destroyed. Hence, they are bound to withdraw themselves from traditional livelihood practices and seek alternative livelihood strategies.

The *Munda* are suffering from severe poverty, which is also supported by other literature (Roy, 2021), and due to poverty, children, after completing primary education, rarely enroll in the secondary level. Findings suggest that female children are mostly married at the secondary education level and male children are going out for securing a livelihood, which is contested by Sharmeen (2013), where it is argued that the *Munda* people are educating themselves and raising awareness to communicate with the rest of the world. Two reasons are identified as responsible for this situation: firstly, poverty, and secondly, the language barrier. Government and non-government organizations should step forward to enhancing livelihood options for the community people for the sake of reduction of poverty and also pay attention to providing education using their language. One of the key findings suggests that the *Munda* people are declining in current years because they seek alternative livelihood options using NGO support. The reason may be the shrinking of traditional indigenous livelihood options, lack of entitlement to land ownership, clearing forests, and so on.

In this study, the religious and cultural identities of the *Munda* community are strongly evident, which have unique characteristics, and the finding is allied to Siddiq et al. (2018). The religious identity of the *Munda* community in the study area is Hindu, and they perform different religious practices such as *puja* on different occasions. For instance, they perform sacred *puja* by praying for rain in the dry season because their livelihood is mainly related to water and nature. Srivastava (2007) observed that traditionally and culturally, the *Munda* community performs sacred *puja* for praising God.

It is found that the *Munda* people are peaceful, are hospitable, and avoid conflicts. The literature argues that people residing in a commonplace having the same ideology, values, norms, and beliefs can be able to carry out commitments (Bonta, 1993) which may ensure peace within the community. Incidentally, the village leaders, who are usually respected persons, settle tribal disputes in the community, and this finding is supported by Domingo and Oliva (2004). For governing the indigenous community and keeping the peace, the role of the leaders is inevitably important.

13.5.2 Theme 2: Perception of the Quality of Water and Its Problems

The *Munda* community of the study area suffers from safe drinking water scarcity due to several climatic hazards and environmental shocks, such as salinity intrusion, floods, and drought. Their knowledge of clean and safe drinking water is also limited. This finding is similar to the findings of Roy (2018). NGOs are working to supply pure drinking water in this community which is insufficient to meet the demand of a large size family. Sometimes, they need to collect the deficit amount of water from a distant place or buy at high costs. Ahsan et al. (2021) found that in Khulna city, people are willing to pay for improved drinking water; however, due to the income poverty of the *Munda* community (Roy, 2021), it becomes difficult for them to pay for safe drinking water. They also use unclear and unsafe water for cooking and other purposes, increasing health risks. In addition, they hold limited knowledge of clean water and can rarely distinguish clean water from contaminated water, thereby suffering different sorts of diseases, including kidney disease, eye infection, etc. It is expected because the *Munda* people are mostly illiterate or less educated; hence, consciousness regarding clean water may be limited. Sharmeen (2013) stresses improving safe drinking water in the Munda community by establishing deep tube wells. Water quality is also deteriorated by natural disasters, animal wastage, fish cultivation, and so on, and this finding is supported by Todd et al. (2012) and Boyd and Tucker (2012). However, to maintain better health status and get quality water from the source, the community people urge to experiment with the water source. As they have a single drinking water source, they urge to test arsenic and other material composition in their drinking water. Apart from that, the community people are extremely income poor; therefore, they are not able to buy water for survival. In this respect, more focus is needed to provide safe drinking water for the impoverished and marginalized *Munda* people. In addition, the *Munda* community is found to have a poor sanitation status, which is also supported by Roy (2018). As they are poor, less educated, and less conscious, they usually maintain less hygiene and sanitation practices.

13.5.3 Theme 3: Separations of Water Quality: Pure (Distilled) vs. Contaminated

Water is sometimes contaminated with natural substances, including arsenic, fluoride, and radon, and sometimes through animal waste, industrial waste, etc. The indigenous people have unique knowledge and practice to purify water. In this respect, Yongabi (2010) argues that the indigenous people of Africa have rich indigenous water treatment technology where they use plant species to disinfect water. In the past, the *Munda* community people purified water using pitchers, sand, broken pieces of bricks, and cotton clothes. Sometimes, they used alum for pond water purification. Very often, they use charcoal for the same purpose. Watts (2012) argues that indigenous communities have enriched knowledge and practices in filtering water but are less valued. The study found that the indigenous people prefer pure water to contaminated water because pure water smells and tastes better than polluted water. In addition, filtered water removes bacteria and other harmful materials; hence, it is perceived that purified water is good for health which appeals to more acceptability in the community people.

13.5.4 Theme 4: Change of Water Administration Framework over the Last 50 Years

It is found that there remains a scarcity of drinking water throughout the year. Seasonal variation creates challenges in the availability and supply of drinking water. As the study area is highly prone to climatic hazards, drinking water's availability mostly depends on nature. In the monsoon season, the study area sometimes becomes flooded, and in the dry season, there often exists drought. The safe drinking water availability over time shifted by means and mode. In the past, no NGO supplied pure drinking water to the *Munda* community. Later, NGO named *Rupantar* got engaged in providing freshwater supply in the community. In the earlier stage, their access to pure drinking water is modified where they used to seek water from ponds and rainwater harvesting; this finding complies with Bayly (1999). Ahmed and Khan (2021) argue that rainwater is highly purified. In the study area, previously, for storing water, they used to prefer mud pitchers. During that period, they used to apply their traditional indigenous knowledge for purifying water because there was unavailability of purification tablets or medicines. After the ages, they have access to pure drinking water such as rainwater and filtered water, stored in bottles, steel pitchers, and tanks. Currently, they rarely use their indigenous traditional knowledge for water purification purposes. The study observes a clear transformation of access to and water purification.

13.5.5 Theme 5: Possible Role of GOs and NGOs in Water Administration and Preventive Measures to Play Down the Breach Between Organizations and Community Individuals

In the study area, a collaboration between GO and NGOs is essential to make people aware, educate, and provide freshwater at the community level. Freshwater is the ultimate demand of the indigenous people; hence, they need tube wells, deep tube wells, and filters. In addition, water quality assessments are also essential for maintaining better water quality. Moreover, the GO and NGOs can work together to raise awareness regarding water quantity and quality among people and give economic support for getting freshwater to the community. Apart from that, the local government can emphasize the indigenous knowledge of water purification. As the indigenous knowledge of water purification is traditional and less costly, hence reviving the indigenous water treatment practices in a wider range such as at the community level can be an effective way to step forward. Along with the indigenous people if the local government takes steps to purify water collected from ponds, rivers, and other water sources, then it will reduce dependency on rainwater harvesting. Using the same indigenous water treatment practices, people may be able to get safe drinking water over the year. On the one hand, this intervention will lead to a supply of sufficient amount of safe drinking water and at the same time will help the community people regain their traditional culture of water treatment practices. This may require financial support from the local administration such as GO and NGOs to buy necessary items.

13.6 Conclusion and Recommendations

The indigenous *Munda* community of Satkhira Shyamnagar Upazila is extremely poor. With economic vulnerabilities, they experience extreme fresh drinking water crises. For getting quality drinking water, they previously used their indigenous knowledge, which was culturally practiced. Currently, NGOs are working with the Munda community, and they are providing pure drinking water for the community. Still, there is a shortage of drinking water supply especially for the enlarged families. The supplied amount of water is not sufficient for maintaining the water demand for the whole year. For buying bottled water, they need to incur costs; however, their economic condition does not allow them in this regard. Against this backdrop, for economic security, which means creating sustainable employment and income generation opportunities, the government of Bangladesh, donor agencies, and NGOs should work collaboratively in the study area. Without external intervention, the community people may not be successful in employing themselves in economic activity as there remains a limited scope of income opportunities in the locality. In addition, economic incentives or food supply may increase the number of participants in educational institutions for providing education to the children. Moreover, to reduce child marriage of the *Munda* school girls, economic security and awareness-building programs are highly recommended. In this respect, their indigenous language can be an effective tool to increase the education level of the community people. It will also assist in sustaining their language in the long run. Apart from these, for a safe and secured water supply around the year, the community should be provided with tube wells, deep tube wells, and filters. Moreover, retrieving their own traditional knowledge and practices of water treatment can be an effective solution to reducing the safe drinking water crisis. This will enable them to fulfil their demand for safe drinking water all year round, and this intervention will also make feel them better culturally. A hybrid method of drinking water supply can be established where both modern and traditional method of drinking water purification will be adopted to solve the water crisis in the *Munda* community. Local governance should provide them financial support in this regard. Both government and non-government organizations can step forward to provide basic facilities to establish tube wells, deep tube wells, and filters. They also need laboratory support to safeguard the drinking water from arsenic and other chemical contamination.

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Chapter 14
The Cultural Approach for Community-Based Conservation of River Basins: A Case Study of the Basin School Network, Taiwan

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Abstract Tackling the gaps between diverse knowledge and interests among stakeholders in basin management, the chapter introduces a civil initiative named 'Basin School' in Taiwan. With the aim of orientating grassroots vitality into water environment issues, the new movement attempts to connect local culture, knowledge, and everyday life when empowering community-based basin conservation. Launched in 2017, the Basin School Network contains 69 member groups, covering urban and rural river basins. Based on first-hand observations and reflections by the author, the chapter portrays the practices of the Basin School Network, along with the cultural strategies in mobilising participants and networking the basin communities. The discussion focuses on the role of Basin School Network in incubating new basin citizenship, following the three principles of its membership: adoption of a basin, regular activities, and commitment to the water body. The chapter indicates that in addition to the formal deliberation in policy making, the soft approach integrates everyday, grassroots-based engagements by local communities, thus envisioning a more diversified and balanced partnership for basin conservation.

Keywords Basin conservation · Community-based environmental management · Cultural approach · Civil participation · Grassroots initiative

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14.1 Introduction

In basin governance, enhancing partnerships surpassing sectors has been emphasised in recent frameworks. To tackle regional conflicts in water resource sharing and basin conservation, multi-scalar networks are proposed to balance local authorities and regional dynamics. Furthermore, when improving transparency and trust of the institutions, which are mostly designed and led by technocrats or hydraulic experts, the embedment of civil society is also suggested. Relevant cases can be observed in the administrative committees of Biwa-Yodo Basin, Japan, and the Bow River Basin, Canada (Hill et al., 2008; Nakamura et al., 2012; Stewart & Bennett, 2017). Meanwhile, involving grassroots citizens in basin governance is not an effortless invitation. Since the water issues are complicated, and people's perceptions of environmental risks are diversified, communicating the policy and engineering measures to the non-experts has become a challenging task (Chiang et al., 2021; Nakamura et al., 2012). When pursuing civil participation in decision-making, inclusiveness and openness throughout the process still face challenges (Kochskämper et al., 2016; Sneddon & Fox, 2007). Given the access to participation, another problem lies in encouraging citizens' engagement. Regardless of direct incentives such as regulation or economic subsidies, examples have presented that place attachment is an intrinsic factor for the motivation of environmental conservative activities (Gosling & Williams, 2010; Ryan et al., 2003). Nonetheless, place attachment still requires empowerment and mobilisation before reaching collective actions. The approaches can be creations of common knowledge and collaborative experiences (Heinmiller, 2009; Ishihara & Pascual, 2009), while the non-government organisations (NGOs) can facilitate the process as a mediator between the technocracy and the grassroots society (Bennett et al., 2016; Lassa, 2018; van Aalst et al., 2008). These organisations often have stronger connections with the civil society; therefore, they can not only assist in policy communication but also apply local knowledge in decision-making.

The chapter introduces a bottom-up example of basin conservation that mobilises citizens via grassroots groups in Taiwan. Besides the specified environmental organisations, a special actor in the network is the community college. The community college[1] is a form of local-based NGO that provides lifelong learning programmes for citizens. Under the supports from the central government and the supervision by the National Association for the Promotion of Community Universities [NAPCU], there are 89 community colleges around the country, covering every municipality (NAPCU, 2022). Due to its close attachment to the grassroots society and environment, most community colleges provide lectures and activities that investigate local history, cultural heritages, and ecological

[1] The English translation of the organisation can be 'community college' or 'community university'. Although the supervising association used the term 'community university', the chapter chooses 'community college' to distinguish it from the academic university that provides formal diplomas and is established in a larger size.

systems. These experiences have made the community colleges a granary of indigenous knowledge. Besides, the community colleges also function as critical gatekeepers of the local civil society when external agents (e.g. the government, consulting firms, and academics) enter the community, further facilitating the resources and understandings brought by diverse sectors (Chiang et al., 2022). To bridge the grassroots activities and supportive partnerships with other sectors, the community colleges launch a nationwide ‘Basin School’. The network aims to integrate education, eco-actions, and policy engagement, particularly from a cultural approach. Since the Basin School is an innovative and ambitious attempt of building a national network that surpasses scales and level, an exploration of its strategies in mobilising the grassroots citizens provides insights into the bottom-up construction of similar partnerships.

The materials for the case study come from first-hand observations and reflections by the authors, with four of them being key organisers and practitioners of the network. Supplemental data is achieved through the publications of the Basin School, as well as the reports provided by the member groups. The chapter first reviews the formation and organisation of the Basin School and then introduces the culture-focused practices in inspiring citizens’ environmental awareness and actions in basin conservation. Finally, the case study indicates the contributions and existing issues of the Basin School in networking and mobilising new basin citizenship.

14.2 Overview of the Basin School Network

The formation of the multi-regional basin partnership could be traced back to 2004 when the community colleges and related NGOs organised a platform for environmental conservation in the basin of Tamsui River, New Taipei City. In 2006, corresponding to the national programme of flood adaptation, the NGOs with concerns of river and basin conducted a conference. The participating groups further constructed an alliance to monitor the governmental flood management in 2007, later hosted another national drainage conference in 2008. Entering the 2010s, coping with the national initiatives of involving stakeholders in basin management, the role of NGOs had been more significant in public-private partnerships. However, due to the requirement of highly specialised knowledge when engaging in river restoration projects, the NGOs decided to separate their approaches to address compatible scopes on different issues. From the hardware approach, the NGOs with expertise in ecological assessment and environmental technology had formed a river platform to oversee the engineering practices. On the other hand, from the software approach, the NAPCU focused on working with grassroots groups to enlighten the citizens’ awareness of the basin environment. With the ‘soft’ perspectives, since 2015, the NAPCU brought out a new programme called ‘Learning about the basin’. The programme encourages the community colleges to design lectures and actions on local basins, which were also connected with the existing activities of community revitalisation.

When organising the community-based basin network, examples of Japanese basins have inspired the design of the Basin School. In the basin of Genbei River, Shizuoka Prefecture, Japan, during the 1960s, water pollution had triggered conflicts between farmers and urban residents for almost 20 years (Watanabe, 2006). As an alternative, the municipality of Mishima proposed a participatory river improvement project, and the Groundwork Mishima, a non-profit organisation, functioned as the major facilitator among the administration, enterprises, and civil groups (Okamura, 2003; Watanabe et al., 2006). In addition to the activities surrounding the Genbei River basin, the Groundwork Mishima enlarged its scope to engage in grassroots actions such as the conservation of environmental and cultural heritages (JSCE Infrastructure Partners, n.d.). The success of networking partnerships in basin management was then spread to Taiwan. The NAPCU developed the agenda of the Taiwanese Basin School based on a similar structure in 2017, when the Basin School conducted its first national conference. In the same year, several indigenous communities in Western Taiwan formed a prototype of Basin School. The NAPCU officially launched the Basin School Network in 2018. As a result of the discussions among invited members, the partnership announced three principles to enrol its membership.

1. *Adoption of a basin.* The member should choose a certain part of a basin as the target area for its activities. The size of the area is flexible and can be decided by the member. For instance, a community group can adopt the upstream basin of a river or the waterways within its region.
2. *Implementation of regular activities.* The member should conduct learning activities on a regular basis. Being active once a year is not acceptable.
3. *Commitment to the waterbody.* The member should intervene if any problem is noticed in the adopted area.

The aspiration of the Basin School is to involve at least one partner every basin nationwide. However, the partnership is still on its way of growth after being implemented for five years. In 2022, the network has contained 69 members, with 35 members focused on urban basins and 30 members focused on rural basins.[2] Figure 14.1 illustrated the rivers adopted by the Basin School partners.

Looking at the geographical distribution, the river basins covered by the partnership were concentrated in the Northeast Taiwan, while most of the adopted rivers in the south were located in rural basins. If focusing on the attributes of the partners, the local community colleges, with 30 of them enrolled, still occupied the majority. However, to ensure the diversity of this partnership, the NAPCU determined that the community colleges should not take over more than half of the membership. Other than the community colleges, there were 14 NGOs from the grassroots to national level engaging in the Basin School. Most of the member groups focused on environmental issues and landscape conservation. The 11 enterprises joining the

[2] Three of the members concentrated on multi-basin facilitation, and one new member had not yet confirmed its basin to adopt.

Fig. 14.1 The rivers adopted by the Basin School Network members. (Map source: Water Resource Agency, 2017a, 2017b, 2017c). Note: The map presented the large basins and whole waterway of rivers, while some of the rivers were only partly adopted. Besides, the map had dismissed small waterways or tributaries that were excluded in the map source

partnership consisted of 4 consultant companies, and the other corporations included farms, agricultural and social business, or agency that provides local tourism packages. Another critical group targeted by the NAPCU was the community association. Along with the community revitalisation movements in the 1990s, community associations had been one of the most active agencies. Their initiatives included cultivating grassroots activities and events to strengthen the residents' local attachment, and to promote local industry or tourism (Chen, 2014). There were seven community associations enrolling in the Basin School Network, and the NAPCU was still inviting more participants to integrate their grassroots experience in

Fig. 14.2 Local high school students presenting their poems at the waterfront concert by Dahu River, Yilan County (Photo source: Luodong Community College)

collaborating with the citizens and knowledge of local culture into the network building.

Despite the limited coverage and membership of the Basin School due to its brief period after launch, the member groups enrolled had already designed and conducted creative activities in basin conservation. The following section introduced the attempts to cultivate grassroots water culture in the daily life of communities, thus enhancing community-based basin protection.

14.3 Cultivating the Grassroots Water Culture

14.3.1 Designs of Local Actions for Basin Conservation

Local activities brought out by the Basin School partners served the fundamental role of mobilising the citizens to engage in basin conservation. The activities included regular events on a weekly basis, as well as seasonal or annual festivals (Fig. 14.2). The regular events included walking tours, bird watching, ecological and cultural surveys, water quality monitoring, river patrol or clean-up programmes at the waterfronts. Some member groups also participated in public hearings, vision workshops, and policy assessments. Among all the activities, environmental education programmes and river patrol were the most popular practices since both adults

Fig. 14.3 The stone stacking championships (Photo source: NAPCU)

and children were capable to engage. Regarding the environmental education programmes, in addition to lifelong learning organisations, partners in school systems, such as Yilan Senior High School in Yilan County and Zhonghe Junior High School in New Taipei City, also integrated the explorations of grassroots knowledge and basin environment into the curriculums of geography and local studies. Besides, the river patrols not only monitored illegal activities and removed invasive species. Some of the member groups also conducted water quality investigations applying citizen science measures such as biodiversity surveys or testing kits, further contributing the data to public sectors or the scientific community for policy making in water management.

