Chapter 14
Adaptation Strategies Adopted by Indigenous Community for Sustainable Livelihood in Response to the Changing Climate: The Role of the Local Authorities and the Corporate Sector in a Case Study of Sherpa Community from Lukla, Nepal

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Abstract Nepal's vulnerability to climate change is high, due to its geographical conditions, which is further exacerbated by its low human development index. Under this context, indigenous people are especially vulnerable due to their close dependence on natural resources and their often weak socioeconomic condition. One such highly vulnerability community in the Himalayan region of Nepal is the Sherpa community who have long been the face of mountaineering guides and have established their livelihood around the harsh topography of the mountain. These mountain communities are at risk of melting glaciers and changing monsoons, which impact their agricultural and tourism activities that they are dependent on.

The adaptation strategies adopted by the indigenous community is very important in building their resilience against increasing impact of climate change and depends on their perception of climatic changes. In the case of Sherpa people in Lukla, this perception study shows that their awareness about present climate change scenario is almost null, and therefore they do not perceive potential threat in the future as well. This differs drastically from literatures and reports that point to the increasing climate change threat in the Himalayan regions. Therefore, the role of local authorities and corporate sectors is strong in bringing climate change sensitization program in the area and to work for robust adaptation strategies.

Keywords Climate change · Impacts · Adaptation · Sustainable livelihood · Nepal · Indigenous community · Sherpa · SDGs

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14.1 Introduction

14.1.1 Climate Change and Indigenous People

The human-induced warming has already increased to reach approximately 1 °C above pre-industrial levels at the rate of approximately 0.2 °C per decade (Allen et al. 2018). This increase in temperature has already resulted in widespread impacts on natural and human systems, as each decade has been successively warmer since the 1850s (Pachauri and Meyer 2014). As the temperature is projected to rise continuously throughout the twenty-first century, the impacts and persistence of climate related hazards will also continue to increase, as well as exacerbate the already existing ones. These risks are unequally divided and pose higher risk to vulnerable communities and places (Pachauri and Meyer 2014).

As the climate-related risks are unequally divided, one of the most vulnerable communities having greater risk of these hazards are the indigenous communities, as their natural resource-dependent livelihood and associated traditional knowledge will be challenged by the changing climate (Adger et al. 2014). Indigenous people are regarded to be vulnerable to the changing climate due to their close dependence on natural resources and also because they are often times socioeconomically marginalized. The indigenous people have a deep spiritual, cultural, social, and economic connection with their territories, resources, and lands, and these are said to be a basis for their "identity and existence itself" (The United Nations Permanent Forum on Indigenous Issues 2019). Due to this close dependence of their livelihood with natural environment resources, indigenous people are often among the first to confront the direct consequences of climate change. This exacerbates the difficulties relating to loss of resources and land, unemployment, economic marginalization, and discrimination that the indigenous people are already facing (United Nations Department of Economic and Social Affairs 2019). Indigenous people also constitute populations that are poorest of the poor and are threatened by social, economic, and environmental vulnerability (International Labor Office 2017). Indigenous people constitute an estimated 5 percent of the total world's population, and in such a less percentage constitute nearly 15 percent of the world's poor (International Labor Office 2017). Indigenous people and their livelihood are evidence to the human-ecosystem relation being reciprocal, where the ecosystem provides services to the community and the community in turn works for the conservation of the ecosystem while also utilizing it (Comberti et al. 2015). As they are so close to the ecosystem, they are active drivers for ecosystem management, making adaptation strategies adopted by them help in enabling ecosystem resilience too (United Nations Department of Economic and Social Affairs 2008).

The impacts of climate change on indigenous communities has been documented by various studies. The Himalayas glacial melts are affecting millions of indigenous rural people dependent on the seasonal flow of water; in the Africa's Kalahari Desert, indigenous people are forced to depend on the governmental support for survival against rising temperatures, dune expansion, and loss of vegetation due to increased

wind speeds (United Nations Department of Economic and Social Affairs 2019). These hazards and impacts associated with climate change will continue to threaten human security and will be an important factor contributing to insecurity by undermining livelihood, compromising culture and identity, and increasing the instances of migration that people would rather avoid (Adger et al. 2014).

However, indigenous people are also a major resource of adapting to climate change by utilizing the knowledge that they have as a result of their long history of adapting to changing and highly variable ecological and social conditions (Adger et al. 2014). As their knowledge of ecosystem is intensive, they are crucial to help enhance resilience of ecosystems. Oftentimes, the indigenous communities have creative techniques to react to the climate change after interpreting it drawing from the knowledge they have (United Nations Department of Economic and Social Affairs 2008). As the 80% of remaining biodiversity lies with indigenous lands, it is also an indicator that the indigenous community plays a major role in environmental protection along with their adaptation to the changing climate (the United Nations Permanent Forum on Indigenous Issues 2019).

Indigenous peoples' representatives have been pushing for engagement on climate agreements and action following the adoption of Kyoto Protocol in 1997 and were given support for their involvement by the United Nations Framework Convention on Climate Change (UNFCCC) by 2004 (Etchart 2017). The Indigenous Peoples' Center for Documentation, Research and Information (DOCIP) stated that indigenous people have been making link between climate change and the rights of indigenous peoples for several decades, "taking center stage in its promotion" (DOCIP (Indigenous Peoples' Centre for Documentation, Research and Information) 2015). The indigenous people also presented themselves as key players for the achievement of Sustainable Development Goals 13, 14, and 15, at the UNPFII conference 2017 (UNPFII 2017).

14.1.2 Corporate Role toward Climate Change Adaptation Fostering Sustainable Livelihood

Adaptation has been defined by IPCC as an adjustment in the natural or human systems, which is a response to actual or expected climatic stimuli or their effects, which would moderate harm or exploit its beneficial opportunities (IPCC 2001). As the temperature of the earth is projected to increase by over 2 degree, the necessity of robust adaptation measures also increases (DiGregorio et al. 2017). The longer the delay in responding to the changing climate, the higher is the risk of social, environmental, economic, and technological challenges (Climate Change 2014: Synthesis report 2014).

As such, action for adaptation should be priority from sectors across the world, and corporate sectors can play an integral role toward it. Corporate sectors across the globe will also undoubtedly be affected by the changing climate, including impact to

their supply chain, disruption to transportation, and higher insurance premiums for doing business in certain parts of the world, as well as sectors from tourism to logistics, including impact on human resources (Alibašić 2018). However, they may also be quick to adjust and seek solutions to the long-term problems, as these tie closely with opportunities and challenges for the global economy. This also ties with the fact that large corporations have been sources of greenhouse emission and therefore have responsibility for mitigation as well as an obligation for repairing the consequences.

In most developing countries, especially the ones with indigenous community, climate change is reported to exacerbate multidimensional poverty. The indigenous community and household will be highly impacted by not only the climatic hazards but also inequalities arising out of institutional adaptations due to the lack of assets flexibility and also disadvantages associated with marginalization (Olsson et al. 2014). These impacts of climate change have been raising issues of climate justice, as the contribution of the indigenous people to greenhouse emission is very low (United Nations Department of Economic and Social Affairs 2008). When it comes to adaptation by indigenous people, the strategies that they are adopting might not be sufficient to manage the rapid climatic changes that are projected (Wittrock and Wheaton 2011), even though they have portrayed a high ability to withstand and adapt to variable environmental conditions (Tyler et al. 2007). Therefore, the role of corporations is high, in bringing expertise and knowledge to support adaptation in line with building disaster preparedness, sensitization in climate change issues, and enhancing food and water security, for overall increase in climate change resilience.