Other creative activities were also carried out by the Basin School partners. Stone stacking championships presented an example of rethinking the water environment from leisure events (Fig. 14.3). The first stone stacking championships took place at the waterfront of Fengshan River, Hsinchu, under a historical stone bridge. The competition was organised on an annual basis by a local environmental NGO, and attracted participants of a broad range of ages. Most players joined with family members, and the eldest player in 2019 was a 90-year-old lady. Aside from the stone stacking championships, the participants could also enjoy various side events such as guided tours in the neighbourhood or music concerts. Later, similar competitions were implemented at the waterfronts in other regions. When the organisers enrolled in the Basin School programme, the design of the competition began to involve deeper and wider concerns about the basin environment. For instance, a desirable waterfront for stone balance should provide stones of diverse sizes, as well as a clean river environment that ensures safety and scenery. These characteristics could be diminished by pollution or concretisation. Therefore, the choice of a suitable place for conducting the stone stacking championships could also function as an examination of the basin environment.

14.3.2 Connecting Grassroots Citizens Through a Cultural Approach

In addition to the on-spot activities, walking tours that connected waterscapes and local lives also enlightened the environmental awareness of citizens. Furthermore, many of the activities adopted the methods of participatory design, making the preparation a process of empowerment and mobilisation. Examples could be found in the basins of New Taipei City, one of the two municipalities of the capital metropolis. The San-Ying walking festival has been conducted annually since 2013. The name San-Ying referred to two neighbouring districts, Sanxia and Yingge, that shared the same basin of Dahan River. The walking festival was hosted by a local NGO that promoted sustainable environmental and cultural conservation. Coping with the event, the NGO cultivated local tour guides to provide a comprehensive introduction to the cultural and industrial landscapes of the basin. The training programme also accumulated a collection of historical records and maps throughout the fieldwork.

A similar initiative of empowering bottom-up engagement was launched in the basin of Jingmei River, Taipei City, by the consulting firm Classic Design and Planning. In 2019, the firm brought out a series of seminars, workshops, and fieldwork that covered spatial design, land use, and environmental revitalisation. The organiser encapsulated the grassroots discussions as action plans and planning insights, then submitted to the local administration for future improvement. On the other hand, some community colleges also attempted to upscale their influence. The Hsindian Chungkuang Community College, New Taipei City, organised regular river patrols and hosted monthly multi-sectoral meeting with the basin authority, interest groups, and hydraulic or ecological experts. The topics in the meeting compassed environmental impacts of river constructions, blue-green infrastructure around the basin, as well as bottom-up policy monitoring and educational programmes. In the basin of Shumeikeng River, New Taipei City, local communities, residents, and external groups had formed an alliance to protect the basin environment. In 2019, the Bamboo Curtain Studio, a member NGO focusing on arts-based engagement and local revitalisation, New Taipei City, took a further step in public participation. The Studio developed a national network that oversaw the

Fig. 14.4 The Clean Drinking Water Alliance announcing their statements. (Photo source: NAPCU)

river constructions around the country. People can access and subscribe visualised details of the engineering projects on an online map platform.[3]

14.3.3 From Local Crises to Collective Actions

Besides community mobilisation and policy engagement, networks facilitated by the Basin School programme had also achieved a regional referendum to protect the local drinking water. In Hsinchu area, one of the biggest manufacturing bases nationwide, water distribution between the industrial sector and settlement had triggered conflicts. In 2017, local citizens found industrial pollutions in the drinking water source. The grassroots groups, NGOs, and community colleges then launched the 'Clean Drinking Water Alliance' (later registered in 2020) (Fig. 14.4). The alliance organised ecological surveys, protests, and other advocative events to raise awareness of the citizens and authorities. Under the pressure from citizens, in 2020, the municipality removed more than 6000 tons of waste from a landfill located

[3] See the website: https://river-watcher.bambooculture.tw/map?limit=3000

in the water conservation area. Furthermore, at the end of 2019, the communities proposed a regional referendum for a clean water act.[4] Following the referendum, the Basin School partners, collaborating with citizen groups and a local university, developed a series of workshops throughout 2020 and 2021. In December 2021, right before the referendum, local stakeholders conducted a conference to compile common visions of the Hsinchu basins. The public discussion suggested putting biodiversity and civil participation in a higher priority. Moreover, the objectives should be accomplished by improving the intimacy between the water environment and the residents. In practice, the conference suggested systematic environmental education about local waterscapes and community developments for all ages, as well as bottom-up, multi-sectoral integrations. Facilitating indigenous knowledge was also a critical aspect. Participants indicated that local citizens should be the key actors to discover and conserve the grassroots knowledge. Communicating the legacies with the public were further expected to enhance local identity and to develop new ways of living. Eventually, the clean water referendum was approved by more than 131 thousand votes (87% of the participating voters with 43.39% of the voter turnout) (Hsinchu Election Commission, 2021b). Responding to the success in the referendum, the mayor promised to legitimise drainage management and improve pipeline facilities to maintain the quality of drinking water (Hsinchu City Government, 2022).

14.4 Networking the Basins by Co-learning

14.4.1 Connecting the Common People

In facilitating the Basin School Networks, a fundamental strategy was to promote a decentralised linkage among member groups, and the citizens should engage as residents of the waterscapes. The strategy enabled the grassroots community to flexibly respond to the highly divergent issues. Furthermore, the diversity of participants also reflected multiple imaginations of local water environment. In practice, the Basin School focused on three basins as demonstrations of networking: Touqian River in the northwest, Dajia River in the west, and Zengwen River in the southwest. It was also stressed that regional connections could better mobilise grassroots communities with various concerns into a shared basin platform. By bridging different problematics and characteristics of the partners, the Basin School Network attempted to develop long-term and divergent relations between society and the

[4] The voters were asked, 'Do you agree that Hsinchu City should make Self-Government Ordinance for Wastewater Management, which stipulates that both wastewater and polluted water produced by industries, hospitals, and businesses must be treated to remove contaminants via specially designed pipelines, instead of allowing the disposal of such water into waterways upstream to contaminate drinking water intake and irrigation water intake areas?' (Hsinchu Election Commission, 2021a).

water environment. The diversity of member groups also extended accesses to more resources and opportunities of interactions from different sectors in society.

In the Touqian River basin, the clean water referendum had incubated a basin network that connected five community colleges along the river. Recently, the Network had been discovering a small historical harbour settlement and developing the neighbourhood as a new hub for environmental activities. In the basin of Zengwen River, the NAPCU had started to target and encourage potential groups to engage as new partners, such as the upstream indigenous hunters and the downstream farmers' groups. The recent event in 2022 was a land art festival with Tainan University of Arts. Entitled 'A Thousand Names of Zengwen River', the land art festival aimed to intertwine discussions of basin issues with cultural creations through arts, thus creating an advocative art festival. The basin community of Dajia River was still at an early stage of formation trying to move forward from experience exchange. Coping with the new scope of the everyday landscape, an experimental initiative was to identify the waterscapes with contexts of basin culture and then invite local partners to investigate and manage them. Furthermore, the practice also aimed to address the connections between community and the water environment and, moreover, to attract citizens to engage waterfront activities and basin conservation.

In addition to providing opportunities for the citizens to investigate local waterscapes, the Basin School partners also contributed data to the scientific community. Such initiatives of citizen science could be found at the fishing championships in Shengou Village, Yilan County. The competition was organised by a group of local scientists under a project entitled 'Sciences in the Farmland'. As an alternative to the ecological surveys, the competition had been conducted annually since 2018. Within the limited time span (around 9 days in the 2022 competition), the participants could freely explore the water environments and capture the living creatures (Sciences in the Farmland, 2022a). After uploading the photos of the animals, the participants should release them at the same spot. The competition had accumulated more than 2500 observation records and attracted external tourists visiting the village (Sciences in the Farmland, 2022a). Furthermore, in 2022, the participants recorded eight protected species, and five of them were newly discovered (Sciences in the Farmland, 2022b).

14.4.2 Communicating the Outputs

To facilitate experience sharing at the grassroots level, since 2017, NAPCU had launched an annual conference with advancing stages of the Basin School's general theme. The development of the Basin School programme could be divided into three phases. The years 2017 and 2018 were the primary phase when the concept, vision, and general principles of Basin School membership were established. The second phase (2019 and 2020) marked a cultural turn of the Basin School. The transformation was highlighted by proposing the idea of 'water culture', and the activities focused on soft approaches instead of overseeing hard constructions. Since 2021, the water culture was then narrowed down to the 'everyday landscape', with particular regard to the connection between daily life and waterscapes.

As a platform for co-learning, the agenda of Basin School conferences included plenary speeches by the invited experts and panel discussions among community workers. Participants could also engage in the side events such as walking tours, salons, and workshops. For instance, the 2019 conference focused on the application of visualised data and multimedia to communicate indigenous knowledge. The basin salons then introduced the investigation of waterscape transformation through historical maps or aerial photographs. In 2020, following the cultural turn of the Basin School, the salons presented examples of integrating grassroots knowledge into various aspects of community building, such as the construction of an indigenous settlement at an urban waterfront. The panellists included the leaders of NGOs and a consulting firm targeting environmental protection and cultural heritage. The panel discussion was then followed by a general conversation. Applying the method of the World Café, the participants exchanged their knowledge, experiences, and problematics in cultivating basin partnerships at the grassroots level. In 2021, corresponding to the theme of water culture, the basin salon invited five authors to portray six everyday waterscapes as demonstrative cases. Besides, discovery of alternatives in the COVID-19 pandemic was also a critical issue. With the growing limitations of conducting in-person activities, online tools served as a substitute. Taking the online walking tour as an example, some member groups adopted a new mobile application to record the waterscapes during walking tours or in everyday observations. These examples showed that digitalisation of everyday waterscapes not only created archives for the local heritages but also provided a co-learning platform that surpassed the community borders.

Along with the annual conference, NAPCU also published a journal entitled 'The Flower Buds of the Locals' (later renamed 'The Flower Buds of the Basins') to communicate the accomplishments of Basin School members. In 2019, the journal introduced the initiatives throughout the year conducted by the 30 members then. The 2020 issue presented a chronology of the cultural heritages of water, covering hardware infrastructures such as water resources development and river improvements, as well as bottom-up activities related to water environments. For further dialogues with diverse alternatives, the journal also contained columns contributed by local actors or external experts. In the 2021 issue, the articles introduced the geographical concepts surrounding landscape, as well as their connections with local water issues. For instance, in urban habitats, flowing rivers and water infrastructures such as pipelines and drainage had weaved the urban texture that incubated certain ways of living (Yu, 2021). Furthermore, despite the impacts of urbanisation, revitalising traditional waterways into urban blue-green infrastructure could also reconnect modern living with local heritages (Chang, 2021).

14.5 Towards the Incubation of Basin Citizenship

14.5.1 Basin Adoption and Reconnection to Everyday Life

The first principle of the Basin School Network is the adoption of a certain basin. Compared to the experts or specified NGOs in environmental conservation, although the grassroots groups' technical knowledge is limited, their experiences on the ground can better facilitate the localised visions that balance community development and basin protection. For instance, in the Fengshan River basin, Hsinchu City, the Ruowu College, a rural hostel in a renewed traditional house, has contained the landscapes of paddy fields and river into its walking-tour packages. Taking the visitors to the waterscapes provides a reconnection between everyday life and the basin environment. Instead of expressing the concepts of basin conservation, the grassroots groups focus on building a new lifestyle that emphasises deeper interactions with local waterscapes. Furthermore, regarding the facilitation of grassroots partnership, the existing network of community revitalisation plays the role of gatekeeper for grassroots intervention, particularly when seeking support from key actors within the neighbourhood.

Cultural approach of basin conservation also creates an alternative to bringing environmental awareness back to the ground. Many communities have started to draw out waterfront events as part of local revitalisation. In this sense, new perspectives of grassroots water culture can not only bridge more external engagements but also promote local tourism. Like the newly launched land art festival in the Zengwen River basin, the Meinong Yellow Butterfly Festival in Kaohsiung City marks a distinguished cultural turn of post-movement contributions. The festival has been designed as a main event of the anti-reservoir movement since 1995. Conducted in the river valley that was planned to be submerged by the reservoir, the festival integrated the local beliefs of 'Tudigong', the lord of the ground, and the yellow butterfly as the symbol to represent the ecological impacts of the reservoir construction (Chiu, 2021). After the administration eventually cancelled the reservoir construction, the festival remained as a representative local event. Entering the 2000s, the festival applied the insights of Satoyama initiative and enlarged its scope to a wider concern of cultural and environmental conservation. The cultural turn emphasised involvement of a larger diversity of participants in a longer time span. The 2019 festival invited the participants to a series of artwork creations, including workshops on theatre, music, literature, and dance, to reconnect themselves with the waterscape (Chiu, 2021). Succeeding the achievements in social movements, commitments of continuous efforts to enlarge the influence in both political realms and civil society is a crucial issue. The Meinong Yellow Butterfly Festival presents a successful example of the transition from social movements to cultural actions in promoting basin conservation and finally became a key to community prosperity.

14.5.2 Regular Activities and Accumulation of Basin Heritages

The second principal stresses regular actions surrounding the adopted basin. Although annual or seasonal events can involve large participants and inspire environmental awareness, everyday practice is also inevitable to sustain people's enthusiasm and consideration of basin conservation. Implementing regular activities has two meanings in incubating basin citizenship. On the one hand, consistent engagements encourage local citizens to embed the river into their daily life, and the outputs can be accumulated as heritages of the basin. For instance, the story-map mobile application builds an archive of historical, cultural, and natural legacies in the waterscape, and the river patrol empowers a group of citizens to oversee potential hazards in the basin. On the other hand, creating a compilation of basin activities also develops different relations between humans and water. These diversified human-water connections are expected to nurture deeper understanding and wider imagination about basin conservation. Regular activities acquire grassroots knowledge about the local waterscape, while annual or seasonal events contribute creative insights to the environmental practices. When achieving civil participation in basin conservation, compared to the emphasis on water resource management and disaster mitigation, cultural strategies focuses on embedment of collective memories and encouragement of different imaginations. In this sense, the cultural approach of civil mobilisation concentrates on the process of directing people to local waterscapes, from raising one's attraction to facilitating observations and reflections, further generating alternative visions for future actions and a shared commitment between different stakeholders.

Through the multi-regional network of the Basin School, members can communicate the local heritages and upscale the impacts. The conference and journal provide platforms that surpass regional borders, and the contributions of citizen science also connect grassroots knowledge to governmental decision-making. Besides the regional collaboration across basins, generational succession is also crucial for sustainable engagement. Corresponding to the educational programmes in some high school Basin School partners, in 2022, NAPCU organised a 3-day summer camp for high school students. The summer camp took the students to different waterbodies in the community, including the valleys with or without hardware constructions such as levees and sluices or the streams polluted by upstream development. Nonetheless, the students also participated in conservative activities like cleaning the ecological ponds and investigating the water pollution of local drainage.

14.5.3 Rooted Commitment and Active Citizens

The third principle of the Basin School Network is a commitment to protect the adopted basin. In other words, the network requests its member groups to act when the basin faces threats. This commitment transforms the position of citizens from passive audiences that enjoy the waterscapes to active stakeholders that engage in public discussions and actions of basin conservation. Along with the activities that accumulate grassroots knowledge and understanding about the basin environment, the Basin School partners are capable to observe potential hazards to either the water quality or the surrounding ecology. The threats include industrial pollution and the impacts of hardware construction. For instance, governmental treatments for disaster recovery tend to cover the waterfront with river embankments. As a result, the authentic environment, both the scenery and the ecology, can be soon interrupted by engineering solutions if no objection is declared immediately. Based on the experience of bottom-up engagement, many Basin School members have built access to voice opinions, and some of them are invited by the authorities for policy consultation. The multi-sectoral meeting hosted by Hsindian Chungkuang Community College, New Taipei City, ensures a platform for civil groups and external experts to participate in decision-making. In recent years, the water governance frameworks have been enhancing civil discussion and public-private partnerships; thus, a more effective role of citizens can be expected.

The commitment of the member groups is a rooted promise to actively engage in community-based basin conservation. Nonetheless, the bottom-up approach distinguishes the Basin School Network from the experts or the environmental education programme provided by the central government. The programme designates environmental education centres in multiple basins, and the materials are produced by experts in related fields. Meanwhile, grassroots groups have more potential to develop intimate relations and localised alternatives. Compared to traditional environmental education which tends to be general and technical, the community-based strategy emphasises that education should be integrated with actions in basin conservation. In particular, community colleges have a broader scope compared to other citizen groups that focus on specified issues. For instance, the community colleges often provide art or cultural courses. Consequently, bridging the activities with local waterscapes can initiate creative outputs in basin conservation. Relevant practices include the artwork creations that use local rivers as the theme, as well as the walking tours and exhibitions that bring the works and the audiences to the waterfront. The strategy opens an innovative pathway that uses leisure activities to variegate the dimensions of grassroots water culture.

14.5.4 Implications and Challenges

When seeking community-based environmental conservation, to guarantee the self-determination of local citizens, integrations of knowledge are often highlighted (Boulton et al., 2000; Duker & Klanarongchao, 2022). In the mobilisation of stakeholders (especially citizens), empowerment in learning and facilitating diverse interests are also stressed (Vall-Casas et al., 2021). The Basin School Network provides an example of adopting cultural strategies to mobilise grassroots residents as active citizens, thus facilitates a platform for community-based basin conservation. At the individual level, the case portrayed the importance of embedding environmental concerns into everyday life in local communities. Apart from the design of civil participation measures (Rydin & Pennington, 2000; Vall-Casas et al., 2021), as a supplemental alternative, the soft approach provides a fundament to cultivate public discussion. Furthermore, at the community level, the rooted human-water linkage promotes a shared sense of responsibility, leading to more creative imaginations of the basin's prosperity. At the basin level, the Basin School demonstrates a flexible and decentralised partnership that connects diverse groups. The member groups function as bridging organisations between grassroots citizens and external groups (Lee & Krasny, 2021). The network focuses on empowering citizens to accumulate basin legacies and embrace the commitment to protect the water environment. Although the Basin School intendedly distinguishes itself from the focus on policy making, the cultural actions still contribute to the formation of a basin community.

Regardless of the innovative attempts to mobilise community-based basin conservation, challenges remain in the development of the Basin School Network. The soft approach lowers the barrier of involvement, but, at the same time, faces difficulties when building a stable and sustainable partnership. In the first place, the programme is still new and experimental. Consequently, despite the determined three principles, the NAPCU and the member groups are still adjusting practical strategies corresponding to the local contexts. In addition, although the loose structure has advantages in mobilising various stakeholders, the understanding and engagements by different member groups are disparate. As a result, within 3 years, several partners have dropped out from the network due to organisational restructure or other reasons. Tackling the issue, NAPCU has picked up three basins as key areas for networking before upscaling to a nationwide platform.