Climate change is said to cause new poor between now and 2100 both in developed and developing countries, jeopardizing sustainable development, with majority of severe impacts projected for rural regions in Southeast Asia and Sub-Saharan Africa (Olsson et al. 2014). As such, it is important to understand how adapting to climate change would help in sustaining the livelihood of the people. On one hand adaptation strategies to climate change help in ensuring sustainable livelihood by minimizing the impact of climate change on the livelihood assets of the community, and on the other hand, sustainable livelihood also helps in reducing the vulnerability of the community to the changing climate. Oftentimes, communities with good access to goods and services are better equipped to leverage their action against climate change. The poor are often the most vulnerable group to the impacts of climate change, and as most of their reliance is usually on environmental service for livelihood, the most effective adaptation approach would be in ecosystem management that would ensure the natural services and support the ecosystem that provides to the people (IUCN 2004). As shown by a study done in a herder group in Tibetan Plateaus, level of climate risks has an effect on the type and level of adaptation strategies adopted by the herders, but the herders with stronger institutional arrangement, social support, better financial assets, and access to products and services are better equipped in leveling up their adaptation options and strategies (Wang et al. 2016). These institutional structures, policies, and legislations have a strong influence in reducing or worsening the impact of climate change in vulnerable people by determining the way any structure or individual operates and

also regulating access to markets, assets, culture, and even power relations in society (Institution for Rural Development FAO 2006).

Climate change mainstreaming is an iterative process that aims in integrating climate change adaptation into the decision- and policy making at all the levels of governance, national, sectoral, and subnational, and in the case of Nepal, Nepal endorsed national Climate Change Policy and National Framework on Local Adaptation Plan of Action (LAPA) in 2011 to implement the priorities of climate change adaptation laid out by National Adaptation Programme of Action (NAPA) (Regmi and Bhandari 2013). This was done to integrate adaptation into the development processes of the country in response to country-specific climate change evidence. Climate change adaptation and sustainable livelihood are identified as a two-way causality because adaptive capacity influences development and vice versa (Wright et al. 2012). As various reports point out, adaptation and coping to climate change are what communities have been doing since the livelihood began, by coping with the climatic variability to ensure their survival by ensuring their agriculture and other income-generating activities. As the changing climate increases these variability and change in local climatic pattern, it is a question of how the community elevates these strategies to fight with the increasing impact of climate change in the future (IUCN 2004). While it is still under debate about what role adaptation plays in any countries response to the changing climate, it has been increasingly pointed out that it should be done symmetric to development agendas to ensure that the policy and activities of the country align with minimizing risk of climate change and amplifying livelihood opportunities to the people (IUCN 2004). While doing so, there are many government agencies, NGOs, academic institutions, and other companies that play a key role in cross-sectoral integration and coordination of climate change adaptation activities (Ayers et al. 2011).

14.2 Literature Review

14.2.1 Adaptation of Indigenous People to Climate Change for Sustainable Livelihood

There has been many research in identifying the concept of adaptation and development, their synergies, and social-ecological complexities affecting development and adaptation (Agrawal and Lemos 2015). There has also been incorporation of climate change adaptation into broader development policies, projects, and policies with increasing urgency (Lemos et al. 2007). People and household face myriad challenges which are oftentimes exacerbated by the changing climate (Berrang-Ford et al. 2011). Often people live in very close association with the nature and climate surrounding them; adapting to the climate change and variability has been an iterative process. Management decisions are usually built by the community to work with the climatic condition of the place. Now the question is if the adaptation

strategies adopted are sufficient enough to address the wider and faster impacts and uncertainty regarding climate change (Levine et al. 2011). Sometimes there have been cases when projects aiming for facilitating climate change adaptation have proven to be deficient and sometimes even leading to more marginalization of vulnerable communities (Nelson et al. n.d.). To address the underlying societal inequities which are seen to fuel vulnerability of climate change, adaptive development was also proposed to take into account variety of climate-related risks faced by household and systems and make appropriate policies and programs accordingly (Basett and Fogelman 2013).

Adaptation strategies has often been linked to securing livelihood assets and services. Oftentimes adaptation helps farmers in improving productivity, for example, in Morogoro of Tanzania, farmers reported increase in productivity after introduction of draft animals and management changes, after which they expected improvement of such practices contributing significantly to climate change adaptation (Below et al. 2012). However, adaptation here has also been affected by social standing, education, and economic, social, and financial assets of the households (Below et al. 2012). Similarly, locals from Morogoro in Tanzania have also faced similar constraints from income and social assets to altering their livelihood strategies and enhancing adaptive capacity in their region (Paavola 2008).

Similarly, a study in the Tibetan herder groups also show how changing climate causes changes in livelihood activities for adaptation. As the changing climate along with anthropogenic activities caused degradation of pasture lands, the local herder group has resorted to lesser herding migration and now also does rotational grazing to protect the pasture land. Similarly, as the condition of the pasture land worsens, they have been working to improve their storage facilities (Wang et al. 2016). Now instead of taking their sheep herd and migrating around, the people are building more permanent houses for settlement and relying on growing and storing forages for the herd (Wang et al. 2016). Notably, there has also been reported increase of invasive species Chromolaena odorata in Bansar, remote village in Lamjung district of Nepal, due to which locals reported loss of traditional herbs and pastoral land, and the locals also had to give up their goats and cows due to lack of grass and fodder (Joshi et al. 2019). There have been projects on adaptation and sustainable livelihoods in India, which aimed at improving adaptive capacity of rural farm-based livelihood to cope with climate variability and change. This was done with focus on the provision of services, planning, and implementation of adaption to climate change in order to support risk assessment planning, along with community-led risk assessment and participatory planning of climate adaptation interventions (The World Bank 2019).

There has been another interesting observation of climate change adaptation and sustainable livelihood by research in fishery in rural household of Chilika Lagoon in India. The author points out that the impacts of climate change are not only on occupational activities but on multidimensional aspect of rural livelihood, and this again has a say on their capacity to adapt to the changes (Iwasaki et al. 2009). According to the research, increase of fish, dominance of fish marketing by fish merchants, and access to fishing group affect fishermen's capacity to adapt. The changing climate has an impact on all the stages of fishery, and these vulnerabilities

have also shown its socioeconomic impact by triggering dropout from school to enter fishing industry. The point of the author here is that climate change does not act independently in impacting livelihood but closely related with other processes to impact the community and development processes and that access to livelihood assets influences their ability to adapt (Iwasaki et al. 2009).

While Nepal has progressive INDC targeted to achieving climate resilience, studies show that Nepal still lacks comprehensive analysis of how government institutions, organizations, and businesses respond to the climate crisis (Tankha et al. 2017), thereby making it a need for a country like Nepal, while trying to adapt to the climate issue, to also take leadership in monitoring and evaluating their developmental progress (Szabo et al. 2016). The needs of people also vary as shown in the study by the author that households that had more resources favored technological solutions, whereas households with poorer economic conditions prioritized social standing and decision-making power (Nagoda 2015). As the discourse of subsequent adaptation and development evolves, climate change adaptation needs to be looked from other disciplines "particularly developmental studies" (Tschakert et al. 2016). Nepal has recently received its first Green Climate Fund for its project in Churia, whose objective is to enhance the resilience of vulnerable communities along with the ecosystems by adopting climate-resilient land-use practices (Green Climate Fund 2020). In parts of Ganges plains in Bangladesh, researches have shown recurrent bouts of droughts. The households have reported adopting coping strategies such as traditionally managed pond excavation, moisture conservation, and retention of rainwater. But they have also relied on government-supported practice whereby the government provided tubewell-facilitated irrigation and mini-ponds for supplemental irrigation (Institution for Rural Development, FAO 2006), which shows how traditionally equipped local people are dependent on governmental support in providing more technically sound adaptation strategies.