14.6 Conclusions

Considering the problematics of community-based basin conservation, the chapter introduces the cultural approach as an alternative to improve grassroots citizens' environmental awareness and commitment. Taking the Basin School Network, a bottom-up platform composed of non-governmental groups in Taiwan, as an example, the case study reviews the network's practices and strategies for grassroots networking and incubation of basin citizenship. Learning from the multi-sectoral platform Groundwork Mishima, Japan, the Basin School aims to connect grassroots groups to develop alternative imaginations of basin conservation. The Basin School distinguished itself from the policy making process that requires more scientific expertise, thus suggesting a soft and cultural perspective regarding the basin issue. In mobilising the partnership, all the member groups must follow three principles: adoption of a basin, implementation of regular activities, and commitment to the waterbody. The three principles also refer to three dimensions of cultural mobilisation in community-based practices. First, basin-focused partnerships bridge the two streams of environmental actions and everyday community life. Deepened connections between community and local waterscapes not only enhance the citizens' environmental awareness but also create opportunities for community revitalisation. Second, regular activities can ensure consistent involvements. Furthermore, the activities also accumulate community heritages of the local water environments. An integration of constant activities and creative events, such as weekly river patrols and seasonal waterfront festivals, facilitates divergent human-water relations and visions. Examples have shown that the diversity of actions can be succeeded by collaborations with different groups of actors, including schools and artists. Utilising the courses of community colleges is also an alternative. Furthermore, the Basin School provides co-learning platforms for the exchange of outputs. The third principle calls for a rooted commitment to the adopted basin. This guarantees the bottom-up actions towards potential hazards to the waterbody, further enabling the communities to contribute and upscale their influence in policy making.

Regarding the limitations of the current case study, more detailed fieldwork at different basins advances further investigation. Besides, future studies can adopt and develop the three principles of partnership in comparison between different cases. The principles also provide an agenda to analyse or examine the practices of similar networks. The chapter illustrates the practices and possibilities in applying cultural dimensions as a strategy to network the basin community. Integration of the soft approach and formal deliberation enlarges the contributions of grassroots actors in community-based watershed management, thus envisioning a more diversified and balanced partnership for basin conservation.

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Chapter 15
Indigenous Knowledge and Conservation Practices for Sustainable Water Management in Lateritic Southwest Bengal, India

Sarmistha Saha, Sudipta Kumar Maiti, and Suman Adhikary

Abstract The districts of Birbhum, Bankura, Purulia, Jhargram, and West Midnapore, a part of lateritic Southwest Bengal, India, receive low rainfall leading to drought. To cope with water scarcity caused by the natural adversities, native people practice water conservation techniques for centuries. In this chapter, indigenous water use techniques practiced in the lateritic Southwest Bengal are documented along with various beliefs and customs. Indigenous methods for water conservation and management to be explained are like pitcher watering system, bamboo drip irrigation, using compost pits as water storage tank, watering of plant for religious belief, wells, large ponds, happa construction, contour dam, sacred ponds, roof rainwater harvesting, bhurbhuri, jharna, etc. Studies of such age-old resources management systems as "situated knowledge" and "situated action" are significant for better comprehension of their applied value in planning of more ecologically safe, socio-culturally feasible, community-based economically viable, and efficient alternative solutions to water resources management problems encountered in recent times.

Keywords Indigenous · Water conservation · Drip irrigation · Pitcher irrigation · Water scarcity

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15.1 Introduction

Access to water, the utmost essential resource for our survival (health, community, and economy), is limited to billions of people throughout the world (UNDESA. 2014). Countries with per-capita water accessibility of less than 1700 cubic meters per year are considered as "water stressed." India has been reported as a water-stressed country with 1545 cubic meters of available water per capita (Water Resources at a Glance 2011 Report). More than 50 percent of the Indian population has no access to safe drinking water. Moreover, water quality has worsened due to improper sanitation induced by the Covid-19 pandemic in the past 2 years as this pandemic has significantly amplified per-capita water use manyfolds (Duttagupta et al., 2021). Therefore, water deficiency is a major concern over the world (Das et al., 2021) and a consistent problem that increases the negative impact on the health, societal, livelihood, and economic development at the global level.

The state of West Bengal, India, is no exception. The decline in practicing traditional water harvesting systems has given rise to a serious imbalance in water use and management in this state. Birbhum, Bankura, Purulia, Jhargram, and West Midnapore districts suffer severe water shortages recurrently throughout the summer (Sikdar et al., 2020; Chatterjee, 2018; WBSAPCC 2010). These are the most under-developed districts of West Bengal from the economic and human development point of view.

A major part of the state's tribal population lives in these districts. These tribal people are entirely dependent on natural resources for their survival. Living in such water-deficient agro-climatic region has made them learn and practice for ages to conserve water in every single way and use it sustainably (Agarwal et al., 2000) to survive in the driest times. These traditional water management regimes are grounded on participatory approaches where the contribution of stakeholders in decision-making, strengthening local community bonding, and integrating traditional situated knowledge, skills, and situated actions into the design of nature-based solutions are significant strategies. These techniques not only aid to meet day-to-day water requirements but help in the conservation of local biodiversity besides recharging groundwater.

The age-old "situated knowledge" and "situated action" are the main focus of our study as they show the way to ecologically safe, socio-culturally feasible, community-based, economically viable, and efficient alternative solutions to overcome the crisis of water scarcity. The present study has documented various indigenous knowledge, beliefs, customs, and practices for water conservation and management prevailing in the districts of lateritic South Bengal.

15.2 Study Area

Birbhum, Bankura, Purulia, Jhargram, and West Midnapore, the westernmost districts covering 27,032 sq. km. area of the state of West Bengal, were the focus area of the current study. Figure 15.1 shows the map of the focus area within West Bengal. The areas within the abovementioned districts that were surveyed for the current study are listed in Table 15.1. A subtropical climate with hot humid summer and cool dry winter prevails in these districts, and it comes under the "red-lateritic"

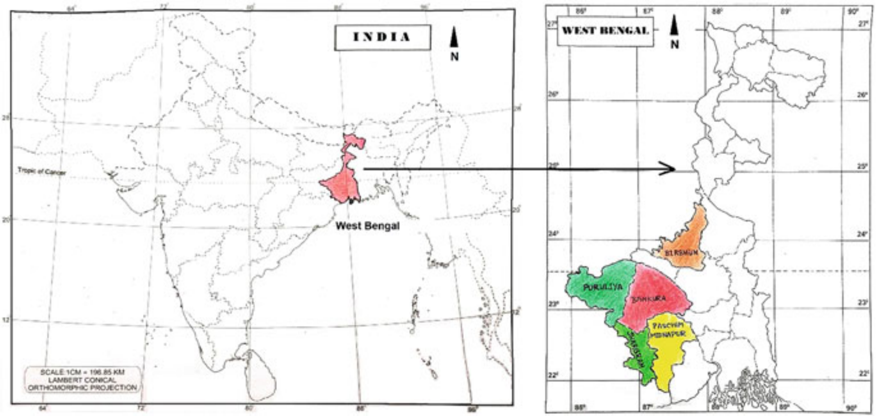

Fig. 15.1 Study area: Birbhum, Bankura, Purulia, Jhargram, and West Midnapore districts of West Bengal

Table 15.1 List of the areas that are surveyed to take up the study in the districts of Birbhum, Purulia, Bankura, Jhargram, and West Midnapore

Name of districts	Areas surveyed
Birbhum	Murari-I, Murari-II, Nalhati-I, Nalhati-II, Nanoor, Rampurhat-II, Khoyrasol, Mayureswar-I, Rajnagar, Sainthia and Suri-II, Rajnagar, Ilambazar, Dubrajpur, Siuri-I, Kayerpur
Purulia	Chamchaka, Chhatni, Manpur of Ajodhya Hills, Jahajpur, Kalimati, Burda, Chorida, Kushaldi, Gobindapur, Kuchrirakha of Baghmundi; Ghatbera of Balarampur and Hetgugui, Shirkabad, Lachmanpur of Arsha, Bakati of Manbazar-I; Bari of Manbazar-II; Bamundiha of Barabazar, Shiulibari, Sirjam, Baykara, Sumaidi of Kashipur; Sindurpur, Nanduara of Raghunathpur-I, Pokabandh Para; Deshra of Hura; Asanbani and Adi Kalyaneshwari Mandir of Neturia, Begunkudor of Jhalda-I; Dumurdih and Sitakund
Bankura	Biharinath Hills of Bankura, Bandudi, Birbandh, Ranibandh, Benachapra, Bijardih, Kasiboni, Molboni, Murgathol, Hingaldoba, Benachapra, Hingaldoba, Saltora
Jhargram	Amdanga, Chandabilla, Nischinta, Pechabindha, Chamarbandh, Chormundi
West Midnapore	Dukhasole, Fulgeria, Rajnagor, Sarsanka, Khudasole, Bhaluksole, Binai

agro-climatic zone which is characterized by high evaporation and low precipitation (Dutta, 2018). The huge area of these districts is under Northern-tropical dry deciduous forest dominated by sal mixed with various species like *arjun*, *kusum*, *mahua*, *neem*, *kendu*, *amla*, *bahera*, *aswagandha*, *haritaki*, *karanja*, and *bamboo plants* (http://www.westbengalforest.gov.in/). *Santal*, *Bhumij (Sardar)*, *Munda*, *Kol*, *Ho*, *Oraon*, *Paharia*, *Lodha*, *Mahali*, *Lohar*, and *Sabar* are the indigenous tribes of the lateritic South Bengal (Barman, 2015). Maximum and minimum precipitation occurs in August and December consecutively (https:// en.climate-data.org/location/48738/). Agronomic yields are hindered here as these districts are declared drought prone due to less rainfall and dry weather by the Agriculture Department, Government of West Bengal (Mondal et al. 2014). These areas have been acknowledged as semi-critical by the State Water Investigation Directorate and Central Ground Water Board considering the groundwater resources in these districts (CGWB and SWID 2011; CGWB 2014). Consequently, these water-scarce and drought-prone areas need special attention for water supply for drinking, household use, and irrigation purposes (Matsuura, 2002 cited in Castelein and Otte, 2002).

15.3 Methodology

Indigenous people of different villages of the districts of Purulia, Bankura, Birbhum, Jhargram, and West Midnapore were surveyed, and data were procured through participant observation, group discussions, and dialogue with knowledgeable individuals, direct observations by the authors, and case studies. The information and traditional knowledge of the local people were documented. The reported information from villages of one district was then validated with the noted findings from the villages of other districts. Secondary sources such as websites and relevant pieces of literature were also discussed to acquire information on other germane studies.

15.4 Water Resources Management: Challenges

The main issues allied with the development and management of water resources are diverse and multi-layered. The challenges might be classified as natural and man-made.

- In natural conditions, subtropical climate causes hefty spatio-temporal variation in climatic factors which lead to periodic droughts and recurrent inundations.
- For urban growth and development, water demand is increasing, while per-capita water availability is decreasing which leads to the deterioration of water quality. A number of cascading conditions have emerged due to man-made urbanization activities such as conflict for water utilization, water-logging leading to change in

soil quality in irrigated lands, groundwater depletion, substantial change in land use pattern, and significant decrease in vegetation cover.

- Exacerbated urbanization has intensely affected the local environment and climate which in parallel has caused an escalation of climate change impacts and induced natural calamities like heatwaves, storms, changes in weather patterns like flooding, and more frequent and intense droughts.

Therefore, adaptation and practice of more sustainable water use methods are the necessity of the moment in parallel to the evaluation of water policies.

15.5 Vivid Account of Indigenous Knowledge and Techniques on Water Conservation

Water conservation methods that are skilled by the indigenous people of different villages of the five districts Birbhum, Bankura, Purulia, Jhargram, and West Midnapore of West Bengal are explained in this section.

15.5.1 "Ail": Contour Bunding

In undulated landscapes, due to the wavy structure, the maximum amount of precipitation drifts very fast as surface runoff. *Ail* is constructed to prevent the flowing rainwater within a very short time. "*Ail*" are 1–1.5-ft.-deep tunnels that are dug in the upland area or beside the arable land at certain intervals along the landscape. Excavated soil is then piled up on the downslope edge of the tunnel to form a boundary or contour (Fig. 15.2A). Consequently, the fast-flowing rainwater, following the slope, gets trapped in the *ail*. The water in the *ail* is used for irrigation, and it helps maintain soil moisture in dry summer, together with aiding in groundwater recharging (Mishra and Rai, 2013). Plantation on the soil mound at the boundary of *ail* provides fruits and sheds and abates animal invasion (Zemadim et al., 2014).

15.5.2 Trench Bunding

Trench bunding or contour trenches are channels dug along the highland side in such a way that they trail a curve and run upright toward the water current. The excavated soil is then used to construct a ridge on the downslope edge of the channel (Fig. 15.2B). Fruits and other plants are grown on the ridge forming a boundary of plants and serving as living fences.

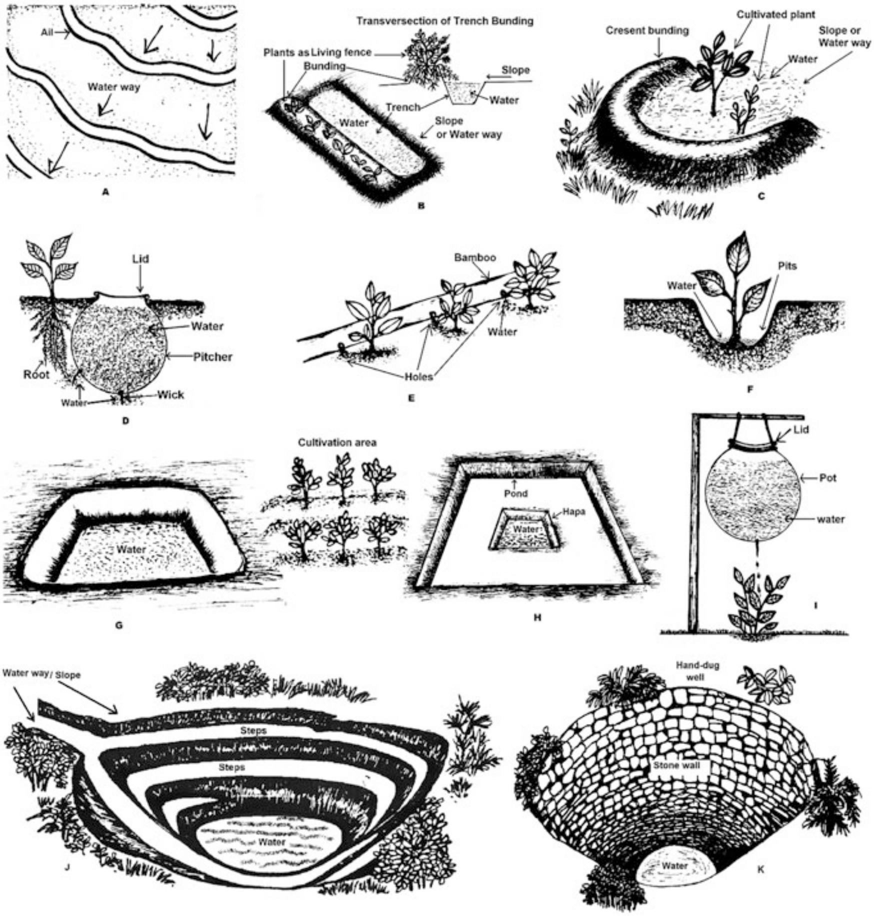

Fig. 15.2 Sustainable techniques of water use and conservation practiced by indigenous people of Birbhum, Bankura, Purulia, Jhargram, and West Midnapore. (**a**) "*Ail*" – contour bunding. (**b**) Trench bunding. (**c**) Crescent bunding. (**d**) "*Kalsi sech*" – pitcher irrigation. (**e**) Bamboo drip irrigation. (**f**). Pit irrigation. (**g**) *Happa*. (**h**) *Happa* in the center of the pond. (**i**) "*Basudhara*." (**j**) "Step" ponds. K. Dug well

15.5.3 Crescent Bunding

Soil is heaped up in a crescent-like structure surrounding a shallow area, perpendicular to the slope forming boundary to collect the flowing precipitation (Fig. 15.2C). Tree crops can be grown using crescent bunding. Catchments are formed perpendicular to the rainwater flow line or slope measuring inter-space availability for tree crops. Rainwater stored in the crescent structures is used to irrigate the trees as reported by farmer Rasi Murmu of Kasiboni, Bankura.

15.5.4 "Kalsi Sech": *Pitcher Irrigation*

Pot or pitcher is known as "*kalsi*" in the local language. Earthen *kalsi* with wicks in tiny holes at the bottom is filled with water and positioned beneath the soil beside specific plants (Fig. 15.2D). Water comes out of the *kalsi* through the wick, making the soil wet which irrigates the plant causing the least evaporative loss and minimum below-ground seepage (Farhate et al., 2020). Ganesh Saren from Sitarampur village of West Midnapore claimed pitcher irrigation to be a cost-effective method as a small *kalsi* with 1 liter water can irrigate a life-size (6–7 ft.) plant throughout the 3 months of the hot and dry summer season (Micro-plan preparation of different forest protection committees of Midnapore soil conservation Division, 2015).

15.5.5 *Bamboo Drip Irrigation*

A full-size bamboo is used for this purpose. Nodes of the bamboo are removed, and small pores are made at an even distance as per the distance between the target plants. The bamboo acts as a pipe that drips the plants when filled with water (Fig. 15.2E). Bamboo drip irrigation decreases the loss of irrigation water through evaporation, whereas no special skill and electricity are required to take up this practice. It also aids in minimizing weed growth as fertilizer consumption is least (Kumar and Palanisami, 2010).

15.5.6 *Pit Irrigation*

Small pits are excavated in the lowlands. Crops or vegetables that need more water are grown in those pits (Fig. 15.2F). Water flowing from uplands gets trapped in those pits during monsoon, while during summer, it gets water that soaks from the surrounding subsurface soil which irrigates the plants.

15.5.7 "Happa": *Digging Small Tanks or Pits on Agricultural Land for Water Storage and Conservation*

Happa or small square pits (approx. 5 ft. in length and 4–5 ft. in depth that are dug at the lowest slope of "*khas jomi*" or farmland to conserve rainwater) are the best sources of irrigation in dryland areas – said Shikha Rani Mahato, farmer of Pechabindha village, Jhargram, as she cultivated "*Rabi*" seasonal vegetables like beans, beet, carrot, mustard, onion, peas, and potato – all irrigated by *happa* water.

As the winter season in lateritic Bengal is rain scarce, it creates a drought state for growing Rabi crops and vegetables. For the survival of their cultivated plants in such adverse environmental conditions, indigenous people use water from *happa* (Fig. 15.2G). Like many others, Sukul Mandi of Hingaldoba village, Bankura, practices integrated duck and fish farming with crop cultivation using his *happas*.

15.5.8 Digging a Big Hole or **Happa** *in the Center of the Pond*

Bhim Rana, an inhabitant of Manpur, Ajodhya Hills, Purulia, told us about another water conservation technique of excavating a large hole or *happa* in the center of the pond (Fig. 15.2H). In Purulia, people dig such *happas* when the ponds get dried in the scorching summer, but Shyamal Lohar of Bhaluksole, West Midnapore, claimed that while digging the pond, they create such large holes in its center (Microplan preparation of different forest protection committees of Rup-Narayan soil conservation Division, 2014). These *happas* remain filled with seepage from surrounding soil and subsurface aquifers and also hold water from sudden precipitation (Pani and Mishra, 2021).

15.5.9 **"Basudhara"***: Ritual of Watering Plants during Summer*

There is a belief among the indigenous people of these districts that ceremonially watering some conventionally important plants during summer will aid to fulfill their wishes. This ritual is known as "*Basudhara*" and is practiced all over the study area (Fig. 15.2I). This practice aids in the survival of several significant plants throughout the extreme heat of the summer.

15.5.10 Large "Step" Ponds

Large ponds are dug in the low-lying area in the field so that all the rainwater flows into the pit during the monsoon. It involves creating tires or steps while digging the pond (Fig. 15.2J). Harvested rainwater will be used further to irrigate the entire land with fruit orchards and vegetables. During the dry season as water goes down, the steps come up where Sundari Hansda, Jagannath Murmu, and many such farmers grow several vegetables like beans, beet, brinjal, coriander, carrot, chili, grass peas, spinach, tomato, mint, etc. as mixed cropping at Kharbana and Dakshin Hansapahari villages of Bankura and Kuchrirakha of Baghmundi, Purulia.

15.5.11 Well for Drinking Water and Irrigation

The utilization of groundwater through dug well irrigation is an indigenous form of irrigation. A dug well is a shallow well, with its bottom at a fair depth below the water table, so that water from the surrounding aquifer accumulates in the well (Fig. 15.2K).

15.5.12 Cultivation Using Environmental Moisture or Dew

Plowing the cultivation area in the afternoon to make the soil moist with night dew is another indigenous farming practice (Ben-Asher et al., 2010). The wet land is tilled, and this practice is repeated for 8–10 days to prepare the soil before planting seeds. After seed plantation, the farmlands are covered with a layer of straw mulch to prevent evaporation loss.

15.5.13 Sacred Pond

Another indigenous water conservation technique is to establish the area as a sacred place or construct a temple or sacred groove beside the water body to keep it clean. Due to their religious belief, local people do not pollute this type of water body which play a vital role in preserving native flora and faunal diversity because of the least anthropogenic influence (Maya, 2003). A total of 127 sacred ponds was found in these 5 districts of West Bengal as per a report on sacred groves of South Bengal.

*15.5.14 Roof-Water/Rainwater Harvesting in "*Doba*"*

Intense water dearth in these districts of lateritic Bengal has made local inhabitants give an enormous effort to conserve and use rainwater in every possible way. Digging quarry (approximate size: 50 ft. x 50 ft. x 10 ft.) (Mishra and Rai, 2013) or "*doba*" (in Bengali) beside the house and connecting it with the roof using bamboo pipes linked with an open drain in such a way that the precipitation accumulated in the rooftop is directed into these "*dobas*" or pits through open drainage is called roof-water harvesting. The Mandi family moderately overcomes water scarcity as farmer couple Khela and Ukil Mandi of Shiulibari village of Kashipur Block, Purulia, use harvested roof-water for both farming and household purposes during dry seasons.

15.5.15 Embankment on River

In dry lateritic Bengal, river embankments are built at the lower region of the river to serve a dual purpose of preventing the river from overflowing during monsoon as well as water storage for the cultivation of the summer crops when the water supply becomes scarce. Plants, fruiting trees, and shrubs grow in the surrounding area due to wet soil and a moist environment. Fruits are used by the local people, while the shrubs, grass, and tree leaves are used as fodder for domestic animals.

*15.5.16 "***Bhurbhuri***": Aquifer*

"*Bhurbhuri*" or aquifer is a body of permeable and porous rock through which water can easily move and come out on the ground spontaneously in appreciable amounts. "*Bhurbhuris*" are naturally created water sources that are used for drinking purpose all season as it does not dry up even in summer. This water form streams which act as a water source for farming and other household activities.

*15.5.17 "***Jharna***": Waterfalls or Springs*

At a particular exit point or over a large seepage area, groundwater is forced above the land surface by natural pressure forming "*jharna*" or spring or waterfall. Springs are an essential part of tribal life in the forest regions of rural Bengal as these "*jharnas*" serve as the only source of drinking water for the local people and animals during dry seasons.

15.5.18 "Gobar Khal": Use of Compost Pits to Store Water

Storage pits of "*gobar*" or cow dung and remnants of vegetables for making compost or bio-fertilizer are used to reserve monsoon precipitation. These compost pits are called "*gobar khal*" as it serves both the purpose of a bio-manure chamber and water reservoir.

It is observed that rainwater runoff causes soil erosion which is the source of large quantities of silt deposition to runoff waters, therefore deteriorating water quality leading to water pollution and aquatic ecological imbalance. All the aforesaid indigenous water use methods lead to lower runoff, and in due course, soil erosion is decreased, consequently reducing environmental pollution together with the increasing accessibility of water for crop production and other usages.

15.6 Water Purification and Cooling Methods

Indigenous people of most of the villages of lateritic South Bengal practice the following methods for water purification:

- The thin stem of a common reed, which is locally recognized as *Nol-khagra* (*Phragmites karka*) (family Poaceae), is used as a pipe for sipping filtered water.
- *Fitkari* (alum) is used to clean water through distillation.
- Fine piece of cotton cloth or "*dhuti*" is used to filter mud water by the farmers during cultivation to get clean and fresh water for drinking.
- During summer, narrow mouth clay pot or pitcher which is locally known as "*Kunjo*" is widely used throughout rural South Bengal to cool the drinking water. The narrow mouth of the pot helps to maintain a lower temperature and avoid dust entry. For cooler water, the pots are covered with a piece of wet cotton cloth and kept on the wet sand.

15.7 Weather Forecasting and Other Beliefs of Indigenous People of Lateritic Southwest Bengal

Native people of this part of *Rarh* Bengal have acquired some skills in weather forecasting. They say "*Soni- seven, Mangal- three, Baki sob dinner din*" which means if rainfall starts on "*Soni*" or Saturday, it will continue for 7 days, whereas rain starting on "*Mangal*" or Tuesday will continue for 3 days, and starting on other days, it will last only for that day. Another belief is that torrential rain is expected if a huge blackish cloud appears on the "*Vador*" corner or the northwest side of the sky. Some beliefs are developed from long-term behavioral observations of both wild and domesticated animals. Wild animals moving from lowlands near water bodies to moorland or deep forests, sudden homeward movement of livestock from pasture, ants leaving their burrow – moving with their eggs toward higher places, and twittering and hasty hovering of birds in the sky are thought to indicate heavy rain or natural calamities.

15.8 Indigenous Usage of Plant Diversity to Quench Thirst

Various plants are used by local people that are edible and can reduce the chance of dehydration by satiating their thirst while long-distance travelling in the scorching summer. Growing in the red soil of lateritic Bengal, water-holding leaves and water-emitting cuts of panthapadak (*Ravenala madagascariensis*) plant and fleshy and sweet roots of palash (*Butea monosperma*) seedlings together with locally grown fruits like watermelon (*Citrullus lanatus*), cucumber (*Cucumis sativus*), *Kakri* or long melons (*Cucumis melo* var. *flexuosus*), sugarcane (*Saccharum officinarum*), *kam-ranga* (*Averrhoa carambola*), litchi (*Litchi chinensis*), *futi* (*Cucumis melo*), pineapple (*Ananus comosus*), etc. help to serve this purpose (Sinhababu et al., 2013).

15.9 Conclusion

In dry and drought-prone areas, rural people use to walk a long way for hours under the scorching sun to collect water. In this difficult struggle for the most essential resource for survival, indigenous people of these dry districts of West Bengal have understood the importance of water management through sustainable water use along with the necessity of water conservation. Over decades, people of these districts have practiced numerous approaches to preserve water to overcome the hurdle of water scarcity. As water deficiency is a universal problem and with ever-increasing global population, the water consumption rate has augmented manyfolds (Haldar and Saha 2015), increasing the severity of the situation. These indigenous techniques are practiced for ages by the people with the least available resources; hence, the techniques are easy to adopt and cost-effective. Therefore, using the vibrant and effective solution to these problems, the situated knowledge, and action that is witnessed by the native practitioners is a more practical option.

Findings of the current study demonstrate the environmental perceptions, cognitive imagination and operational spheres of these traditional practices as an integral part of the water management system in adverse condition, which might encourage the promotion of such resources management strategies to improve small-scale local community lifestyle in a sustainable manner.

Our chapter will benefit to generate awareness and understanding about the techniques for rural villagers and growers to overcome water shortage and livelihood generation through cultivation in the dry season. This might aid in policy improvement by local administrations for social and financial advancement, accentuating maintenance of water health and sanitation.

Declarations

Ethics Approval and Consent to Participate Not applicable

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Chapter 16
Importance of Women's Indigenous Knowledge of Water Conservation and Management in Sri Lanka

Sachini Kavinda Jayakody and Mrittika Basu

Abstract Indigenous knowledge held by women are different from men due to their daily roles, interests, and experiences. Despite their perspective, knowledge help by women is seldom integrated into the decision-making process. In the present study, elderly village women from Sri Lanka are enquired about the value of water to them, the local practices for use, storage and conservation, and the loss of indigenous knowledge. The findings of the study demonstrate the importance of water as perceived by these women when they relate water to life. The elderly respondents identify several local water use and conservation practices including recycling the wastewater to water the plants and for cleaning up soot from used pans and pots. However, the elderly village women unanimously stated that indigenous and local water knowledge and practices are declining rapidly since households get piped water supply and people do not have any more motivation and need to save water compared to previous times. Hence, the local practices that were adopted to save water are no more practiced leading to loss of knowledge. The study demonstrates the gap in integration of indigenous knowledge while planning for piped water supply to households. In case of any future disruption in supply, the local people will be in despair as they do not hold the indigenous knowledge anymore. The current study highlights the importance of integrating indigenous water knowledge held by village women into the decision-making process for future water sustainability.

Keywords Water knowledge · Gendered approach · Indigenous knowledge · Local water practices · Water reuse · Sri Lanka

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16.1 Introduction

As of 2021, an age where technology has advanced and a number of countries are highly developed, billions of people still lack access to clean water, which is a very basic need for every human being (Felter and Robinson, 2021). More than 2 billion people live in countries that experience water stress, which is when 25% or more of a country's renewable freshwater resources is being withdrawn (UN-Water, 2021). Consequently, as population continues to grow with water being used and managed in the scenario of business-as-usual, communities facing water stress will continue to grow along with the increase in water scarcity. Water scarcity can be due to water shortage or inability of people to access water, and it is seen to increase all around the world at double the growth of population (UN-Water, 2021). Such shortages can also have a cascade of impacts on ecosystems, biodiversity, agriculture, and food. This can also lead to tensions among regions and countries as they compete for a valuable resource as the scarcity is not evenly distributed around the world. The most impacted by this would be the world's poor who are already facing many other challenges. As such, sustainable use and management and conservation of water are of utmost importance to ensure that freshwater continues to be a renewable resource available for healthy ecosystems and healthy communities.

Traditional practices of water management from indigenous people around the world have developed from their interactions with the natural world and not having access to modern technology. Many countries have still not fully integrated indigenous knowledge in policy planning and decision-making when considering water management and conservation. In countries like Australia, even though effort is being made to be inclusive, there are clashes between western solutions and indigenous knowledge as different aspects of the environment, processes of nature and using natural resources related to water are viewed in different ways (Ayre and Mackenzie, 2013). However, in many other countries, the importance of indigenous knowledge is not studied in depth. A lot of effort needs to be put into gathering indigenous knowledge before its lost and then to preserve it so that it can be used in current and future problems that arise in managing water sustainably (Nianthi and Dharmasena, 2009).

During the International Conference on Water and Environment in January 1992, one of the main outcomes was the agreement that women play a major role in water provision and management but that they hardly take part in water governance, and this has not improved much since (Khayat, 2021). The importance of recognizing the role of women in water management and including them in governance of it can be highlighted from the case in Malawi from the 1980s when the government of Malawi introduced a piped water distribution system to low-income communities as explained by Trivedi (2018) of the World Resources Institute. A committee consisting of 90% men was created to manage community-run taps and collect payments; however, since it was mostly women who stayed home and used the water and the men were mostly not home, the committee did not fulfil its duties. Once a high proportion of women were included in the committee and trained, the payments were done with regular meetings, and access to water increased with redesign of taps, leading the project to success. According to the report by UN Women (Prasad, 2018), in household without direct access to water, 80% of the time, women and girls bear the responsibility of collecting water. This role means that women are more likely to have more knowledge on how these systems work and what the requirement are for an efficient water system that will be taken up by a majority of people. This type of role in collecting water also means that women will have less of a change to pursue a career and girls are hindered in their education process which in turn affects their career path. A study in Ghana found that while women did realize they have a crucial role to play in water governance, they face hindrances in participating due to social and cultural norms in a male-dominated community where men play a bigger role in public (Svahn, 2011). Similarly, data from many other projects around the world show that including women in the decision-making process regarding water will only push the project to be better and successful in achieving its goals (Women for Water Partnership, 2016). Women's knowledge in water management has accumulated for years from them being cast in the roles of collecting and managing water, and they are very specific to local conditions, which is a common feature of indigenous knowledge. Therefore, women's input in water governance is very important as they are better able to recognize issues that are overlooked, leading to better outcomes.

In the past, Sri Lankan women played a specific role in managing water for household needs including livestock watering. This indigenous knowledge of Sri Lankan women is sparsely studied, and women are seldom included in the decision-making process. It has been identified that there is a major lack of data regarding water issues and gender (Athukorala, 2002). Women farmers also still continue to undertake a variety of techniques in farming practices, including irrigation, derived from the indigenous knowledge that has been passed down, and they are well aware of these benefits as per a recent study (Hettiarachchi, 2022). Furthermore, in recent times, women's participation in rural water schemes, which can be seen as business models, has led to women taking up some leadership roles in these schemes but not necessarily as entrepreneurs as there are a number of challenges they face including lack of formal education, family commitments, lack of empowerment, etc. (Donald Sinclair, 2020). Thus, this chapter aims to explore and understand the knowledge currently retained by some indigenous women in Aranayake, in the Sabaragamuwa Province of Sri Lanka, to determine the importance of consolidating such knowledge of indigenous women to better manage and conserve water.

16.2 Research Methodology

16.2.1 Study Area

Sri Lanka has a number of administrative division levels where provinces (the first major division) are divided into districts (administered by a district secretariat). Each district is further divided into 5–25 "divisional secretariat" divisions (DS divisions) and broken down into even smaller administrative units called "Grama Niladari" divisions (GN division) which are a collection of few villages. The area selected for this study was Aranayake, a DS division within the district of Kegalle in the Sabaragamuwa Province of Sri Lanka (Fig. 16.1) and which covers an extent of 122.8 km^2. The Kegalle district has an area of 1694.5 km^2 (Survey Department 2022) where, according to the Department of Census and Statistics (DCS), approximately 47% is cultivated, while 0.96% is taken up by large inland waters, 9% makes up forested areas, and 33.6% consists of home gardens (DCS 2021). High rainfall can generally be observed for most of the year from April to December with peaks in May and October (DCS, 2021).

The Aranayake DS division's main sources of income include cultivation of tea, cloves, and pepper. There is also some paddy cultivation. The major stream of Sabaragamuwa Province, known as Maha Oya, originates in Aranayake and flows out into the Indian Ocean from the west of Sri Lanka. The main sources of water for people living in Aranayake include natural springs, Maha Oya, and piped water from the National Water Supply and Drainage Board (NWSDB). Some people use pumps to pipe water from natural springs to their homes; however, a majority have access to piped water from the NWSDB.

16.2.2 Data Collection

In line with analyzing indigenous women's knowledge on water use in Sri Lanka, the sample was restricted to women over the age of 60. Ten women were interviewed from two GN divisions in Aranayake DS division, namely, Randiligama (four) and Yodhagama (six), as indicated in Fig. 16.1, which cover an extent of 4.73 km^2. Half of the women interviewed were over the age of 80. A structured interview was conducted for qualitative analysis. The questionnaire focused on everyday sources of water for use in the household. The questions aimed to understand the significance of water to women and how its importance and the way water is used have changed over time. The questionnaire also aimed to determine how water availability has changed over time. Specific questions to understand folktales regarding water and local and traditional practices of water use and conservation were also included. Overall, the same eight questions were asked from each person. For some of the women, the question(s) needed to be asked/clarified multiple times due to their problems with hearing or them requiring clarity on the question. The interviews were conducted in Sinhalese and recorded with verbal permission from each interviewee. The answers where then converted to English for analysis.