14.2.2 Role of Local Authorities and Corporates in Climate Change Adaptation in Nepal

Nepal's share of GHGs is only 0.027%; however, it is very highly vulnerable to the impacts of climate change (Government of Nepal Ministry of Population and Environment 2016). Nepal's vulnerability is high and increasing, now placed fourth after placing 24th in Climate Vulnerability Index in 2017 (Eckstein et al. 2018), while it has very low adaptive capacity, placed at 128th position in Resilience Index (FM Global 2019). Poor communities mostly depend upon natural resources for their subsistence livelihoods and usually have limited adaptive capacity making them further vulnerable to climate and other changes (ICIMOD 2010). Nepal has therefore been claimed to be one of the most vulnerable countries because of its high dependency on natural resource for livelihood, high poverty, fragile physiography, as well as low adaptive capacity (Oxfam 2009).

In the case of Nepal, the government of Nepal has modified its Climate Change Policy in 2019 to keep up with the changing context, with the new policy being centered on increasing resilience of climate change in livelihood and the ecosystem (Government of Nepal 2019); it has become important for the government of Nepal to mainstream climate change adaptation into its overall development process while also increasing institutional capacity, financial resources, technology, and knowledge to address the problems of climate change (Government of Nepal 2019).

The changing environmental conditions along with socioeconomic factors continue affecting vulnerability at local level, which require a changing innovative and adaptable interventions that will keep up with the changing context, therefore, making it necessary to have new and modified vulnerability-reducing measures with an understanding of what is to come in the future. This means it is important for decision-makers to identity how social and environmental changes impact poor livelihood and be able to provide improved access to information as well as capacity building for them. Changes induced by climate have a strong influence on resource flow, which is important to be understood for providing locally relevant adaptation strategies (IUCN 2004).

In this, local authorities and national and local corporations can have a major role to play in terms of mainstreaming climate change into different sectors, for a more effective adaptation strategies from each sector. For instance, an effective adaptation to climate change would require sensitization as well as adaptation projects and also depend on availability of required resources. A study conducted in communities in the Himalayas showed that the households near district headquarters were equipped with better facilities and infrastructure than the households farther away from the district headquarters. The report stated that the households near the district headquarters with better facilities and better access to resources were in more advantageous position than the households that lacked them. The study also found out that the households near headquarters were shifting to modern practices for adaptation, while the latter were more reliant on traditional practices. As the facilities and infrastructure differed between the two and depended on their livelihood situations, the report points out on the responsibility lying on the government in providing support to the ones who lacked these facilities (Pandey et al. 2017). The Local Government Operation Act (LGOA) of Nepal 2017 also recognized that "local people and local bodies are the most appropriate points of entry to meet the climate change adaptation needs at the local level" (Nepal, Mainstreaming Climate Change Adaptation into Sectoral Policies in Nepal: A Review, 2019).

There is a role to be played by the local authorities, as well as educational, agricultural, and tourism sectors, along with other agencies to better formulate and implement adaptation strategies based on each of their specialization. In the case of Nepal, Nepal developed the Pilot Program for Climate Resilience, under which there is a Strategic Program for Climate Resilience (SPCR) which has four key areas of intervention, including building climate change-resilient communities through private sector participation. This is a program under the Climate Investment Funds (CIF) (Climate Investment Funds 2018). Under this, one of the projects is in promoting climate-resilient agricultural practice which has the involvement of

various private companies, agribusiness firms, commercial banks, research councils, district development offices, and government agencies for building capacity of farmers with innovative adaptive practices and technologies, along with climate change sensitization (Climate Investment Funds 2018). Similarly, with large proportion of income in Nepal dependent on tourism, the tourism industry also faces the impacts of climate change and also highlights the importance of robust adaptation strategies for minimizing its contribution to climate change and has emergency responses available during climatic disaster events (Bhandari 2014). With the realization of importance of climate change awareness for effective adaptation, the Curriculum Development Center (CDC) along with other agencies has updated the curriculum of schools and universities in Nepal, incorporating information about climate change along with sustainable development (Ministry of Science, Technology and Environment 2017).

For a robust adaptation in place to foster sustainable development, there are many enabling factors: communications for information flow; transportation to function even during extreme events; finance that enables banking, credit, and insurance services; economic diversification that gives livelihood options; education that enables understanding of risks and strategies; organizations that voice concerns of diverse public, private, and civil society; scientific study to proactively identify hazards, risks, and solutions; and platforms to implement these solutions (Moench and Dixit 2004) and as such call for the need of contributions from various sectors and agencies.

14.3 Methodology

As this study was highly based on the perception of the indigenous people living in Lukla, and that of developmental and governmental agencies, discussions were done with the community people. This was done in order to allow the research participants to fully describe their perceptions and their experiences. The analysis of the threat of climate change impacts, adaptation measures, and linkage to sustainable livelihood was done based on their description and perception, which were dependent on their view of their environment and community and the changes taking place. This interpretation helped in gaining significant amount of information regarding the phenomenon (Cresswell 2013), which in this study was about impacts of climate change and the actions they were taking to adapt to these changes.

The necessary ethical approval was acquired to adhere to the accepted ethical standard required in the research. A consent form was created to make people aware of the aim and objective of the research and also the premises under which the data obtained will be used. The respondents were briefed beforehand about the aims, objectives, and use of their responses obtained. For the key informant interview, the interviewees were briefed about the data usage, and their signature of consent was obtained at the end of the questionnaire. Similarly, during the focused group discussion, briefing about data usage was done to the participants before the

interview, and a separate attendance sheet was created to get their signature, to signify their attendance as well. While taking photographs, permission were obtained beforehand.

14.3.1 Data Collection

For this research, primary and secondary data were collected for the study.

14.3.1.1 Primary Data Collection

Survey: Household questionnaire as well as focused group interview survey was done in the study area to get information about climate change trend and adaptation strategies of community people to the impacts of climate change. The survey was done in the household level, with focused groups as well as key informants, to get to wider number of respondents (Cresswell 2013). Convenience sampling along with snowball sampling was done, as the guide from the indigenous group determined the route to be taken and people to interact. Also, respondents went on increasing with the recommendation of the locals. The sample size was decided to be 25 households for around 50 households in the study area. While there is no definitive ideal sample size for qualitative research, the sample size was decided upon attainment of saturation (Glacer and Strauss 1967), as well as barriers regarding time, resources, as well as language.

Focused group discussions were done with community people, local leaders group, women group, and local high school. Similarly the key informants interviews were done with private trekking agencies, Office of the Investment Board, National Adaptation Programme of Action of Nepal, Food and Agricultural Organization of the United Nations, Nepal Mountaineering Association, and Tourism Board. This selection was done on the basis of the information gained from household and community survey that showed that agriculture and tourism were the major economic activities of the people.

Field observation was crucial in the study to observe firsthand the existing condition of the place, the population dynamic, as well as socioeconomic condition. Important observations were mapped and recorded to parallel with the responses from the community people. The same community person who helped in guiding the interviews helped in the field observations too.

14.3.1.2 Secondary Data Collection

Rigorous literature review was conducted for identifying literatures relating to the subject area. The climatic data could not be obtained from the Department of Hydrology and Meteorology, and therefore, secondary climatic trends from reports

and journal articles were referred to for the study. Data published from the Central Bureau of Statistics (CBS) along with previous studies was used to get the relevant data on the socioeconomic condition of the community. However, some of the information was also obtained from the community people, as the specific location details could not be obtained from the CBS. Required maps, land use, and other relevant data were obtained from official relevant sources.