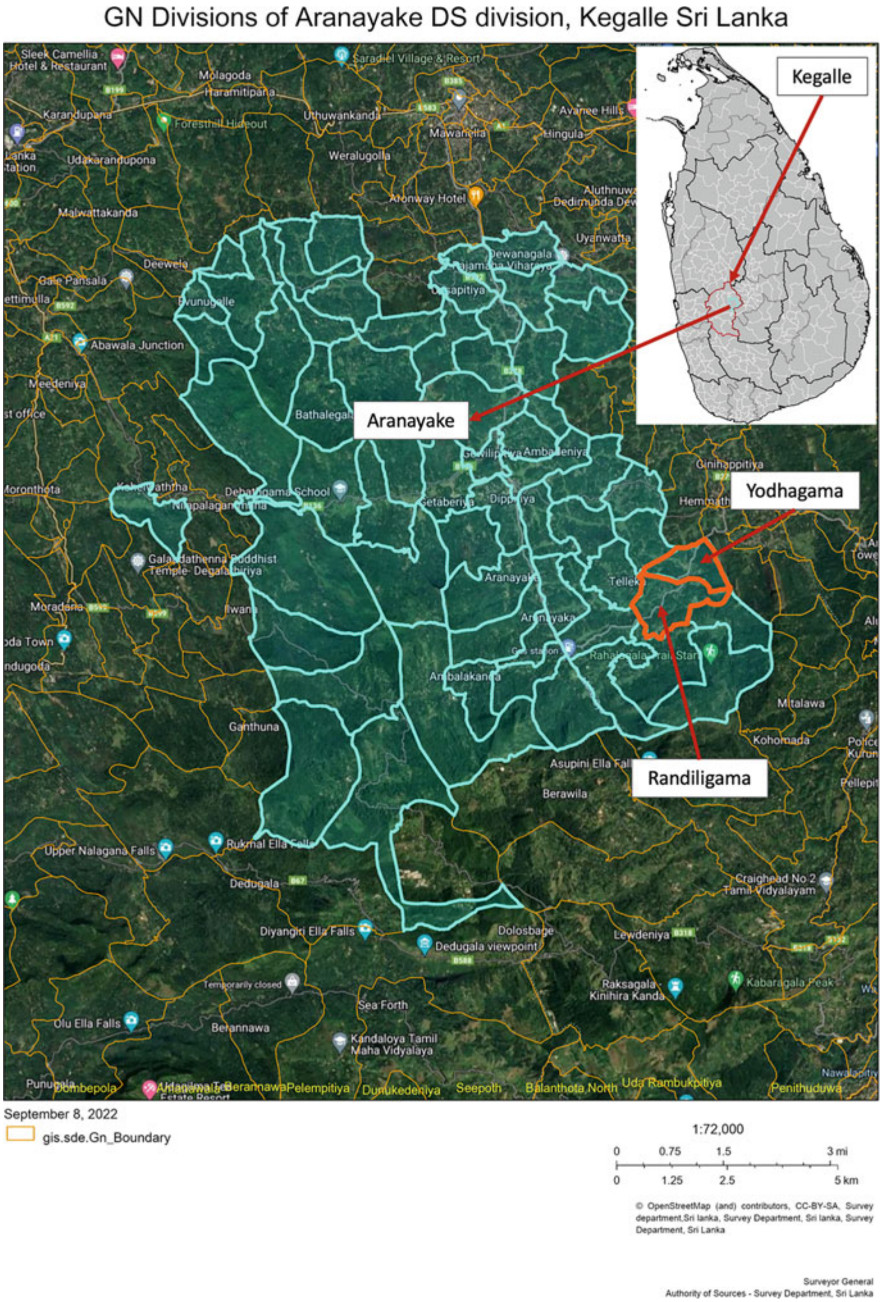

Fig. 16.1 Map of Sri Lanka and location of Aranayake and study area. (Source: Survey Department (2022))

16.3 Results and Discussion

Gender plays an important role in mediating the interaction between human and environment. It often influences the use, knowledge, management, access, and control over environmental resources (Sunderland et al. 2014). Women and men held different knowledge, perceptions, and preferences for environmental conservation, and these may influence which conservation and development options are most appropriate for a given site (e.g., Rao et al., 2003). Women, being the provider as well as highest user of water in household, decide the use, the treatment, as well as the conservation of water for domestic purpose. Due to the different tasks that women perform at the household and community level and the amount of time they spend in their immediate environment, it helps them to acquire knowledge on a range of matters related to the management of water (Mcleod et al., 2018). Women possess significant knowledge on availability of water and practices to use water wisely to minimize losses. Women have a lot of experiences in conserving resources for family as well as community consumption and have a comprehensive understanding of their local surroundings (Shonsey and Gierke, 2013; Carvajal-Escobar et al., 2008).

In the present study, data collected through interviews are analyzed qualitatively using thematic analysis.

16.3.1 "What Is Water to You?"

To explore how elderly women from the study area value water, the first question asked to them is "what is water to you?". The received answer, as expected, was unanimously "Water is life." All the respondents agreed that water is the most essential natural resource required for sustenance and that there is no alternative to it. Water, being the most important natural resource, has always been highly valued, and for women who take care of the daily household chores, water is an integral part of their lives. Understanding the significance of water is the first step toward its mindful use and conservation.

McGregor (2001) reiterated that "water is life" and is considered "a living entity." Several articles also stated that water is life, water is sacred, and water is alive with a spirit (Chief et al., 2016; Cave and McKay 2016; McGregor, 2012). This difference or similarity in understanding what water is is the basis of how different peoples manage, understand, and exist with water.

16.3.2 Changes in Water Values and Availability.

When asked if the value of water has degraded over the years, the elderly respondents unanimously agreed. As now water is available at every household through piped connections, the availability has significantly improved, and women no longer must suffer from the hardships of collecting water from a distance. But, as two respondents pointed out, piped water is sometimes muddy, especially in monsoon season, and not suitable for use. Earlier, when the women used to collect water from wells, they used to never get muddy water. One respondent (age – 65 years) said:

> *We never collected muddy water from the wells. If water in the well started looking muddy or off colour, we used to remove all the water and let the new clean water from the spring collect in the well again. Since we went to the well to collect water, we could also see any issues with our agricultural fields (paddy and vegetables) like water levels and that way we used to be able to protect them as well. But now we can't see such issues since we do not go to the wells often.*

The respondents agree that though the availability has been significantly high, the water values have decreased. With increased land clearing and pollution, water is losing its natural properties, and it becomes difficult to consider them as holy. The contaminated water is not used for drinking or any other purpose; thus, the value of water as a pure resource declines.

16.3.3 Local Water Practices for Use and Conservation.

In rural developing countries, women and girls are recognized as primary stakeholders in household daily activities, including fetching water, cleaning, cooking, washing, and sanitation, as opposed to men (Garcetti and Kevany, 2013). In the current study, the elderly respondents stated different practices that are used for water storage, use, and conservation at the household scale. The use of these local practices primarily depends on the socioeconomic conditions of the household. An elderly respondent (age – 82 years) from Alagalla village stated:

> *We would bring water from the well and filter it into a kettle and boil the water before drinking. Also, the water used to wash rice is reused to wash cooking pots and pans to remove soot. Since we cook on woodfire there was a lot of soot collected on the pots and pans. Since we must walk far to collect water, we try to save water by reusing it.*

Boiling water is a well-known practice for consumption purpose in households with no other water filtering equipment. The reuse of water left after washing rice in removing soot is an indigenous practice adopted by local households. Another respondent (age – 81 years) from the same village responded:

> *When washing dirty pots and pans, dishes, and cups/mug, we follow a certain process. First, we pour clean water into a basin, then we wash the dirty items. After the washing is done, the dirty water is used to water vegetable patches, plants, and trees instead of throwing it out. Then we rinse everything again with some more clean water, and the water from the second*

wash is usually used for brick making when required for any construction around our house. We also use water that has been used to wash rice to wash pots and pans and water plants to save water. We filter water using cloth.

The reuse of water is a common practice by women to save water. As women must collect water from a distance, they are more mindful about the conservation of water. Women are not only adopters of water conservation practices but are also responsible for educating children and supervising family members in performing these practices (Weng and Nitivattananon, 2007).

Another elderly respondent (age – 74 years) from Medhiliya village mentioned about a local technique for collecting rainwater. She stated:

Rainwater is collected into basins by tying branches from Areca nut tree, where the leaves are plaited together, so that water can be directed from the tree to the basin. This water was used for purposes other than drinking.

Though these local practices are not highly specific to the study area, and various rural areas across developing and less developed countries practice similar techniques, the examples cited here help to understand how women value water and adopt practices for its judicial use.

16.3.4 Loss of Indigenous and Local Knowledge

The global discourses about indigenous knowledge and practices of water emphasize on them being lost. Globally, the indigenous cultures are losing at an even faster rate than the loss of species. In the present study, irrespective of the villages, all the respondents agreed to the fact that indigenous and local knowledge are losing rapidly. The respondents explained that piped water supply has made water easily available and that too in sufficient quantity. Hence, the local people do not need to collect water anymore, store them, or filter them. This has led to loss of motivation and conservation attitude among people which in turn leads to the loss of indigenous and local practices that were previously carried out to save water. While piped water supply is one of the major achievements from the water quality, quantity, and health point of view, it has its disadvantages leading to the loss of valuable indigenous and local knowledge and practices, as perceived by the local respondents. At a cognitive level, piped water supply led to a disconnection between people and the indigenous and local water knowledge and practices, causing what Pyle (1993) calls "the extinction of the experience."

16.4 Conclusion

This study presents an account of how water is valued and how it has led to the adoption of different water use, storage, and conservation practices among women. Indigenous and local knowledge about water is highly place-based, which is also evident from the current study. The elderly women under study highlighted the various local water practices that have been conducted to meet the household needs. However, the village elderly women unanimously agreed that these knowledge and practices are going downhill rapidly, more so with the laying off piped water supply. The local people have seemed to experience loss of motivation as water is available abundantly and the need to recycle and reuse water is lost. Availability of water has also led to its wastage. The developmental dilemma is very prominent in this case where a needed developmental intervention leads to loss of highly valuable local and indigenous knowledge. With the loss of this knowledge, in case of any future disparity in piped water supply, the local people are supposed to be in immense despair. Integration of the local and indigenous knowledge held by women to technological development and documentation and sharing of this knowledge is imperative for sustainable water supply to the local community.

Gender refers not only to the literal meaning of women or men but also to their status, responsibilities, rights, and participation in all areas and at all levels of social affairs, which include resource management, public authority, and decision-making. The indigenous knowledge and skills retained by women often differ from the knowledge held by men. These differences are particularly reflective of their daily roles, interests, and experiences. However, females are not usually considered as equals to males in participating in water governance because of gender discrimination, lack of knowledge, tradition, and culture limitations. As a result, the views and feelings of females, as well as gender disparity toward use and conservation behaviors, are consistently ignored in public policies. Such neglect results in inefficient water resource management . Therefore, understanding female views, consciousness, and perceptions toward water use behaviors and gender disparity is essential to formulate effective public policies.

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Chapter 17
Role of Ponds as a Local Practice in Mitigating Salinity Intrusion Threats at Coastal Aquifer: A Case Study from Sundarban Biosphere Reserve, India

Abhiroop Chowdhury, Raghav Prakash, Santanu Bhattacharyya, and Aliya Naz

Abstract Ecological knowledge plays a fundamental role in defining water conservation practices. Due to climate change and sea level rise, coastal aquifers are under salinity intrusion threat. In developing nations across the globe, coastal communities are dependent on groundwater for irrigation and drinking purposes. This chapter looks into the water harvesting methods used by local communities and their utility in augmenting livelihood systems of local communities. The Indian Sundarbans is the world's largest contiguous mangrove forest, which is home to about 4.6 million population along with mangrove dwelling tigers. Unlike other forest areas, the Sundarbans do not have an indigenous population. The settlements in the Sundarbans can be traced back to the British colonial period (1905). They brought with them their traditional water harvesting systems. Household ponds are an essential part of the Sundarbans. Most of the landed farmers favours maintaining at least one small pond in their backyard. Pond management systems are one of the resource effective and cost efficient tools to address the issue of water security, household food security and augment economic conditions. Additionally it

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retains the monsoon precipitation, eventually recharging the groundwater and ameliorating the salinity intrusion threat. A socio-environmental project at 2017–2020 has commissioned 139 old pond re-excavations and 42 new pond excavations at the Indian Sundarbans. Baseline data on water quality when compared with post re-excavation results showed a drop in salinity (37%) in the groundwater levels near the pond sites along with providing water security for integrative farming methods. This proves that the local pond management system can play a prominent role in managing the salinity intrusion threat in coastal regions as well as play a key role in achieving the UN Sustainable development Goals (SDGs) in the remote, socio-economically marginalized coastal regions across the globe.

Keywords Climate change · Sea level rise · Salinity intrusion · Pond management · Water harvesting · Integrated farming

17.1 Introduction

Water bodies such as ponds play an integral role in the lives and livelihood of marginalized communities residing along the coast lines in tropics/subtropics. One of the major climate change hazards is the intrusion of salt water in the coastal aquifers and estuarine water bodies (DasGupta & Shaw, 2015). Sea level rise and receding glaciers, the source of perennial rivers, are resulting in pumping of salt water in the estuaries and deltas (DasGupta & Shaw, 2013). A study by Chowdhury et al. (2021) showed increased salinity trends along the Indo-Gangetic delta in both surface and groundwater. Water harvesting systems are part of culture and tradition for different coastal communities of the Indian subcontinent. These water harvesting structures not only help in the recharge of groundwater and soil but also play a pivotal role in the economic conditions of the community. With focus on Sustainability Development Goals (SDG), and green livelihood alternatives, household water bodies have been seen as an excellent way to manage the vagaries of climate change (such as rise in salinity) as well as a gateway to different livelihood options.

The UN Sustainable Development Goals (SDGs) were established to achieve targets to make the Earth a green, pollution-free, and poverty-free space. Amongst the SDGs water harvesting system can address following goals-SDG-1 (No poverty), SDG-2 (Zero hunger), SDG-3 (Good health & Well-being), and SDG-10 (Reduced inequality). These target the socioeconomic upliftment of residential communities. The Indo-Gangetic Delta is the world's largest, most populous, and extremely vulnerable disaster-prone region of the globe. Here, conservation collides with the need for a decent livelihood, economic well-being is hindered by repeated natural disasters as well as ever-changing landscape, and development confronts the ideas to preserve the unique wildlife. Achieving the targets of UN-SDGs is vital in order to envision a sustainable society. This is also the home to the world's largest contiguous mangrove forest and the home to about 4.6 million populations along with 96 mangrove dwelling tigers. Unlike other forest areas, the Sundarbans does not have an indigenous population. The settlements in the Sundarbans can be traced back to the British colonial period (1905). Populations from different parts of India, Bangladesh, and Myanmar were brought into this coastal wetland infested by Malaria-causing mosquitoes, crocodile, and tigers to clear the mangrove for starting agricultural cooperative (Harms, 2015). They brought along with them their traditional agriculture and water harvesting system. Household ponds are an essential part of the Sundarbans.

Salinity intrusion is a major problem in all the coastal regions across the globe. Climate change results in melting of glaciers that increases the sea level across the global oceans. This in turn increases the intrusion of salt water in estuaries and delta, shifting the freshwater–saltwater balance towards the later. Hence salinity intrusion is one of the key indicators in sea level rise in estuarine, deltaic regions. Water holding structures can recharge the groundwater and create an effective barrier against saltwater intrusion. As per Ghyben-Herzberg equation, there exists a balance between fresh water in the aquifer and the intrusion of salt water from nearby sea/coastal premises. Hence, when too much fresh water is extracted out of the aquifer, it facilitates the intrusion of salt water by destabilizing the freshwater saturation of the aquifer (Chowdhury et al., 2021).

This chapter focuses on local ponds and their role as a barrier to saltwater intrusion in coastal regions as well as providing possible livelihood augmentations for the socio-economically marginalized communities. This work also highlights case studies where the construction of the water holding structure at the Indian Sundarbans has decreased salinity trend in nearby groundwater.

17.1.1 Pond-Based Farming

Pond-based farming has helped sustain lives for the coastal communities. Laapo and Howara (2016) worked on how the communities in the Indonesian region were involved in both monoculture and polyculture farming (Laapo & Howara, 2016). A study conducted by van Brakel et al. (2003) suggested how five broad categories of capital underpin household livelihood—physical, social, human, natural, and financial. Ponds come under the umbrella of natural and physical assets depending on if they are unimproved or improved. The study indicated the fact these household ponds can have several utilities, for instance, if farmers grow crops/fish/livestock for their need (Human), but if they use it for reducing the price of another commodity, it is finance (Financial) (van Brakel et al., 2003). The researchers shed light on how ponds are essential when social obligations are high. In coastal areas, ponds are considered more efficient in harvesting fish even where fish are found in abundance. This study suggested how household ponds in some areas of Africa are seen as a social symbol and a prized asset.

A study highlights how farmers could store water post-monsoon season in a pond in Aliba Mokukchung, Nagaland. The stored water was further used to irrigate the crops in the area. The farmers also shared how their yield was more by Rs. 27,500/Ha than earlier yields (Chowdhury et al., 2016). Rabbani et al. (2018) showcased the important part ponds play in the coastal zones of Bangladesh. This work expressed how climate change-induced cyclones are wreaking havoc in the city's coastal area. Another issue the coastal communities face is high salinity in the ocean waters, making it challenging to grow crops, though, with ponds in the area, the growth of crops, livestock, and fish has become very efficient. This work has also been presented by the World Fish Center, which suggests that the ponds produced approximately 0.8 million tonnes of fish in 2006 and aided in the development of winter crops (Rabbani et al., 2018).

Furthermore, the nourishment of the fish is done by the women of the coastal community, which keeps them productively engaged. The farmers are also earning a livelihood from pond-based farming as they sell the fish in the area. Rabbani et al. (2018) shed light on how these ponds are crucial for the disadvantaged group as a primary or secondary source of livelihood. Farmers are now growing various fruits and vegetables due to the growing demand, for instance, watermelon. Water is taken from the ponds located nearby in the vicinity and used for cultivation. Moreover, the researchers detailed how, on the southwest coast, most farmers have a small pond that helps them sustain their livelihoods. This study established how these ponds support 96% of the families for everyday water usage. For instance, chores like cooking, drinking water, small-scale irrigation, washing clothes, etc., are done through pond water (Rabbani et al., 2018).

Different pond-based livelihood options and integrative farming systems are depicted in Table 17.1.

17.1.2 Integrated and Traditional Farming

Integrated and traditional farming uses multiple farm enterprises like horticulture, forestry, fishery, livestock, and the farmer's ability to sell them for profit (Singh et al., 2018; Sharma & Chowdhury, 2021). A study conducted by Alam et al. (2009) recorded how traditional pond integrative farming is an aid for income in rural populations. Rautaray et al. (2013) indicated how pond-based farming is helping in creating job opportunities for the rural population, increasing farm income, and improving soil health. Furthermore, this study highlighted how it is beneficial to encourage biodiversity, minimize risk, and promote a healthy ecosystem (Rautaray et al., 2013).

17.1.3 Problems Faced by Coastal Communities

Coastal communities host more than 40% of the world's population in a radius of 100 m (Flagg et al., 2019). This population pressure is now becoming a socio-economic-environmental issue for the coastal communities. The ever-growing population poses a threat to the coastal area. An article by Pavithran et al. (2014) opined

Table 17.1 Pond-based livelihood options adopted and studies by various coastal areas in India

S. No.	Location	Pond-Based Livelihood Options	Remarks	References
1	Vaniyamkulam panchayat of Palakkad district, Kerala	Horticulture and fish farming	This study suggests how integrated farming is an essential mode of farming. In the area of Palakkad district of Kerala, pond-based horticulture cum fish farming is practiced. It was observed how the method was very successful in the area in terms of money making. The researchers shared how before integrated farming the production of vegetables was 4000kgs but after it was 6000kgs in a year. Moreover, pisciculture also displayed positive results, before integrated farming it was 500kgs and after 700kgs in a year.	Lekshmi et al., 2022
2	Tripura, India	Fish farming	The article talks about integrative pond-based farming and the constraints with the usage of such a model. The study highlighted a few constraints—Not having a clear idea of how to integrate crops and livestock etc. near the pond: Inadequate training support in the subject, etc.	Singh et al., 2018
3	India, eastern Himalayan region	Rice, vegetables, fruits, fish, pigs, poultry, and goat	The paper shows how 11 pond-based IFS models were studied to see the benefits and risks with IFS. The best pond model was the one with rice (pond+ rice+ vegetables+ pig integration, 4.04MG). The returns were the highest in this model—INR 23,900/ year.	Das et al., 2013

(continued)

Table 17.1 (continued)

S. No.	Location	Pond-Based Livelihood Options	Remarks	References
4	Tropics	Pig, poultry, vegetables, and fish	This work explains how the different methods of integrative farming give varied results. For instance, many methods for increasing production were detailed—To increase farm area or to increase yield per unit. Furthermore, the researchers shed light on which fish species are considered best for aquaculture.	Edwards et al., 1988
5	Odhisa, India	Rice, vegetables, fruits, fishery, dairy	The paper delves into the economic aspect of the integrative farming system. This study describes how an investment of Rs. 18,515 gave a gross income of Rs. 66,540/. Further, it was detailed how the purpose of IFS is to create employment opportunities and at the same time increase yield.	Behera et al., 2010
6	Coastal states of India	Rice, ducks, livestock, fish	The paper provided an in-depth study on how coastal communities must use integrated farming systems. This work highlighted how small and marginal farmers are having maximum benefit. For instance, integration of crop (0.80 ha) with pigeon (10 pairs on 0.01 ha), goat (5 female +1 male on 0.05 ha), agroforestry (0.10 ha), and farm pond (0.04 ha) were seen to be a great alternative farming with recycling of the composted goat manure. The researchers give several methods of ISF that can be used to	Behera & France, 2016

(continued)

Table 17.1 (continued)

S. No.	Location	Pond-Based Livelihood Options	Remarks	References
			improve livelihood of coastal communities.	
7	Himachal Pradesh (Una, Bilaspur, Kangra, Mandi and Kullu), India	Livestock, cereal, fodder, fruits, and vegetables	The particular case study talks about how IFS is in 4 specific districts of Himachal Pradesh. In districts Una and Bilaspur, livestock-based farming and then cereal-based farming gave the best output. In these zones 63.9% and 59% farmers were dependent on livestock-based farming; and 33.3% and 36.8% farmers were dependent on cereal-based farming. In zone 3 72.2% of the households were dependent on fruit farming which was followed by vegetable farming which was 23.6%. The maximum share in the gross income was by (1) fruits (36.4%), (2) livestock feed production (28.77%), (3) cereals (23.28%), and (4) vegetables (8.11%).	Rana, 2015
8	India	Mangroves, fish farming, and halophyte plantation	This study has presented various models and given the benefits and challenges associated with integrated mangrove fish farming (IMFF). The method mainly deals with growing fish and halophyte plantation in the pond. It was seen how mangroves (when grown to the age 4–5 years) act as natural barriers against and provide the fish/prawn/crab with nutrients. Furthermore,	Aggarwal & Lal, 2009

(continued)

Table 17.1 (continued)

S. No.	Location	Pond-Based Livelihood Options	Remarks	References
			matured leaves and twigs which fall in the pond provide the fungus and bacteria with detritus which they can grow on. Lastly, it was seen how halophytes can be grown on top of bunds which are grown for commercial purposes.	
9	Xuan Thuy National Park, Vietnam	Integrated aquaculture mangrove (IAM), intensive shrimp (ISH), and rice-based farming (RB)	The paper provides an in-depth study of different farming systems in the coastal zones of Vietnam. In the study, it was recorded how IAM has the lowest yield.	Nguyen et al., 2019
10	Malaysia	Fish farming production	The paper provides extensive research on fish farming production. Researchers presented fish intensification methods: (1) addition of an energy-rich feed like rice bran or cereal. The yields with duck and fish farming reported a low count, i.e., 1.5–4.7 tons/ha/year. Commercial farms in Taiwan with rice bran feed displayed a higher yield of 13.5–18.0 t/ha/year. (2) the alternative method is stocking a higher initial biomass and intermediate harvesting as the growth curve starts to decline.	Siaw-Yang, 1992
11	India	Aquaculture	The article highlights the research on aquaculture—Problems and contribution to farmers. The study shed light on how aquaculture in India has benefited farmers and increased their income. The data	Ponnusamy & Gupta, 2009

(continued)

Table 17.1 (continued)

S. No.	Location	Pond-Based Livelihood Options	Remarks	References
			depicted how an increase of Rs. 9000–200,000 could be achieved (depending on tools and farm enterprises). Additionally, integration of cropping with allied farm enterprises like fisheries is seen to give a much higher net return.	
12	India	Rice, vegetables, horticulture, poultry, and fish	This study sheds light on how integrated farming systems are a great source of livelihood and income generation in the rural sector. The arguments were supported by data found from the research. The researchers shared how there is an increase by 2 to 3 times in production and 3 to 5 times in net returns while using IFS. In this case, resources are also being saved and this can further increase the income by Rs. 400–500 per household.	Sharma, 2021
13	Khordha district of Odisha, India	Fish, vegetable, fruit, flower, horticulture	This study has presented an in-depth study using the case study approach. A total of 3 case studies have been discussed using different methods of IFS. The maximum returns were seen in case 1—Fish-vegetable-fruit-flower-mushroom integration. The owner has 0.8 ha of land and earned Rs. 5,19,600 by growing fish, seed, vegetables (bitter gourd, snake gourd, pointed gourd, cucumber), fruits (mango, papaya), flower (marigold), mushroom	Dash et al., 2015

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Table 17.1 (continued)

S. No.	Location	Pond-Based Livelihood Options	Remarks	References
			(paddy straw mushroom).	
14	Gerua Assam, India	Rice and fish	This study was conducted in the year 2002 for knowing how beneficial rice and fish integration is for increasing the income of farmers in lowland rainfed areas of Assam. The researchers shared how in an area of 5000 m^2, approximately 11,226 INR was profit when rice and fish were cultivated. An additional benefit was the creation of employment for 350 men.	Rautaray et al., 2005
15	Dilla Zuria Woreda	Fish, poultry, and vegetables	The paper presents how fish farming integrated with poultry and vegetables is beneficial for farmers. The researchers had conducted field research and detailed on the fact: Land size for integration 0.0224 ha, for fish there is (1) 0.0048 ha, the poultry house was (2) 0.0036 ha with 20 hens and white leghorn breed, (3) 0.014 ha for vegetables, and (4) 0.224 ha for mono farming of vegetables. The net present value was found to be 8.5% discount rate. This gave birr 622 per 0.0224 ha which was acceptable. The profit in this case could be of Rs. 29619.05 birr/ha.	Garade & Ketema, 2016
16	Mekong Delta, Vietnam	Shrimp and mangroves	This work indicates how shrimp and mangrove integration has become a success in the Mekong	Binh et al., 2008

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Table 17.1 (continued)

S. No.	Location	Pond-Based Livelihood Options	Remarks	References
			delta of Vietnam. It was recorded by the scientists how there was a net return of USD 362 ha/year with the method of shrimp and mangrove farming in the Mekong delta. In a different region the return was lower—320 ha/year. This work also highlighted how the profits ranged from USD 109 to 412 ha/year. It was highlighted how both the coasts had mangroves which were giving highest returns (net profit was USD 314 and 412 ha/year for the east and west coast, respectively).	
17	Cambodia, Bangladesh, Vietnam, and Myanmar	Rice and fish	This study focused on the importance and benefits provided by the integrative farming of rice and fish. A total of 4 case studies of different locations highlight the rice-fish integration farming system. The benefits of rice-fish integrative farming are numerous: (1) making use of scarce water and land resources; (2) maintaining biodiversity; (3) reduction in the use of agrochemicals for the production of rice; (4) providing local food and nutrition security.	Freed et al., 2020
18	Ri-Bhoi district, Meghalaya	Crop, fish, pig, and duck	The researchers have conducted research for generating results on how integrative pond-based farming is beneficial for small and	Das et al., 2013

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Table 17.1 (continued)

S. No.	Location	Pond-Based Livelihood Options	Remarks	References
			marginal farmers. This work provided data on how pig and duck based MUW (multiple use of pond water) through diversified farming (fruit, crop, livestock, and fishery) helped an increase their income. It also reported that net return was increased by Rs. 28,250 and 20,350 which were more than 284% and 196% respectively as compared to farmers without intervention. The MUW interaction of crop-fish-livestock also increased employment from 52 to 67 men in the field.	
19	Orrisa, Bihar, Assam, West Bengal, India	Rice, fish, poultry, livestock, vegetables	The work has taken different locations to assess how Integrated Farming System (IFS) has been aiding in the income and employment generation in the coastal areas of India. A total of 4 case studies have been presented. Taking the case of Assam: (1) operational cost Rs. 33,156 (rice, fish, and horticulture + farm construction); (2) gross returns Rs. 44,382; (3) net return Rs.11226. This is showing how IFS were able to increase the income for the population of Assam and the other locations as well.	Sahoo et al., 2012

that coastal communities are plagued by problems such as sand mining, natural disasters, loss of land due to coastal erosion, etc. Sand mining is a significant threat to the community; many issues have arisen due to the loss of sand. It was seen how the water tables have reduced, the biodiversity in the river has been affected severely, and reduced water holding capacity. The immense need for sand is to cater to the need of the construction and real estate industry. Authors detailed that India would need to spend approximately $500 million to construct infrastructure in the region. Mangroves are a natural barrier against sea level rise and high-speed winds in coastal areas, though, in the coastal regions of Kerala, only 50 sq. km of mangrove forests are present. Such a massive decline in the cover is due to sand mining, growing population, prawn farming, dumping of wastes, etc. (Pavithran et al., 2014).

In a study by Shammi et al. (2019), it was opined that saline water is a pressing issue in the coastal aquifers. The researchers expressed how it is a significant issue as rivers and canals are affected by saline water which ruins the fresh water bodies. The mega delta coastal areas like Vietnam, Bangladesh, India, etc., are most at risk. The surface and near-surface drinking water are most susceptible to contamination by saline water. This issue is frightening as the communities face multiple health problems: high blood pressure, hypertension, etc. The researchers shared that there is a significant amount of sodium, above permisible concentrations, found in the population pool, exposed to drinking water laced with salinity contamination. They shared how drinking water sodium (DWS) has numerous health effects, especially on pregnant women. A study recorded how approximately 20% of adults and 40–65% of elderly suffer from hypertension (Shammi et al., 2019). This problem is intertwined with sodium consumption, found in the water. Mahmuduzzaman et al. (2014) recorded that approximately 105.6 million hectares of coastal land were affected by saline water intrusion in 2009. Sea level rise is a threat to the coastal communities as it affects the livelihood and habitat of these communities. According to UNEP, the sea level will increase by 1.5 m in 2030 in Bangladesh, affecting 22,000 sq. km area. The World Bank shared how there will be an increase of 10 cm, 25 cm, and 1 m of seawater in 2020, 2050, and 2100 respectively.

A study conducted by Miah et al. (2020) opined how salinity intrusion is rapidly spreading and hampering coastal agriculture. The researchers elaborated on how the coastal areas of Bangladesh like the Bagerhat, Khulna, Sathkhira, and Jessore districts face the brunt of salinity intrusion. This study also reported how the saline aquifer had penetrated approximately 151 km in the Khulna region. Miah et al. (2020) detailed that year-round crop production and diversified crop cultivation have been ruined due to soil losing the yield capacity.

Moreover, the number of fruits and forest trees is being significantly reduced—for example, fruit trees like mango, date, palm, and betel nut decrease in number. The biggest issue remains food security. The coastal lands of Bangladesh are affected by less cultivable land, scarcity of irrigation water, and unfavorable climatic conditions. It was recorded how southwest Bangladesh is the critical factor for food induction as it brings in an excellent quantity of salt to the crop's soil and roots. This results in crop reduction due to the osmotic process, which induces large-scale plant growth and development problems. Researchers conducted a study and found that yield has been reduced by approximately 14.05 lakh tons which are 40–60%. These crops were cereals, potatoes, pulses, oilseeds, etc. These issues are now being worked on by using household integrative farming practices. Pond farming has given women more economic status and reduced household food expenditure. The fish produced by the population is for self-consumption and sale.

17.2 Case Study: Household Ponds and Salinity Reduction

The Sundarbans is the world's largest mangrove contiguous forest and ecosystem. It covers the southern bulk of Ganges-Meghna-Brahmaputra delta system. The mass settlement in this region began during the British colonial period (1860–1947). Socio-economically marginalized people were transported to Indo-Gangetic delta from different regions of India, Bangladesh, and Myanmar. Reclamation of islands started around 1903 under the cooperative initiative of Sir Daniel Mackinnon Hamilton, which is still continuing. During partition in 1947 and later during 1970–1975, socially marginalized (lower caste Hindu or Muslim) refugees from Bangladesh settled here. Hence, the Sundarbans do not have any "traditional forest" communities unlike other forest locations across south-east Asia. Settlements came at the expense of the mangrove forests. Settlers brought their cultural traditions along with them.

Household ponds are popular in the region as a ready source of fresh water in the islands surrounded on all sides by salt water. The water is also used for agricultural practices as well as pisciculture. In view of this, a social project was initiated in 2017 that focused on rejuvenating the pond-based water holding systems.

Old ponds have been re-excavated while new ponds were also established as a part of the project at 3 Revenue Villages in Chhoto Mollakhali Gram Panchayet, 2 Revenue Villages in Amtoli Gram Panchayet, and 7 Revenue Villages in Satjelia and Lahiripur Gram Panchayets of Gosaba Block (Figs. 17.1 and 17.2).

In 2020, a total of 23 old ponds were re-excavated and 7 new ponds were excavated. During 2019, a total of 72 old ponds were re-excavated and 22 new ponds were excavated under the project. During 2018, a total of 44 old ponds were re-excavated and 13 new ponds were excavated under the project.

Therefore, a total of 139 old ponds were re-excavated and 42 new ponds were excavated under the project between 2017 and 2021. The total area of cultivation for the beneficiaries of pond excavation and re-excavation is 3.4 hectares; among that 2.2 hectares for paddy cultivation and 1.2 hectare for vegetable cultivation.

As depicted in Fig. 17.2, the pond water is being used for various livelihood initiatives. It is used as a primary freshwater source during the dry summer months at the Indian Sundarbans. Rivers surrounding the islands carry saline water, making it unsuitable for agricultural usage. Hence, ponds and groundwater are the only option left for the marginalized farmers to procure fresh water to irrigate their fields. With pond water available, overexploitation of groundwater resource is also minimized, putting less pressure on already salinity intrusion affected coastal confines and unconfined aquifers. The water is used for integrative farming including duckery, pisciculture along with watering the agricultural plots. Hence, it helps to improve the

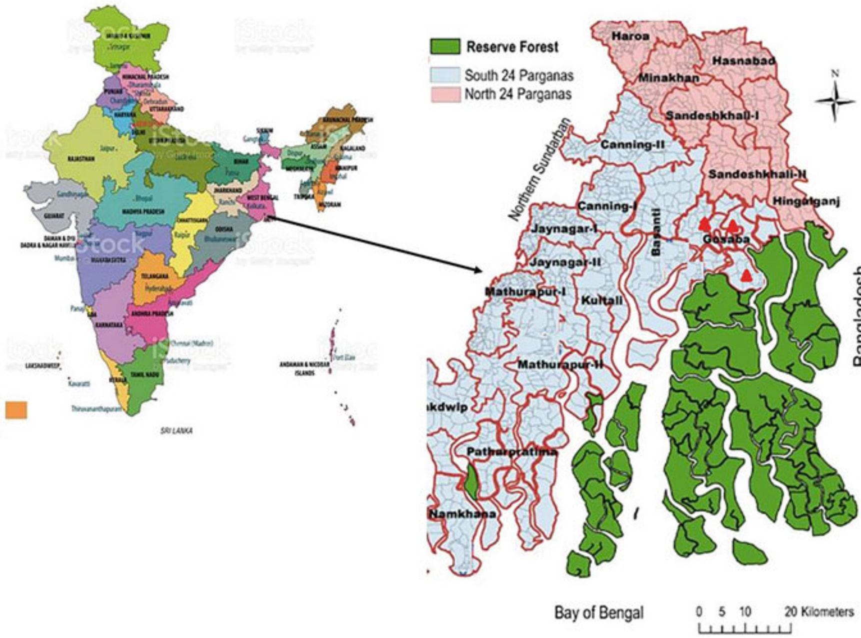

Fig. 17.1 The area of the Indian Sundarbans has been zoomed out from the map of India and in the map of Sundarban Biosphere Reserve; the intervention areas for pond excavation/re-excavation have been highlighted by red-colored triangles

nutritional security of the local population as well as providing an option to procure access to liquid cash.

17.2.1 Impact of Pond Structures on Groundwater Salinity

Salinity assessment has been performed during pre-monsoon (May), at the sites (S1 = Chotto-Mollakhali, S2 = Amtoli, and S3 = Satjelia island) near the ponds (tube wells) every year between 2017 and 2020. Changes in salinity profile in the region are assessed using the Mohr-Knudsen method (Strickland & Parson, 1972; Chowdhury et al., 2021). Measurement is done in a day ($n = 3$). Then salinity is calculated from the chlorinity data using the formula,

$$\text{Salinity (S)} = 1.805\text{Cl}^- + 0.03\ \text{g/kg}$$

pH was measured by a multiparameter pH probe (HI-2020, Hanna Instruments, India). The average salinity and pH of the sites have been calculated by taking the mean of the data from the three sites, and linear regression has been used to record the changes in salinity and pH trends from 2017 to 2020.

Fig. 17.2 The pond excavation and benefits from a pond established as a part of the social intervention at the Indian Sundarbans have been elucidated. (**a**) The excavation of new pond is in progress in the island of Satjelia, (**b**) the pond is helping the locals to sustain their freshwater needs as well as duck farming, (**c**) the water of the pond is being used for integrative farming during dry months (summer), and (**d**) production of chili plants during winter as a part of integrative pond-based agri practices

The changes in salinity profile are being elucidated in Fig. 17.3a–d.

It is evident from the investigation that after the construction of the ponds in 2018, there has been a steady decrease in salinity trends in the nearby groundwater. It is already a known fact that water harvesting structures play a role in decreasing the salinity intrusion in the deep and shallow aquifer, which is also proved by this investigation. Both average pH and salinity are seen to in a decreasing trend near the water bodies constructed/restored in the villages.