14.3.1.3 Data Processing, Analyses, and Interpretation

There are various ways to do a qualitative analysis; one of the approaches to do the qualitative analysis includes the three main stages procedure, namely, reduction of the text, followed by the exploration of the text, and then the integration of the exploration (Attride-Stirling, 2001). For this research thesis, the qualitative analysis was done based on the preliminary stages of the research which included selection of research paradigm, participants, semi-structured questionnaires, transcription, and literature review (Akinyode & Khan, 2018). First the data was logged, notes and anecdotes were collected, the data was coded, and thematic areas were identified (Akinyode & Khan, 2018). Data was analyzed qualitatively with the help of Excel. The social data was categorized and coded and database was maintained in MS Excel. Content analysis was done by categorizing and tabulating the data. The data from the interviews were categorized on the basis of impacts, adaptation, and perception. Coding was done manually to represent theme or idea. These themes were identified based on repetition of information and from the respondents and also based on the graphs derived from Excel. Due to the small number of sample size, this was done manually without the use of any software.

14.4 Study Area

Nepal is a small country with an area of about 800 kilometers along the Himalayan axis by 150 to 200 kilometers across with an area of 147,181 square kilometers. It is a landlocked country bordered by India on three sides and China's Tibet Autonomous Region to the north. Home to some of the highest peaks in the world, the entire territory of Nepal is considered in the Hindu Kush Himalayan Region (Wester et al. 2019a).

Lukla is a small town in the Khumbu Pasanglhamu rural municipality of Everest region of Nepal. It is situated at 2860 meters elevation and is regarded as the entry point of visitors heading to Mount Everest. Lukla is a small airstrip with many lodges and shops, and Chaurikharka lies about half an hour walk downhill from Lukla. The Everest Region lies in between 86°31′–86°58′ east longitude and 27°47′–28°71′ north latitude. The Everest region further is classified into three subregions, namely, Khumbu in the north, Pharak in the middle, and Solu in the north. Lukla lies in the Khumbu of the Everest region. This Khumbu region is located in northeast

Nepal, at 2860 N and 86,420 E, and is approximately 140 Km from the capital of the country, which is Kathmandu.

Lukla is also within the Dudh Koshi valley, where the Dudh Koshi River is located, one of the many river systems of Nepal originating from the Himalayas and flowing through the west of Lukla (see Figs. 14.1, 14.2, and 14.3).

Out of Khumbu's total residents, which is about 3500, 90% are Sherpa, while the remaining 10% of are from Rai, Tamang, Brahmin, Dalit, or Chettri communities (Sherpa and Bajracharya 2009). All the respondents to this particular research are from the Sherpa community. Most of the livelihood in the entire Khumbu Pasanglhamu municipality is based on agriculture, pastoralism, and tourism (Sherpa and Bajracharya 2009). Previously there was high dominance of agro-pastoral system that was dependent and varied based on elevation and seasonally determined cropping and grazing patterns (Stevens 1993). Even the settlement is not always permanent in the entirety of the Khumbu Municipality, where they are dependent and defined by bioclimatic locations. The mid-elevation settlements are permanently occupied, also referred to as "Yul," which usually have 80–170 households. High-elevation summer places are called "Yersa," and low-elevation winter place are called "Gunsa" (Mcdowell et al. 2013). In this, Lukla is a permanent small town, which consists of year-long stay; however, mostly during winter, and during less tourism inflow season, some people migrate toward Kathmandu and other places. This seasonal migration toward Kathmandu has been reported in earlier studies too, where people traveled to Kathmandu and brought income directly or through remittance to relatives living in Khumbu (Stevens 1993).

14.5 Results and Discussion

14.5.1 Lack of Climate Change Awareness in Lukla

The household survey and focused group discussion with the community members of Lukla show a very interesting case of people who are perceiving changes in the climate, without having knowledge or even hearing about the ongoing climate change and associated crisis. Out of the 23 households in Lukla that were interviewed, respondents from only 3 households reported to have heard of climate change. But, when they were asked if the climate of the area was different than that of 25 years ago, the response was uniform: that they do see the changes in the climate of the place. The changes perceived have been the reduced snowfall in the area with more rocks visible in the mountains, as well as increase in temperature and rainfall.

The Department of Hydrology and Meteorology lacked the meteorological data from the meteorological station in Lukla. There are various reports that point to this lack of meteorological data being a barrier for efficient climate change analysis and that the localized effects in regard to the changing climate on Khumbu region remains yet to be well understood (Sharma et al. 2009). However the perception of the people regarding these changes does correlate with the reports and other

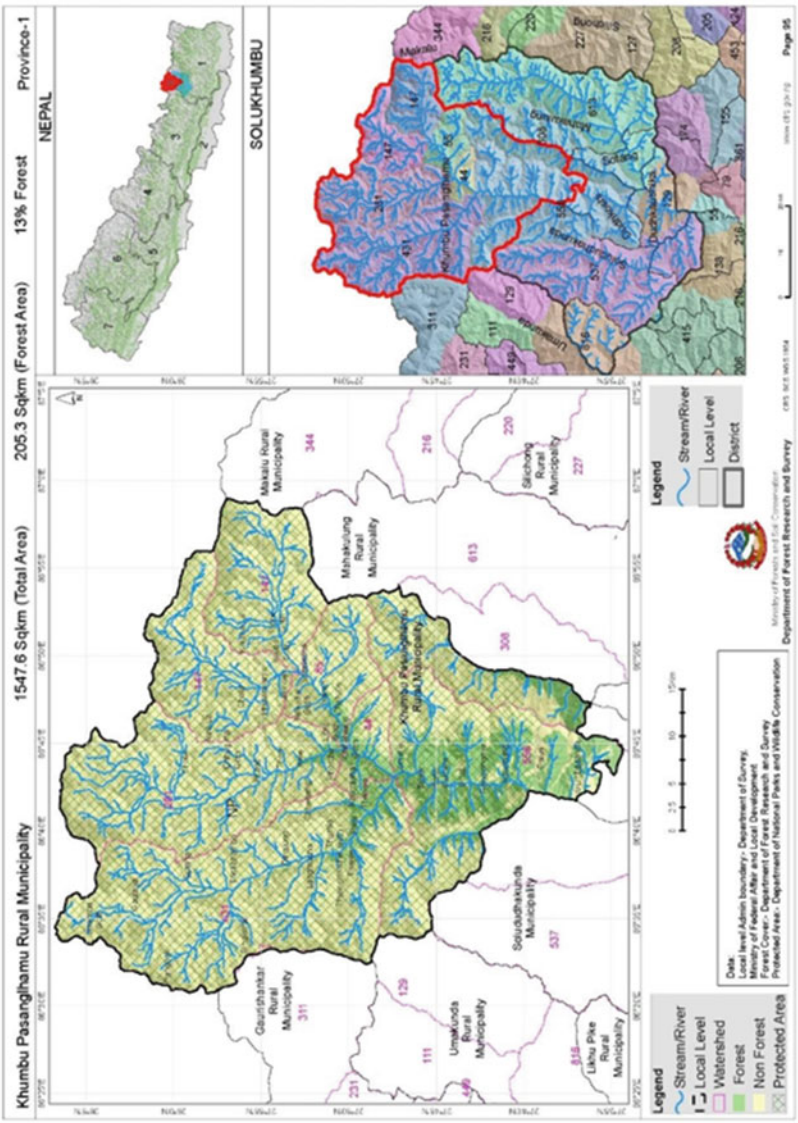

Fig. 14.1 Local resources map of Khumbu Pasanglhamu municipality of Nepal

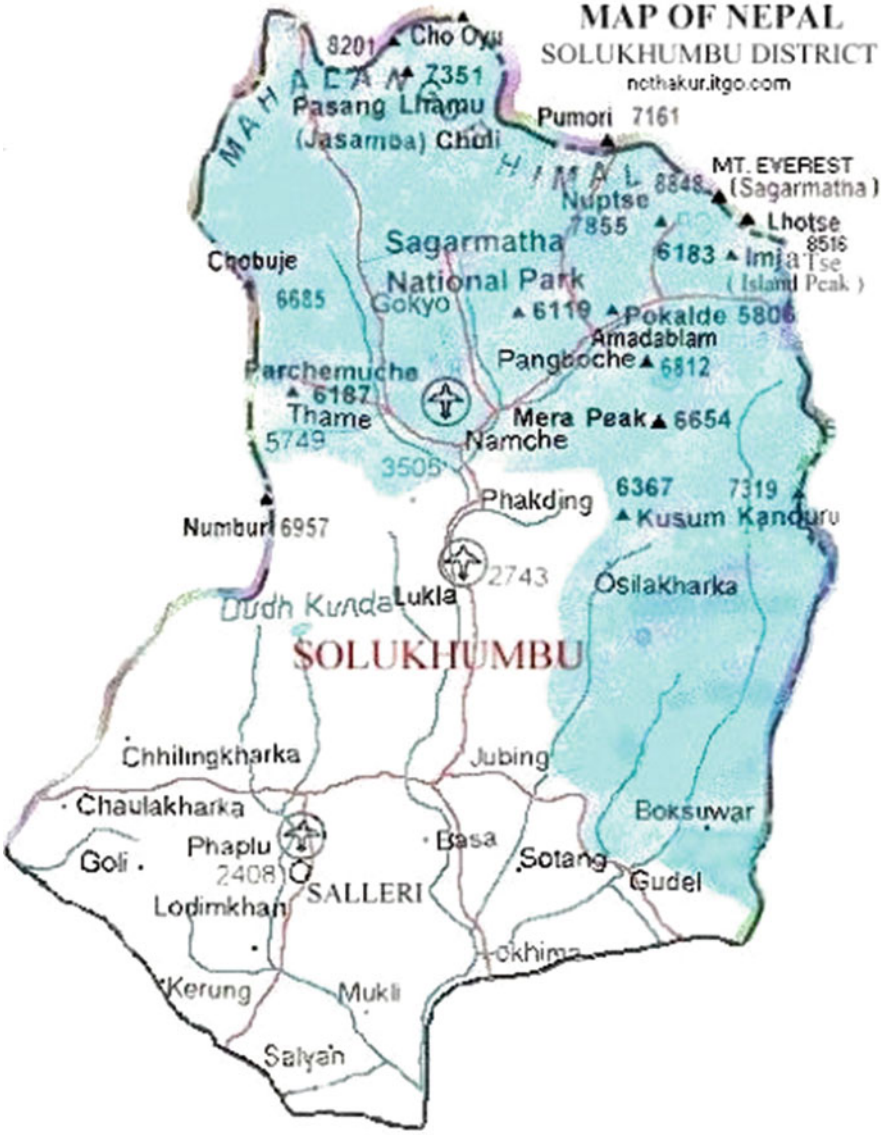

Fig. 14.2 Map of Everest region (Solukhumbu Region) of Nepal

literature reviews regarding the same. There was a rise of mean annual temperature of 0.057 °C a − 1 across the Himalayas between 1971 and 1994 (Shrestha et al. 1999). There has also been reported trends of decreasing total precipitation, which also showed change in precipitation phase, with lesser precipitation falling as snow in the northwestern Himalayas between 1996 and 2005 (Bhutiyana et al. 2010).

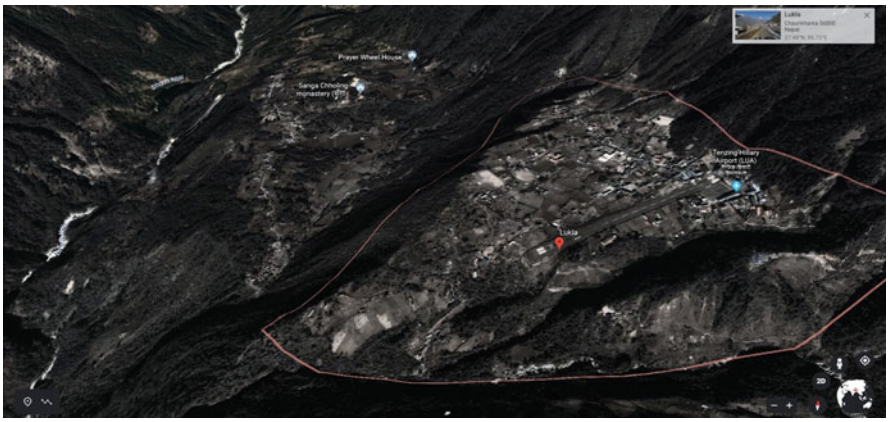

Fig. 14.3 Satellite image of Lukla

As people are unaware about climatic changes, it is alarming but obvious that they do not believe the impacts of climate change will increase in the future. They believe that weather fluctuations are natural without imminent threats or that being under God's grace, they would be safe. However, reports point otherwise: that the climate change impacts on the mountain community are projected to keep increasing. Not only the local communities but also the entire countries in many places of the world dependent of mountain for water are in a risk of decreasing water availability in the future, because of climate changing leading to extinction of permanently cyrospheric areas (Barnett et al. 2005; Viviroli et al. 2007; Bolch et al. 2011; Kääb et al. 2012; Soncini, et al. 2016). As the temperature of the world increases, the impacts are projected to hit the Hindu Kush Himalayan region including Nepal, and as the global temperature rise by 2 °C continues to disrupt climate system and biodiversity, it would also cause resulting warmer days, changing rainfall patterns, extremes, high altitude ecosystem destruction in Asia along with glacial melt and forest degradation, and shifting of tree line with biodiversity loss (Dahal et al. 2009). Also the IPCC also states that by 2050, 25% of the global mountain glaciers would disappear (IPCC 2014).

14.5.2 Need of Concrete Plans for Future Adaptation Options in the Region

The perception of people to climate change is very important in determining the steps they are willing to take to cope in the short term and adapt to the changes in the long term (Deressa, Hassan, & Rangler). The vulnerability of the mountain areas to climate change however remains of high concern, as in the high altitudes of Hindu Kush Himalayan region, and in Nepal, data from 1980 to 2015 showed that the

floods, landslides, and epidemics were the major causes of disaster-related human loss (Carpenter and Grunewald 2016). The perception of Lukla Sherpa people regarding the changes in climate is alarming without being aware about the future scenario they are going to face; the adaptation strategies adapted by them would not be sufficient.

14.5.2.1 Role of the Local Authorities

Climate Change Policy of Nepal has also recently been updated in 2019 after its first declaration in 2011, in order to keep up with the increasing climate change debate in national and international area and to incorporate the element of resilient livelihood for the vulnerable communities of Nepal. As Nepal also shifted to federal republic state, the new policy gives emphasis to incorporating climate change programs in all the levels of the government. The local municipality can draw from these strategies and start building capability in their tourism and agriculture sector in relation to climate change.