17.3 Conclusions

Water harvesting structures have played a significant role into the lives and livelihood of marginalized communities residing along climate change vulnerable coasts. Pond structures are popularly used for integrative/sustainable agri practices along the coastlines of India and other tropical/subtropical developing nations. Another service of local pond-based water harvesting structure is to reduce instances of salinity

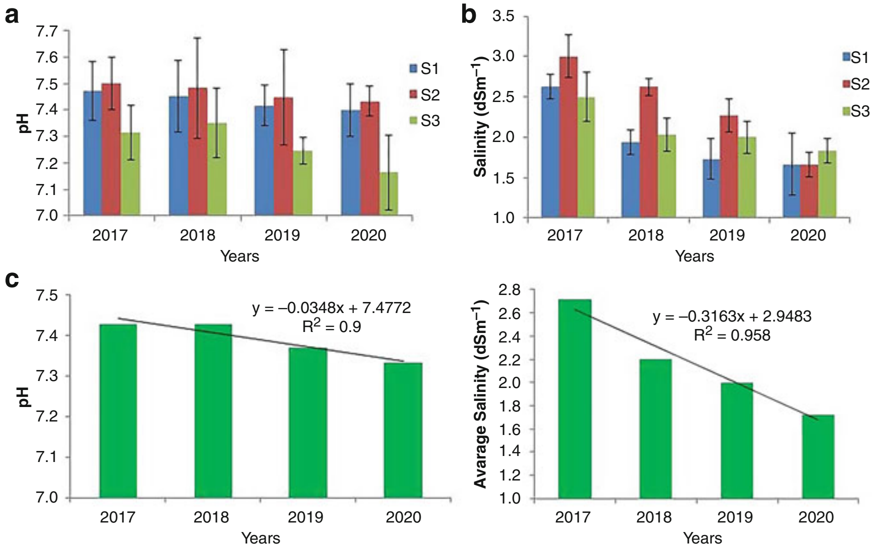

Fig. 17.3 The pH and salinity profile has been elucidated before (2017) and after the excavation/re-excavation of ponds. (**a**) The pH profile of groundwater collected at three intervention sites during the summer season 20 ($n = 3$, Error bar = +1 SD), (**b**) average salinity profile of groundwater collected from three sites at summer month between 2017 and 2020 ($n = 3$, Error bar = +1 SD), (**c**) the trend in changes of pH in the region after construction of the water bodies, (**d**) the trend in changes of salinity in the region after construction of the water bodies which shows a clear decrease of salinity in the groundwater collected near the newly constructed/re-excavated water bodies

intrusion in the deep/shallow aquifers. Salinity intrusion is a major concern across ground and surface water across the Indian Sundarbans. Research has revealed that over the period of 4 years there has been a reduction of average groundwater salinity from 2.7 to 1.7 dSm^{-1}, in the vicinity of the excavated/re-excavated ponds. Local communities are dependent on the pond for their access to fresh water. The use of pond water in agriculture reduces the instances of over-exploitation of groundwater reserves of already stressed coastal aquifers. The communities use pond for various purposes, foremost among them are pisciculture and duckery. This helps to achieve the United Nations SDGs: SDG-1 (No poverty), SDG-2 (Zero hunger), SDG-3 (Good health & Well-being), SDG-10 (Reduced inequality). These pond structures are key to achieving economic sustainability and conservation targets in coastal regions. The case study highlights the following achievement along with the reduction of salinity in the nearby aquifer. Hence, water harvesting structures need to be promoted not only as an alternative livelihood support initiative but also as a barrier against salinity intrusion (indicator of climate change–sea level rise) along coastal regions.

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Chapter 18
The Water Cult and Conservation in India

Deepak Singh and Hari Charan Behera

Abstract Water has been one of the fundamental conditions for the growth of life on the planet earth. Growth of human civilization went hand in hand negotiating and forming the water cultures in sync with religious orders across the globe. The Indian sub-continent has also seen the growth of different cultures and way of life across the banks of rivers and water bodies. These were embedded in socio-religions and cultural system. All this had unbroken tradition till the arrival of modern technologies and water harvesting systems. The uncontrolled expansion of technology-intensive planning bereft the cities and villages of traditional water systems, which were the result of centuries-old human-nature negotiations. Slowly, on the name of economic expansion, both rural and urban areas have started overpowering the water culture's body-soul relationship, i.e., separating culture from the water.

Keywords Cultural value · Water · Sacred water · Water conservation · Indigenous knowledge

18.1 Introduction

With notions of purification and socio-religious sanctity attached, the traditional societies revered water as a living entity (Erbil & Mouton, 2012; Hã, 2007; Lawrence, 2006). The Hittite texts attest to the idea of a water-centric sacred cult bestowed to the rivers and the spring goddesses (Erbil & Mouton, 2012). The traditional Indian societies also rhyme the similar ritualistic node which connects its water systems with civilizational ethos (Bhargava, 1987). The sacred values attached to the Indian river systems such as the Indus (earlier Sindhu), the Ganges,

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the Brahmaputra, the Narmada, the Kaveri, the Godavari, and the Tapti are well known (Agoramoorthy, 2015; Warrier, 2014).

For revered hermits and saints like Buddha, Guru Nanak, Kabir to Adi Shankaracharya, the water bodies of India have been an apostle of syncretism (Lorenzen, 1987; Sharma, 2012). On its banks and pavements, numerous sages meditated, preached, and professed the message of universal togetherness. Many cultures and traditions like the "Ganga-Jamuna Tradition" (in doab of rivers Ganga and Yamuna) have flourished for centuries on these fertile plains (Safvi, 2014). Even the term *Hindu*, which symbolically ascertains the idea of multiculturalism than the monochromatic manifestation of religious identity, is derived from the river *Indus*, i.e., the cultures prevailing beyond the eastern banks of the river Sindhu (Safvi, 2014; Thieme, 1970).

Along with the saints and their enlightened thoughts, the socio-religious sanctions of the pilgrimage economy were also centered around the banks of major Indian rivers. The temple towns like Rishikesh, Haridwar, Prayagraj (formerly Allahabad), and Varanasi are the striking examples in this context, whereas the *Kumbha Mela* (Fair) is one such largest congregation held in a cycle of 4 years at four different towns located on the banks of ancient rivers, viz., Prayagraj (at the confluence of the Ganga, Yamuna, and Saraswati rivers), Ujjain (river Shipra), Haridwar (river Ganga), and Nasik (river Godavari) (Chauhan, 2011; Dwivedi et al., 2020). This establishes a major connection between masses, rituals, and the water systems in the Indian society (Cole & Kanit, 2010; Hughes, 2002; Moorthy, 2016; Sharma & Shruthi, 2017).

The inherited traditions of the holy dip in rivers, lakes, and ponds have further developed sacred cultural complex for Hindu, Muslim, and Sikh communities (Desai, 2016; Lowry, 1983; Sarkar et al., 2019). Several such alive cultural traditions highlight the centrality of water resources in religious discourses. For instance, in Odisha, the Chandan Yatra, a yearly religious procession, at the Narendra Tank around the Puri Jagannath temple is another striking example. Every year, this event is celebrated for 3 weeks in which the representative idols of Lords Jagannath and Balabhadra along with their sister Subhadra are taken in a procession from the Lion Gate of the Sri Jagannath Temple to the Narendra Tank (Rath, 2004). Thereafter, the deities are placed on two well-decorated boats for an evening cruise of the tank.

Water systems like tanks and ponds around the pilgrimage routes also have a conservatory message. The *Pushkar* is a place in the Ajmer district of Rajasthan known for its great cultural significance for the pilgrimages (Mishra, 1999). And the *Pushkar Snan* (the holy dip in the Pushkar lake) is another sacred practice. Bathing in *Lake Pushkar* marks a special significance especially during Makar Sankranti Festival (marking the first day of astrological transition of Sun into Capricorn's influence). And within the same Ajmer district, the Chisti Dargah Sharif also has a huge pond in its complex used for *wazoo* (purification practice before entering the shrine). Similarly, in Sikhism, the ponds (Sarovar) in the Gurudwara complexes of Sri Harmandir Sahib/Golden Temple (Amritsar) and Gurudwara Hazur Sahib Sachkhand (Nanded) are indicative of close relationship with water cult. And in several Indian churches, the priest sprinkles the holy water at the end of the mass, and the visitors touch the holy water.

In India, water bodies share a sacrosanct relationship with festivals too. For instance, the *Chhath Puja* is a popular week-long festival also associated with ritualistic baths and nature worship during the early winters (October–November) in the eastern parts of India (Bihar, Jharkhand, and Eastern Uttar Pradesh). The community members observe fast to seek the Sun God's divine intervention for healthy wellbeing, by largely offering proceeds of agrarian origin like fruits, flowers, and sweets made from grains and dairy products (Singh et al., 2016). Weeks before the festival, the members of society customarily perform a cleanliness drill of the water ponds and the river banks (Pahariya & Patil, 2020). During the festival, the whole area is lighted with earthen clay lamps and adorned with *rangolis* (decoration pattern with colors and flowers).

18.2 Culture Discourses of Water

Across the socio-cultural landscape in different geographies, the water bodies and religion have developed a metaphysical relationship. The concept of *Apāṁ Napāt* (*The Water Child*) in the Indian Vedic texts corroborates to the value attached to religious narratives with water (Findly, 1979; Magoun, 1898). In Southwest Asia, the Jordan river is adored for the Baptization of Jesus Christ by John (Kala, 2017). Similarly, the Greek gods of water like Amphitrite and Poseidon attest the cross-cultural similarities (Shaw, 2005). For instance, Poseidon's son Percy Jackson has the power of hydrokinesis, and Achilles is indestructible as his mother Thetis dipped him in river Styx. This highlights the strong socio-religious roots in different civilizations where notions of science, conservation, and mysticism are cob-webbed together as *water culture* (Nelson, 1998).

Water and cultures are intertwined with each other like a cotton handicraft. As the design (cultural imprint) on the cloth has limitless possibilities, so are the water and its relationship with different customs and traditions. The religious practices associated with water among various cultures have imbibed the notions of conservation and sustainability as an intrinsic social value, thus limiting the options for its misuse (Cannadine & Price, 1987; Nair, 2004). This makes the water culture a complex entity with multiple functions associated with elements of purification and pollution (Sivaramakrishnan, 2001).

In Hinduism, the focus is on bodily emissions, inauspicious life-cycle events, and elements of obstacles for the creation and maintenance of sacred places (Nelson, 1998). Nelson has elucidated a wide range of human activities associated with a religious impurity (Nelson, 1998). Performing a ritual (*Puja*) without bathing is considered as a taboo among the Hindus as well as among other religious communities (Hudson, 1980). Physical purification is mandatory before entering into these sacred shrines. As previously mentioned, the water structures around the temples, Gurudwaras, and Sufi Dargahs are the living testimonies of such conventions (Desai, 2016; Lowry, 1983). The practice of reading sacred hymns during regular or ritualistic bathing is common among the Hindus living in the Indian sub-continent (Nair, 2004), where taking a deep bath in water or even a mere aspersion has a seminal cultural value (Chamberlain, 2019). Such ritualistic bathing is an act for purification of body, mind, and past sins (*Karma*) (Singh, 2004; Nautiyal, 2009).

The dialectics of pure-impure implodes the deeper socio-cultural constructs and taboos associated with the use of water and entry into religious places (Freed, 1970; Joshi, 2011). In ancient Indian society, a person of lower caste/social order was barred to access public dug well due to rigid practices of untouchability (Freed, 1970). Casteism creeped into and continued even with the arrival of egalitarian faiths like Islam and Christianity in medieval times (Ahmad, 2007; Dirks, 2001; Fuller, 1976; Jadhav, 2005). And even in contemporary Indian society, many such archaic practices related to casteism limit the access to clean water for several communities (Beteille, 1992; Jadhav et al., 2016).

During the Vedic period (1500 BCE to 500 BCE), cultural approaches to water conservation (with limits to social hierarchy and ethnic groups) were consciously built with a concept of equity for all living entities. On the one hand, bathing in runoff water has functional dimensions of conservation without hampering the ecological cycle (Lipner, 1998; Sharma & Shruthi, 2017). And on the other hand, the traditional approach to water conservation through cultural sanctions augmented this further. For instance, the temples in the southern Indian state of Kerala have historically played an important role in harvesting surplus water in tanks; every village at least has one temple associated with some sacred groves and tank (Maya, 2003).

Several water harvesting practices associated with socio-religious communes are still prevalent across India with certain variations in design, construction, ownership, and social relationships (Ekhalak et al., 2012; Livingston, 2002). These structures symbolize fecundity, and water is used in temple rituals for regeneration and purification (Lipner, 1998). Apart from rituals and drinking and irrigation purposes, such systems also contribute to the village "community affairs," where social relations are articulated, reproduced, and challenged. However, the symbolic "production of locality" to which water systems contribute is also shaped by local ecology (Mosse, 1997). These arrangements are not just the structures and techniques of water harvesting but the way of cultural life, which is slowly vanishing (Mishra, 1995, 2012).

18.3 Changing Ecosystem, Extinction, and Climate Change

Looking beyond the arguments of ignorance versus innovation, it is evident that the notions of sacredness attached to water and its conservation helped the cause for *sustainability* even before the term was invented. Humans before the age of industrialization understood the harmonious relationship between land, water, and ecosystem for thousands of years through natural and cultural adaptations (Kala, 2017;

Mishra, 1994, 1995, 2012). Although caste/class hierarchies added certain restrictions on the open usage at many places, still there are visible traditions demonstrating controlled scientific prowess keeping watershed development structures in concordance with the ecosystem (Mishra, 1994).

The coming of first revolution in agrarian domain established a harmonious relationship between farming practices, water systems, and the religious orders. The surplus proceeds from cultivable land changed the swidden practices toward more concentrated, stable, and profit orientation. Hence, the economic logic of life in traditional communities which was for sustainable survival within the limits of available resources started witnessing transition through ideas of material wealth and overexploitation of depletable resources like water (Danda, 1991; Jain, 2001).

Rural and agrarian societies were the first casualty of such a transition. The advent of modernity through mechanized approaches like canal colonies, large dams, and dupable water harvesting systems like pump sets added a notion of technological determinism with the human-water relationship (Ali, 1979; D'Souza, 2008). The premise of *Malthusian Trap* is now answered with fertilizer, modern seeds, and perennial water harvesting structures (Kögel & Prskawetz, 2001). This weakened the traditional water cult and emboldened the modern human's onslaught over water bodies. Although such an approach bears fruits for a few years or decades, in the long run, things started burning out. For instance, the land of the five rivers "*Punjab*" which was known for its early farming cultures through Vedic texts is currently witnessing severe decline of water table and pollution/encroachment of water bodies (Agrawal et al., 2010; Chakraborty & Mukhopadhyay, 2014).

In the urban interface, modern cities (like Delhi, Varanasi, Lucknow, Hyderabad, Ludhiana, Amritsar, Ajmer, etc.) thrived and expanded on the river banks, trade, and pilgrimage routes with foundations of inherited conservatory culture and logistical negotiations. Subsequently, the urban centers became the engines of scientific knowledge and growth. The rising towns slowly consumed the peripheries and its inhabitants with promises for material prosperity at the price of disassociation from the cultures and traditions. Consequently, the sulking urban landscapes with skyscrapers, slums, and chimneys replaced the traditional watersheds, natural landscapes, and common property resources (Wagner, 2013). This restricts the natural runoff and the rainwater absorption capacity in the urban areas, making flash floods and waterlogging a new normal (Singh & Upmanyu, 2019).

The city of Lucknow presents a striking example. It had alone 964 ponds in 1952 which has reduced to 494 in 2006 (Verma, 2016). The magnificent Hussain Sagar and Osman Sagar lakes built for the water supply by the Nizams of Hyderabad during the Mughal period are now witnessing decay due to urbanization (Ramachandraiah & Prasad, 2004). A similar position is for most of the emerging megapolis like the Indian IT City/Silicon Valley Bengaluru, which was flooded recently due to poor drainage situation resulting from the encroachment of water bodies.

Water management was the first mark of civilization (Nair, 2004). However, it is now one of the first tragedies of urban agglomerated modernity (MacKenzie & Dickens, 2008). The cumulative anthropogenic pressures professed the materialistic ideas for technologically controlling the water flow to feed the megapolis (McKenzie & Ray, 2009). The rising prosperity of middle- and high-income groups in the cities creates the demand for water-intensive lifestyles like bathing tubs, flush toilets, and water-related entertainment ventures (swimming pools and water parks) (Sainath, 2000). The private bore-well models and the water-tanker mafia have added more fuel to the fire (Ranganathan, 2014). Consequently, the municipalities of many modern cities have exploited the water resources both vertically (groundwater) and horizontally (lakes, ponds, rivers basins, etc.) to quench the thirsty cities. The industrial discharge in the water bodies adds more nails into the coffin. It results in a heavily stressed Indian water system, with more than half of the districts either water-deficient or polluted (Chakraborty & Mukhopadhyay, 2014).

18.4 Closing Thoughts

The rituals in *water culture* had a body-soul relationship. In contemporary Indian society, the rituals continue, but cultural centrality with ecological conservation is gradually decimating, leaving the body without the soul. Being the second-largest country on the planet, India needs to look back and re-establish the broken links for traditional knowledge of ecological conservation hidden in cultural-religious ethos. Chronic water deficiencies have been the major reasons behind the decline of many advanced civilizations; the sooner it is realized, the better it will be. The historical water bodies need immediate revival (desilting, recovery, and rejuvenation) along with the prevention of further encroachment. Modern technology and capital can bear better results if combined with traditional wisdom for water conservation. The inclusion of the grassroots stakeholders in both policymaking and implementation can be a good beginning (Sainath, 2019). In India, there have been several activists like Rajinder Singh, Medha Patkar, Anupam Mishra, and Prof. GD Agarwal who did pioneering job by dedicating their lives for fighting to restore the water culture. Such voices of wisdom need to be seriously heard and adopted in town and country planning by the policymakers.

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Chapter 19
Concluding Reflections on the Indigenous and Local Water Knowledge, Values, and Practices and Lessons Learned

Mrittika Basu and Rajarshi Dasgupta

Abstract The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) Global Assessment (GA) demonstrated the importance of Indigenous peoples and local communities (IPLC) to global biodiversity conservation and ecosystem management. Bridging indigenous and local knowledge systems with scientific knowledge systems is vital to enhance knowledge, practice, and ethics to move toward sustainability at multiple scales. Apart from the indigenous water knowledge, religious and spiritual value of water demonstrates the significance of water and employs its followers as caretakers of water resources. As editors, we summarize the key lessons in the final chapter drawn from the 17 chapters included in this book volume. The chapter concludes with the key learnings which emphasizes on the mainstreaming of indigenous water knowledge, values, and practices into the formal water management process.

Keywords Indigenous knowledge · Water management · Water conservation · Cultural value · Water governance · Religious value

19.1 Introduction

Discourses around the use of indigenous knowledge started five decades back in Allan's, 1965 text on standard narrative on development, population, and land pressure. Allan (1965) recognized that indigenous agricultural systems demonstrated knowledge that could positively contribute to development. In addition, a significant number of literatures unveil how local knowledge has contributed immensely to rural development (Barker, 1979; Howes, 1979; Brokensha et al., 1980; Scoones & Thompson, 1994). A common perspective shared by the scholars is the shift from centralized technically oriented solutions toward development projects that valued

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indigenous knowledge (Agrawal, 1995, p. 414). Around the 1990s, development was discussed in the context of social capital and development which encapsulated indigenous knowledge as part of mainstream development (Eyzaguirre, 2001). Furthermore, literature mentioned the acceptance of the indigenous knowledge discourse in development.