The municipal office of the Khumbu Pasanglhamu municipality is also now being constructed near the study area, which can be advantageous for the local residents to take their concern to. As such, it can play an important role in mobilizing necessary resources and training relating to adaptation to the local community. Once the municipal office is built, it would also pave road to build agricultural center. The municipal office can play a role in building project relating to climate-resilient agriculture.

According to the local leaders, there has not been any program specifically focused on climate change in the area and no formal adaptation strategies adopted. Some of the afforestation programs and water management programs that they have conducted could have some relation to help adapt from climate change; however they stated that the main purpose was not directly related to adapting to climate change but more toward protecting the ecosystem and ensuring their services to the people. However they do emphasize the necessity of incorporating climate change issues, including sensitization and adaptation measures in future plans. The local authorities can also play a major role in creating database on climate and sociocultural aspect of the study area. It was very difficult to get data on decades of climate or even about sociocultural data of the study area. According to the Department of Hydrology and Meteorology, there is only a couple years data of rainfall from the meteorological station in the airport of Lukla and none on temperature. Therefore, an overall general picture had to be drawn on climatic changes through literature review of past works. It is recommended to have a good database of the study area, which would also be available readily for research purpose, as well as to showcase the sociocultural aspects of Lukla.

14.5.2.2 Role of Tourism Sector

The instances of GLOFs, avalanches, and snow storms are also projected to increase in the future with the changing climate. This in turn is claimed to be further exacerbated by the topographically difficult and inaccessible areas of the mountain (Neupane & Chettri, 2009). The key informant interviewees also shared similar concerns, claiming that due to inaccessibility of the mountain areas, it might be difficult to formulate and implement many adaptation strategies, especially technological ones, in tourism sector in the mountain.

Mr. Phuri Kitar Sherpa, who has been in tourism business for three decades, claims that there are many threats to tourism in the future. He notices changes in the snow amount in the trekking routes and also the increasing temperature. He claims to notice visible changes around Mera Peak, which now has very less amount of snow, and believes that mountaineering in the future will be very risky with the increasing temperature, as it is now reducing the density of the snow. He mentioned that with the reduction in the density of the snow, there will be more accidents, as during mountaineering, the climbers have to dig their equipment in the snow. He also believes that the Khumbu icefall will continue to be more dangerous in the future. However, among all the other respondents in household survey, only couple respondents shared similar sentiment. They stated that they noticed the decrease in use of snow ladders in some places. While they previously had to use three snow ladders in a particular place in the mountains during their expeditions, now they have to use only one, due to the decreasing snow. The other respondents however say that they have not given it much consideration and do not feel the huge changes.

However, many news and reports show that the changes are much more rapid. Adrian Ballinger, an Ambassador from Protect Our Winters, mentioned in one of the news coverage that he has noticed big changes in glacial recession in his past 12 years in Nepal Everest region and is wary about how much less stable the Khumbu Icefall has become. Soon after the 2014 avalanche in Everest, he moved to the north side of the mountain, to avoid the unpredictable and even more unstable Khumbu Icefall.

As Lukla is highly focused and dependent on tourism, it is important for them to understand how the tourism industry might change in the future and what repercussion climate change has to mountain tourism. The impacts of climate change, like increasing avalanches and icefalls, are serious concerns to immediate and long-term safety of the people. Therefore, similar trainings and knowledge are important to be disseminated to the people, so that they can equip their capabilities better. There is also a need to incorporate more robust emergency responses, long-term tourism strategies for people dependent on changing mountain tourism, and a capability to adapt to the changes. The Tourism Board, Ministry of Culture, and Tourism and Civil Aviation, along with private tourism agencies, have a strong role to play for paving the way.

14.5.2.3 Role of Agriculture Sector

The Hindu-Kush Himalayan Region assessment done by ICIMOD shows that the increasing temperature trend of the Himalayan region will continue even if global warming would remain to 1.5 °C and that the warming in the region will likely remain 0.3 °C higher (Wester et al. 2019b). This large warming is projected to trigger multitude of impacts, biophysical and socioeconomic, including increased glacial melting resulting in less predictable water availability and biodiversity loss which impacts the livelihoods of the people (Wester et al. 2019b). The KII with the agriculture experts from FAO also highlighted this fact of changing water availability and increasing risks of climate change on agriculture. According to them, it is more difficult for taking adaptation programs to higher elevations, because of the difficulty in topography.

Nepal government has now made it mandatory for each municipality to have an agricultural support center in each municipality, but according to the household respondents, the center is yet to reach Lukla. As the people are already welcoming newer farming practices like tunnel farming, centers like those could help the farmers in addressing the concerns relating to agriculture, increasing pests, or climate-resilient farming. Similarly, collaboration between local authorities, agricultural experts, microfinances, and adaptation experts could pave a way for facilitating a better long-term agricultural improvement in the region by bettering agricultural produces, market, and finance.

14.5.2.4 Role of Education Sector

It has been stated that adaptive capacity can be increased by investing in information and knowledge (Lemos et al. 2007). However, while the mountainous region has been discussed to be highly vulnerable, there has been no sensitization and awareness program in this region. There has been no specific vulnerability study in Lukla region, but the National Adaptation Programme of Action of Nepal conducted a vulnerability mapping that showed that Everest region is one of the most vulnerable districts in Nepal. However, there has been no program relating to this in the vicinity of Lukla, which is also the first stop to higher elevations. This shows that research studies and discussions have been taking place in national and international arenas but the people facing these threats are not aware about it.

The participants of interviews also mentioned that they don't know about these issues because they could not learn it from anyone. Some of the respondents also mentioned that there was similar program in a village near them but it never reached Lukla. The complaint intoned in the said response denotes that they would be more than willing to have programs that could help them know more. The monk from the village who knew about climate change attended the program that was conducted in another village and also referred the same to be conducted in their village. The lack of understanding about climate change has also been shown in another research

whereby despite providing explanation of the term and concept of climate change, many participants could not comprehend the meaning (Banstola et al. 2013). In earlier similar research in another indigenous community of Nepal, the Chepang, the authors showed that the curriculum plays vital role in perceiving climate change and acting on it and showed that the students of the area did not have curriculum regarding the same (Piya et al. 2012). They also recommended and urged the need of curriculum regarding climate change in the Nepalese education. However, in Lukla, a mountainous region, marginalized and inaccessible by road, the curriculum has included issues of climate change as well as sustainable development.

During a focused group discussion with the high school students of a local school in Lukla, they were highly aware about the cause behind climate change being global greenhouse gas emissions. This shows how good curriculum regarding climate change helps in imparting knowledge about the issue. Most of the older respondents did not know about climate change in the area, but all the students from the high school were highly aware about the fact.

Deploying sensitization programs in the region will enable stronger communication between the youngsters and the residents in being apt about climate change issues and building their confidence on robust adaptation. Along with bringing awareness programs to Sherpa here, the education sector also has the role to incorporate the traditional knowledge of Sherpa for adaptation. Traditional and local knowledge has increasingly been recognized as an effective adaptation strategies. The Ministry of Science, Technology and Environment, in its report about traditional knowledge, stated that in the Khumbu region, Sherpa communities' forest management was integrated with formal regulatory framework of National Park management, which helped in achieving sustainable use of natural and agricultural resources (Ministry of Science, Technology and Environment, 2015).

14.6 Conclusion

The research study on the Sherpa people in Lukla has shed light on how indigenous groups who have been discussed to be vulnerable to the impacts of climate change by literatures and conferences across the world are themselves unaware about the phenomenon and how this leads to them being impassive of any future threats in the region. As such, the role of local authorities and corporations is quite strong in bringing sensitization and adaptation programs in the region. As studies and experiences show, areas with closer proximity to local governmental offices get better facilities and ability to bring adaptation programs. Lukla can now make use of the new municipal office in bringing stronger sensitization relating to climate change in the region.

During household survey and focused group discussions, many individuals shared that they were very shy to interact with the author, as they believed that they do not know anything about climate change and feel lacking in terms of their intelligence. Similarly, the few minority of people who did hear about climate

change also shared that they were disappointed in learning about this ongoing crisis from tourists who came from other countries rather than from their own locality or national experts. This has shed light on how important it is to have awareness raising programs in the region, not only to make people know about climate change but also to build their confidence in the issue which is close to them. Education sector, NGOs, INGOs, or other educational agencies can play an important role in bringing training programs to this region and its people, who are more than willing to learn and know about this issue. The local school of this region has been very effective in imparting the knowledge of climate change to the students, which has even made them motivated to work accordingly to save their tourism option in the future. It is important to fuel this motivation of the students by involving them in discussions and allowing them to impart this knowledge to their community as well.

Apart from sensitization, Lukla is also an open arena for any agricultural and tourism adaptation strategies, as it is dependent on these two sectors for economy but unaware that changing climate might be hampering it. There is a possibility of introducing climate smart technologies other than tunnel farming and introducing concept of insuring their agricultural products, as well as ways to reduce pests that many households faced. The recent pandemic also completely halted tourism for nearly a year in the region. Agricultural produces can help this community to be better resilient when one of their income sources collapses.

In regard to tourism sector, there is a huge role to be played by the tourism board and local authorities along with trekking and tour agencies. There were only a handful tourism industries who took changing climate into consideration, which is not a good scenario for a tourism-dependent mountainous country. While Nepal has introduced better emergency response schemes, trekkers' tracking devices, it seems these information are yet to reach many communities, as the respondents to this research were not aware about such necessities. Changing climate is said to increase disasters and change mountain tourism scenario, and while such discussions are ongoing in national and international levels, such information and training programs should reach tourism-dependent community of Lukla.

References

Adger WN, Pulhin J, Barnett J, Dabelko G, Hovelsrud G, M. L., … Vogel, C. (2014) Human security. In: Climate change 2014: impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change. Intergovernmental Panel on Climate Change, Geneva Switzerland

Agrawal A, Lemos M (2015) Adaptive development. Nat Clim Chang:185–187

Akinyode BF, Khan TH (2018) Step by step approach for qualitative data analysis. Int J Built Environ Sustain 5(3):241–252

Alibašić H (2018) Role of corporations in addressing climate change. In: A. F. (ed) Global encyclopedia of public administration, public policy, and governance. Springers, Cham

Allen, M., Dube, O., Aragón-Durand, F., Cramer, W., Humphreys, S., Kainuma, M., … Zickfield, K. (2018). Framing and context. In: Global warming of 1.5°C. an IPCCSpecial report on the

impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways. Intergovernmental panel on climate change
Attride-Stirling J (2001) Thematic networks: an analytic tool for qualitative research. Qualitative Res 1(3):385–405
Ayers J, Kaur N, Anderson S (2011) Negotiating climate resilience in Nepal. IDS Buletin 42:70–79
Banstola A, Chhetr M, Schneider R, Stebbing M, Banstola A (2013) Knowledge related to climate change and willingness to act for adaptation and mitigation practices in rural Nepal. Vietnam J Public Health 1(1):22–32
Barnett T, Adam J, Lettenmaier D (2005) Potential impacts of a warming climate on water availability in snow-dominated regions. Nature 438(17):303–309
Basett T, Fogelman C (2013) Déjà vu or something new? The adaptation concept in the climate change literature. Geoforum 48:42–53
Below T, Mutabazi K, Kirschke D, Franke C, Sieber S, Siebert R, Tscherning C (2012) Can Farmers' adaptation to climate change be explained by socio-economic household level variables? Glob Environ Chang 22(1):223–235
Berrang-Ford L, Ford J, Paterson J (2011) Are we adapting to climate change. Global Environ Change 21:25–33
Bhandari LN (2014) Climate change impacts and adaptation strategies on tourism in Nepal. Crossing the border: international. J Interdiscip Stud 2:113–126
Bhutiyana M, Kale V, Pawar N (2010) Climate change and the precipitation variations in the northwestern Himalaya: 1866–2006. Int J Climatol 30:535–548
Bolch T, Pieczonka T, Benn D (2011) Multi-decadal mass loss of glaciers in the Everest area (Nepal Himalaya) derived from Stereoimagery. Cryosphere 5:349–358
Climate Investment Funds (2018) Promoting climate resilient agriculture in Nepal: building climate change resilient communities through private sector participation. Climate Investment Funds
Comberti C, Thornton T, Echeverria VW, Patterson T (2015) Ecosystem services or services to ecosystems? Valuing cultivation and reciprocal relationships between humans and ecosystems. Glob Environ Chang 34:247–262. https://doi.org/10.1016/j.gloenvcha.2015.07.007
Cresswell J (2013) Qualitative inquiry & research design: choosing among the five approaches. Sage Publications, Thousand Oaks, CA
Dahal N, Ojha H, Baral J, Branney P, Subedi R (2009) Impact of climate change on forests and livelihoods: issues and options for Nepal. Livelihoods and Forestry Programme, Kathmandu, Nepal
DiGregorio M, Nurrochmat D, Paavola J, Sari I, Fatorelli L, Pramova E et al (2017) Climate policy integration in the land use sector: mitigation: adaptation and sustainable development linkages. Environ Sci Policy 67:35–43
DOCIP (Indigenous Peoples' Centre for Documentation, Research and Information) (2015) Sustainable development goals and the post-2015 development agenda: indigenous peoples' fight not to be left behind, DOCIP
Eckstein D, Hutfils M-L, Winges M (2018) Global climate risk index 2019. German Watch, Bonn, Germany
Etchart L (2017) The role of indigenous peoples in combating climate change. Palgrave Commun 3: 17085
FM Global (2019) 2019 resilience index annual report. Pentland Analytics, London
Glacer B, Strauss A (1967) The discovery of grounded theory: strategies for qualitative research. Aldin Press, Piscataway, NJ
Government of Nepal (2019) National climate change policy. Government of Nepal, Kathmandu, Nepal
Government of Nepal Ministry of Population and Environment (2016) Intended nationally determined contributions (INDC). UNFCCC, New York
Green Climate Fund (2020) Building a resilient churia region in Nepal. Retrieved from Green Climate Fund Projects and Programs. https://www.greenclimate.fund/project/fp118