However, Briggs (2005) argued that, around the late 1990s, there were tensions between indigenous and western claims. Local knowledge rejected western science's claim to universality and its institutionalization that it can be archived and transferred. This study concurs with the view that, despite the acknowledgment of the role of indigenous knowledge in development, indigenous knowledge has failed to contribute profusely to the development discourse or mainstream despite the optimism (Sillitoe, 2010, p. 12). Briggs (2013) mentioned three thematic areas that highlight why indigenous knowledge has failed to impact and to be mainstreamed over the years.

Indigenous knowledge has been locally and geographically specific, i.e., it varies due to geographical, economic, and cultural settings. Sillitoe (2010) attributed the failure of indigenous knowledge to settings which are different; therefore, unless the communities share similar economic, geographical, and cultural settings, it may be difficult to understand the utility of some indigenous practices or processes. Briggs (2013) mentioned how the IK can inform research beyond the context and geographical location undertaken. It might be difficult to use ideas, concepts, and results derived from one specific context to the other which poses the problem of universality.

The second concern raised is how indigenous knowledge can be formally integrated with formal science to produce hybrid knowledge. Barrera-Bassols et al. (2006) carried a study on the interface between natural and social sciences. Several scholars have embarked on studies related to the integration of indigenous knowledge and formal science (Homann et al., 2008; Thomas & Twyman, 2004; Blanckaert et al., 2007; Lado, 2004; Liwenga, 2008). The challenge of incorporating the two still remains a concern (Homann et al., 2008; Liwenga, 2008) although some scholars like Lado (2004) call for intertwining the two modes of knowledge in a sustainable, realistic manner for sustainable development. Despite realistic propositions on how these binaries can integrate, there are issues of power relations between stakeholder groups and knowledge systems themselves (Briggs & Sharp, 2004). Western knowledge has been prioritized, and still there is unwillingness to use indigenous knowledge ignoring local social, cultural, and economic priorities.

The third and recent concern raised is the appropriation of indigenous knowledge into the prevailing discourse of neoliberalism (World Bank, 1998, 2007). IK is still seen as a poor relation of Western scientific knowledge. The important grounded nature of IK will be lost in trying to universalize systems which are locally and geographically specific. This runs the risk to serve the needs of capitalism and neoliberalism (Busingye & Keim, 2009; Laurie et al., 2005).

The 17 chapters included in this book (except Chaps. 1 and 19) reflect and highlight the diversity and significance of indigenous and local water knowledge and the religious and spiritual values of water to different community of people and enlist several local and indigenous practices which are vital toward the sustenance of local and indigenous people.

19.2 Key Lessons and Takeaway from each Chapter

The first chapter presents an overview of the book highlighting the already existing knowledge, gaps, and challenges related to indigenous water knowledge, values, and practices. The chapter explains the definitions, concepts, and characteristics of indigenous knowledge and the challenges in mainstreaming the existing information into policymaking and governance.

Chapter 2 of this book discussed a detailed and critical scenario of water management and how indigenous people and knowledge are seldom included in the decision-making process. The author highlighted the dominance of technology and scientific information and tools which in turn results in a gap in translating the local knowledge into the decision-making process. In the process of discussing the hindrances in mainstreaming indigenous knowledge, the author pointed out that increasing privatization of water resources and infrastructural facilities has narrowed down the value of water to mainly economic values. This in turn masks the benefits of local indigenous system. On the other hand, indigenous water knowledge is dynamic and context-specific, but generally adopt an integrated, insightful, and harmonious perspective. The chapter emphasized on the power dynamics, political preferences, and discourses that limit the mainstreaming of indigenous water knowledge and practices into the decision-making process. Knowledge sharing and collaboration, as identified by the author, is one of the key avenues that can transform the water system by integrating indigenous knowledge and western science and technologies.

The cultural, spiritual, and religious values of water constitute an integral part of the indigenous knowledge system. The first section of this book presents the cultural, spiritual, and religious values of water and the role of these values in transforming the water use behaviors, conservation practices, and decision-making. Chapter 3 explored the symbolization of water in Hinduism, and the author profoundly explains how different rivers, especially the Ganges River, are represented in Hindu texts and scriptures. As per Hindu scriptures and mythology, water contains purifying power and has properties to wash away sins and impurities. River Ganga is synonymous to Hinduism and India. River Ganga water is indispensable when carrying out any Hindu ritual, and the water is considered to possess supreme purifying powers that cleanses not only the body but also the soul. Water is a multifaceted symbol in Hinduism. Along with earth, fire, air and ether, it is regarded as one of the *Pancha Tattva*, five primeval elements of the universe. Water as a particular element with associated characteristics and related symbolism forms the basis of the texts of the *Jyotish Shastra* (Hindu astrology) and the *Ayurveda* (ancient Hindu medicine). A myth which brings to the fore the symbolism of water as a vivifying force is recounted in the *Rig Veda*, the oldest of the Hindu scriptures. It tells the story of the god Indra slaying the demon Vritra after a long battle and freeing the river Indus (*sapta-sindhu* in Sanskrit). Figuratively, this act is seen as representing the slaying of primal inertia and the setting flowing of the waters of life. A disjuncture is also apparent between the scriptural (*dharmashastrasic*) view of water and that of modern legislation. While the *dharmashastras* associate water with cleanliness and ritual purity and leave the ownership of water undefined, modern legislation views water as a resource and vests its ownership in the State. Referring to the convenience and economic benefit of the general public as its rationale, the State has increasingly expanded its role in controlling and managing this national resource. Associating water with physical health, it simultaneously disassociates water from ritual purity. The orientations of the *dharmashastras* and modern legislation pertaining to the role of water are based on quite different value premises.

Culture, including religion, clearly influences how people perceive and manage a resource such as water. Although this aspect was often neglected in development projects in the past, development agencies increasingly acknowledge the importance of local culture and values in their policies. In Chaps. 4 and 6, authors examined the relation between Islam and water. The chapter is highly interesting and significant as it provided a detailed explanation of how water is valued among Muslim people directed by their holy sayings and book. In Islam, two main Sharia ideas define water rights: “shafa,” which provides the most basic need of humans and animals to satisfy their thirst, and “shirb,” or the right to irrigate field. Based on geographic, social, ethical, and cultural variations, many Islamic nations interpret these two core Sharia concepts (*shafa* and *shirb*) differently as per their characteristics. The authors critically reviewed various existing literature and the holy book of Quran to interpret how water is envisioned in Islam. Water management in Islam primarily follows two concepts – *Tawhid* and *Fitra*. While *Tawhid* directs people to be responsible and use the natural resources including water sustainably, *Fitra* encourages basin- and inter-basin-level collaboration. Conservation is a fixed concept in Islamic teaching. It is a way of living that should be implemented through the Muslim’s whole life: not as an ad hoc solution to shortages nor in occasional situations. All human beings rely on water for life and good health, but, for Muslims, it enjoys special importance for its use in *wudu* (ablution, i.e., washing before prayer) and *ghusl* (bathing). A Muslim cannot hoard excess water – rather, he is obliged to allow others to benefit by it. The Prophet (pbuh) stated that among the three people Allah will ignore on the day of resurrection are “a man [who] possessed superfluous water on a way and he withheld it from the travellers.” The recognition of water as a vital resource, of which everyone has the right to a fair share, is emphasized by the following hadith, which effectively makes water a community resource to which all, rich or poor, have a right: “Muslims have common share in three things: grass (pasture), water and fire (fuel).” There is no contradiction between what Islam says about water management and the emerging international consensus on the issue. However, as highlighted in Chap. 6, several Muslim-dominated countries across the Middle East and North Africa (MENA region) face severe water stress. Lack of public participation in the water governance and incompliance to the rules and ethics established by Islam are identified to be some of the main reasons behind increasing water stress in these regions.

Chapter 5 is an interesting attempt to explore how water is valued by Shintoism. Shintoism, primarily followed by Japanese people, is an indigenous religion of Japan. Shintoism emphasizes on maintaining a harmony between nature and human and has several gods and goddesses who act as guardians of different earthily components like fire, water, forests, mountains, children, marriage, etc. This chapter is significant as there lies a significant gap in knowing as well as understanding how Shintoism values water and how those values are practiced by the modern Japanese society through different rituals. In this chapter, the authors conduct extensive literature review and provides a detailed account of Shintoism and the various rituals followed that demonstrate the importance of water under belief. This chapter makes an important contribution to the not-so-known field of Shintoism and water and shares the knowledge to the outside world.

In Chap. 7, the author discussed the cultural value of water in India, especially in the northern hilly areas of India. The author delineated different water harvesting structures built high up in these mountainous areas which are also closely intertwined with the religious and cultural values of the population in this area. Age-old water harvesting structures like *Naula*, *Dhara*, and *Chuptaula* mainly focused on storing safe and sufficient water for household use, and many of these structures have faces of gods and/or myths attached to them that prevents exploitation or pollution of these water storage structures. The author very well explained how water is used and valued in different rituals, for instance, the tradition of *Naula Bhetna* when the newlywed bride is introduced to the *Naula* (water source) in the area. The newlywed bride must worship the *Naula* and bring water from it which is distributed in the village as an offering. Water plays an important role in this old tradition, and this practice is considered to bring happiness and prosperity in the life of the newlywed couple. The rituals, cultural practices, and myths associated with the water sources, streams, wetlands, and rivers in this part of India are presumed to imbibe the significance of water among the local people which in turn ensures the supply of clean, safe, and sufficient water for daily use.

Chapters 8–18, included in the second section of the book, include various case studies from different countries across the world like Iran, Bangladesh, Taiwan, the Philippines, Zimbabwe, Sri Lanka, and India.

To begin with, Chap. 8 authors provide an insightful account of evolution of water sources and harvesting structures in Delhi. Traditional water-holding structures like step wells were also found in New Delhi showing their usefulness in storing water for domestic use. However, with time and urbanization, advancement in water management practices was adopted, and technological interventions started to replace the age-old traditions. Yet, the water stress condition still prevails in several part of the megacity, and continuous 24x7 water supply is still a distant dream for the population. The traditional water-holding structures and the knowledge behind their construction and design of the city are under the verge of extinction. The authors emphasize to look beyond technological interventions and propose the water managers to visit the traditional water harvesting structures and cultural landscapes across the city to understand the indigenous knowledge involved in the construction of these structures. This may help in designing more sustainable water sources across the megacity and meet the increasing water demand of the urban inhabitants. While Chap. 8 discusses about integrated urban water management (IUWM), Chap. 9 presents a case study from Iran where lake Urmia, one of the largest natural permanent hypersaline lakes in the world, shrunk down due to prolonged drought and unregulated overexploitation of water. The shrinking and drying up of the lake are primarily due to the destruction of Zagros forests and diversion of water from the lake basin to powerful agricultural land users. Unlike other indigenous communities in Iran who adopt different indigenous practices like water sharing to curb the effects of water crisis, farmers from Lake Urmia Basin have never adopted any indigenous or local practice to adapt to water-scarce conditions, mainly due to sufficient supply of water from the lake. Lack of reliance on indigenous and local practices and overexploitation of the lake ecosystem are presumed to be few of the reasons behind the drying up of lake Urmia. Hence, the chapter authors emphasize on the adoption of indigenous knowledge which are practiced in other parts of Iran like water sharing practices in the Lake Urmia Basin for long-term sustainability across multi-generational timeframes.

Indigenous peoples around the world have been governing the waters and lands within their territories since time immemorial, and indigenous water governance is closely linked to understanding water as a living entity who must be respected (Daigle, 2018; Wilson & Inkster, 2018; Yates et al., 2017). Zimbabwean communities have a long history of indigenous water governance as discussed in Chap. 10 of this volume. Traditional leaders play an important role in water management systems at the local level as they implement traditional norms, beliefs, and performances. Mythological and religious beliefs also play an important in indigenous water governance in Zimbabwe. Religious beliefs impose rules and moral codes that local people have to comply while governing water, and myths regulate access and ensure sustainable utilization of water resources. The author gives examples of taboos believed by different indigenous communities that govern the fair use of water resources. However, the author also highlights the conflict between the traditional and the formal water governance system and the reliance of local communities over traditional water governance as it is capable to address their needs and challenges. It is recognized that management of water by any one system or only by local communities is not a feasible option. An integration of formal and traditional water governance system with effective public participation can lead to sustainable water management.

Chapters 11 and 15 examined various indigenous water conservation structures and practices across the red lateritic belt of Southwest Bengal in India. This area is dominantly inhabited by different tribal communities including *Santhals*, *Munda*, *Kol*, *Sabar*, *Lohar*, etc. This belt is also frequented by droughts and chronic water stress conditions. The authors provide a detailed account of different water storage and harvesting structures like ponds, *happas*, dug wells, contour bunding, dew irrigation, etc. that provide water not only for domestic use but also for irrigation purposes. The need to integrate this traditional water conservation and harvesting structures into village-level water management plans is identified by all the authors. Chapter 12 elucidates the local knowledge on water ecosystem services across villages located in different altitudes in Mindanao, Philippines. Traditional knowledge is place-specific which is well articulated in this chapter. Though the studied villages are in the same watershed, knowledge on water management and water ecosystem services were distinct for villages under different elevation. For instance, the lowland village inhabitants possess a unique local knowledge of water use for aquaculture production, while the upland villagers considered the river and springs to possess healing properties and that a healing bath could cure ailments. The chapter illustrates the traditional knowledge associated not only with water management but also with water ecosystem services including the biodiversity of water ecosystems. Similar to the indigenous knowledge possessed by indigenous communities of Southwest Bengal (Chaps. 11 and 15), *Munda* community from the Satkhira district of Bangladesh practice different indigenous water use and conservation practices to deal with their daily struggle with saline water around them. Authors from Chap. 13 identified several water-related issues faced by the *Munda* community and the water filtering techniques adopted by the community as they lack the access to safe drinking water. Several programs and/or approaches are adopted that aims to integrate local knowledge with formal water institution. One such initiative is the Basin School Network in Taiwan. However, the Basin School Network under study adopted a three-way cultural approach to involve grassroots communities into basin conservation. Chapter 14 authors reinforce the fact the adopting the cultural approach ensured increased participation of local communities in the conservation of waterscapes. Involving communities through various events conducted by the riverbank or involving them in various activities not only increased their awareness about the waterscapes but also imbibed a sense of ownership in them toward the maintenance of the waterscapes. The Basin School Network in Taiwan could be an example to adopt in other river basins to ensure effective grassroots involvement and maintain the water resources sustainably.

Due to the traditional roles associated with men and women in most societies, gender continues to be a significant factor in the stratification of the use and access of indigenous knowledge. Women are known to have a wide grasp of indigenous and local knowledge due to their exposure to daily activities and alongside seniors and traditional leaders, who are regarded as custodians of the knowledge system. Women are the principal users of water in a household and the main bearers of indigenous knowledge. Yet, the traditional knowledge held by women often get unnoticed and subsequently lost. In the study presented in Chap. 16, the authors attempted to conduct interviews with elderly village women in Sri Lanka and enquire their perception about the value of water and traditional knowledge they hold. Unanimously, all the elderly village women valued water as the other form of life. However, the village women agreed to the fact that with the installation of piped water supply, the indigenous knowledge held by local people are getting lost as they do not have the need to practice that knowledge. This is an ideal example showing how technological advancement makes life easier while, on the other hand, leading to the loss of traditional knowledge. This could pose serious threat to future communities as with the loss of indigenous knowledge, they are solely dependent on technology which can fail to function in case of any uncertainty. Chapter 17 discusses the role of ponds, a common tradition water conservation practice, in livelihood development in Indian Sundarbans. Due to increased salinity intrusion in the Sundarbans area, most of the agricultural lands are unsuitable for cultivation. Pond-based farming helps to sustain livelihoods of local communities. In addition, it provides freshwater for domestic use. These traditional water harvesting structures are a sustainable alternative for the coastal communities facing frequent storm surge, increasing salinity, and looking for water sources. The final case study comes full circle back to India. In Chapter 18, the authors provide a critical account of cultural discourses and conservation practices of water in India.

19.3 Concluding Statement

Integration of indigenous water knowledge, values, and practices is increasingly considered to be inevitable in combination with formal scientific and technological advancements for a sustainable water future. Western water management regimes commonly fail to include local communities and the knowledge they possess in developing water governance systems. Through 17 case studies from South Asia, Africa, the Middle East, East Asia, and Southeast Asia, this book volume demonstrates the existing indigenous knowledge repository in the Global South of which very few people are aware of. The examples of traditional and local water practices cited in the volume show the expanse of place-specific indigenous knowledge that needs to be identified, documented, and mainstreamed in the policymaking. It is urgent for scientists, academicians, and policymakers across the world to acknowledge the significance of indigenous water knowledge and integrate them into the decision-making process irrespective of the geographical location or context. In conclusion, some of the common learnings from the 17 chapters, challenges, and research gaps are identified. In terms of shared learning, the following points briefly highlight the research outcomes and key learnings from this book volume:

- Indigenous knowledge systems are dynamically regulated systems and are context-specific, place-based, and long-tenured. Indigenous water knowledge, water values, and practices are dynamic in nature and have distinct characteristics based on the context.
- The traditional water practices are comparatively easy to implement, and local communities connect to these practices more closely than to formal water management practices. This is one of the main drawbacks behind the failure of various technology-based water management systems as local communities fail to connect to these systems.
- The key defining characteristic of indigenous and local knowledge is that it is at least constituted, and often both controlled and managed by, indigenous peoples and local communities through formal and informal institutions. Indigenous

methodologies are approaches undertaken by the knowledge holders themselves and thus firmly embedded in their worldviews, reflecting their reality, history, and lived experiences. Knowledge sharing and learning within can also strengthen indigenous institutions.
- Almost every religion and spiritual belief put utmost importance to water and have given directives on how to use and conserve water. The spiritual and religious representation of water helps to develop moral codes and ethics which the followers should follow for sustainable use and conservation of water. The religion and spiritual beliefs aware the local communities of the significance of water and its purification properties and make them aware about the judicious use of water.
- Because people connect to religious and spiritual beliefs easily, integration of these values into formal water management plans will increase their acceptability among local people and will ensure more public participation in the decision-making process.
- Traditional water harvesting and conservation structures are highly durable and resistant to changes over time. This again reinforces the need of understanding the traditional engineering designs to develop sturdy and sustainable modern water sources.
- Mainstreaming of the indigenous water knowledge in the formal water management system is the main challenge, as identified by all the authors. Over-reliance on western theory of water management has shifted the focus away from indigenous knowledge systems. Hence, the current decision-making process relies on technological interventions, scientific evidence, and engineering skills. Though these are equally essential for sustainable water management, participation of local communities and inclusion of their skills and knowledge ensure sustainable water management and governance that meets the demands of the beneficiaries equally.

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