Hussain A, Rasul G, Mahapatra B, Tuladhar S (2016) Household food security in the face of climate change in the Hindu-Kush Himalayan region. Food Security 8:921–937
Hussain A, Sarangi GK, Pandit A, Ishaq S, Mamnun N, Ahmad B, Jamil MK (2019) Hydropower development in the Hindu Kush Himalayan region: issues, policies and opportunities. Renew Sust Energ Rev 107:446–461
ICIMOD (2010) Climate change in the eastern Himalayas: observed trends and model projections. ICIMOD, Kathmandu
Institution for Rural Devleopment, FAO (2006) Livelihood adaptation to climate variability and change in drought-prone areas of Bangladesh. FAO, Rome, Italy
International Labor Office (2017) Indigenous peoples and climate change: from victims to change agents through decent work. International Labor Office, Geneva, Switzerland
IPCC (2001) Climate change: impacts, adaptation and vulnerability. Summary for Policy Makers, Geneva, Switzerland
IPCC (2014) Climate change 2014: impacts, adaptation, and vulnerability. IPCC, Geneva, Switzerland
IUCN (2004) Sustainable livelihoods and climate change adaptation. IUCN, Gland, Switzerland
Iwasaki S, Razafindrabe B, Shaw R (2009) Fishery livelihoods and adaptation to climate change: A case study of Chilika lagoon, India. Mitig Adapt Strateg Glob Chang 14:339–355
Joshi A, Farquhar S, Assareh N, Dahlet L, Landahl E (2019) Climate change in Lamjung District, Nepal: Meteorological Evidence, Community Perceptions, and Responses. Environ Res Commun 1:031004
Kääb A, Berthier E, Nuth C, Gardelle J, Arnaud Y (2012) Contrasting patterns of early twenty-first century glacier mass change in the Himalayas. Nat Prod Lett 488:495–498
Lemos M, Boyd E, Tompkins E, Osbahr H, Liverman D (2007) Developing adaptation and adapting development. Ecol Soc 12:4
Levine S, Ludi E, Jones L (2011) Rethinking support for adaptive capacity to climate change. Overseas Development Institute (ODI), London
Mcdowell G, Ford J, Lehner B, Berrang-Ford L, Sherpa A (2013) Climate-related hydrological change and human vulnerability in Remote Mountain regions: a case study from Khumbu, Nepal. Regional Environmental Change 13:299–310
Ministry of Science, Technology and Environment (2015) Indigenous and local knowledge and practices for climate resilience in Nepal. Kathmandu, Nepal: Government of Nepal, MInistry of Science, Technology and Environment
Ministry of Science, Technology and Environment (2017) Mainstreaming climate change risk Management in Developement. Ministry of Science, Technology and Environment
Moench, M., & Dixit, A. (2004). Adaptive capacity and livelihood resilience: adaptive strategies for responding to floods and droughts in South Asia. Institute for Social and Environmental Transition
Nagoda S (2015) New discourses but same old development approaches? Climate change adaptation policies, chronic food insecurity and development interventions in northwestern Nepal. Glob Environ Chang 35:570–579
Nelson D, Lemos M, Eakin H, Lo Y (n.d.) The limits of poverty reduction in support of climate change adaptation. Environ Res Lett II 11:–094011
Neupane GP, Chettri N (2009) Vulnerability to climate change of nature-based tourism in the Nepalese Himalayas. Tour Geogr 11:95–119
Olsson L, Opondo M, Tschakert P, Agrawal A, Eriksen S, Ma S et al (2014) Livelihoods and poverty. In: Climate change 2014: impacts, adaptation, and vulnerability. Part A: Global and sectoral aspects. Contribution of working group II to the fifth assessment report of the intergovernmental panel on climate change. Intergovernmental Panel on Climate Change, Geneva, Switzerland
Oxfam (2009) Even the Himalayas have stopped smiling. Climate change, poverty, and adaptation in Nepal. Oxfam International, Oxford, UK

Paavola J (2008) Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. Environmental Science and Policy 11(7):642–654
Pachauri R, Meyer L (2014) Climate change 2014: synthesis report. Contribution of working groups I, II and III to the fifth assessment report of the intergovernmental panel on climate change. IPCC, Geneva, Switzerland
Pandey R, Jha S, Alatalo J, Archie K, Gupta A (2017) Sustainable livelihood framework-based indicators for Assesing climate change vulnerability and adaptation for Himalayan communities. Ecol Indic:338–346
Piya L, Maharjan KL, Joshi NP (2012) Perception and realities of climate change among Chepang communities in the rural Mid-Hills of Nepal. J Contemp India Studies Space Soc 2:35–50
Regmi B, Bhandari D (2013) Climate change adaptation in Nepal: exploring ways to overcome the barriers. J Forest Livelihood 11(1):43–61
Sharma E, Chettri N, Tse-ring K, Shrestha AB, Jing F, Mool P, Eriksson M (2009) Climate change impacts and vulnerability in the eastern Himalayas. ICIMOD, Kathmandu, Nepal
Sherpa L, Bajracharya B (2009) View of a high place: natural and cultural landscape of Sagarmatha National Park. ICIMOD, Kathmandu, Nepal
Shrestha A, Dibb C, Mayewski P (1999) Maximum temperature trends in the Himalaya and its vicinity: an analysis based on temperature records from Nepal for the period 1971-94. J Clim 12: 2775–2786
Soncini A, Bocchiola D, Confortola G, Minora U, Vuillermoz E, Salerno F, Diolaiuti G (2016) Future hydrological regimes and glacier cover in the Everest region: the case study of the upper Dudh Koshi Basin. Sci Total Environ 565:1084–1101
Stevens S (1993) Claiming the high ground: Sherpas, subsistence, and environmental change in the highest Himalaya. Motilal Banarsidass Publishers, New Delhi
Szabo S, Nicholls RJ, Neumann B, Renaud FG (2016) Making SDGs work for climate change hotspots. Environment Science and Policy for Sustainable Development 58:24–33
Tankha S, Ranabhat S, Bhatta LD, Ghate R (2017) Disinterested agents or mismatched plans? : Public administration capacities and climate change responses in the least developing countries. Int J Climate Change Strategies Management 11:372–391
The United Nations Permanent Forum on Indigenous Issues (2019) Indigenous peoples' collective rights to lands, territories and resources. UN Department of Public Information, New York
The World Bank (2019) Sustainable livelihoods and adaptation to climate change. Retrieved from The World Bank: https://projects.worldbank.org/en/projects-operations/project-detail/P132623?lang=zh
Tschakert P, Das PJ, Pradhan NS, Machado M, Lamadrid A, Buragohain M, Hazarika MA (2016) Micropolitics in collective learning spaces for adaptive decision making. Glob Environ Chang 40:182–194
Tyler N, Tur J, Sundset M, Bull KS, Sara M, Reiner E et al (2007) Saami reindeer pastoralism under climate change: applying a generalized framework for vulnerability studies to a sub-Arctic social-ecological system. Glob Environ Chang 17(2):191–206
UNFCC (2016) Opportunities and options for enhancing adaptation actions and supporting their implementation: reducing vulnerability and mainstreaming adaptation. UNFCCC, New York
United Nations Department of Economic and Social Affairs (2008) Climate change and indigenous peoples
United Nations Department of Economic and Social Affairs (2019) Indigenous peoples at the UN. United Nations Department of Economic and Social Affairs
UNPFII (2017) Indigenous speakers in permanent forum decry governmental abuse of traditional lands, natural resources, urge respect for self-governing systems
Viviroli D, Dürr H, Messerli B, Meybeck M, Weingartner R (2007) Mountains of the world, water towers for humanity: yypology, mapping, and global significance. Water Resource 43:W07447
Wang J, Wang Y, Li S, Q, D. (2016) Climate adaptation, institutional change, and sustainable livelihoods of herder communities in northern Tibet. Ecol Soc 21:5

Wester P, Mishra A, Mukherji A, Shrestha A (2019a) The Hindu Kush Himalaya assessment—mountains, climate change, sustainability and people. Springer, Cham, Switzerland

Wester P, Mishra A, Mukherji A, Shrestha AB (2019b) The Hindu Kush Himalaya assessment: mountains, climate change, Sustainability and People. ICIMOD, Springer, Cham

Wittrock V, S. K., & Wheaton, E. (2011) Canadian prairie rural communities: their vulnerabilities and adaptive capacities to drought. Mitig Adapt Strateg Glob Chang 16(3):267–290

Wright H, Kristjanson P, Bhatta G (2012) Understanding adaptive capacity: sustainable livelihoods and food security in coastal Bangladesh. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)