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Climate Change Effects on People's Livelihood

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Definitions

Climate and Climate Change

Generally climate is defined as the long-term average weather conditions of a particular place, region, or the world. Key climate variables include surface conditions such as temperature, precipitation, and wind. The Intergovernmental Panel on Climate Change (IPCC) broadly defined climate change as any change in the state of climate which persists for extended periods, usually for decades or longer (Allwood et al. 2014). Climate change may occur due to nature's both internal and external processes. External process involves anthropogenic emission of greenhouse gases to the atmosphere, volcanic eruptions, and changes in the motion of the Earth's tectonic plates. The United Nations Framework Convention on Climate Change (UNFCCC) made a distinction between climate change attributable to human contribution to atmospheric composition and natural climate variability. In its Article 1, the UNFCCC defines climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods" (United Nations 1992, p. 7).

Livelihood

Livelihood refers to the means of making a person's or supporting family's living. For instance, a village person's livelihood can be farming, fishing, or raising livestock. According to Chambers and Conway (1991), a "livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living" (p. 6). In a broader sense, a livelihood is sustainable when it can maintain assets and resources for the present and the future and enabling it to cope with, and recover from, external shocks such as climate change impacts and other natural hazards (Scoones 2009). Recent understanding of livelihood seems to be applied to a wider variety of topics ranging from income, poverty, food security, and health through to human settlement (Scoones 2009).

Introduction

Climate change effects are broadly defined as the consequences of anthropogenic climate change, which involve both existing and potential harmful effects on human and biophysical systems (Folke et al. 2002). Climatic effects are not only disrupting established functions of

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ecosystems and biodiversity but also posing strain on the long-term sustainability of the planet's ecosystem for future generations (Rockstrom et al. 2009). Scientific observations since 1950 confirm that frequency, magnitude, duration, and spatial extent of natural hazards and extreme weather events associated with climate change have increased in many parts of the world (IPCC 2014). Climate change stimuli can disrupt land uses, freshwater, and marine resources and impact overall ecological balance (IPCC 2014). In climate change research, the overall impacts of climate change cannot be measured without accounting for its impacts on human systems and well-being (Rockstrom et al. 2009). Hence, it is necessary to know how climate influences ecosystems and in turn influences the livelihood of people that depend on ecosystems in many regions of the world.

The biophysical impacts of climate change on people have initially been examined in isolation from existing social-economic and political contexts (Reed et al. 2013). During the last two decades, this approach has been criticized with a view that climate change vulnerability will not take place separately from the existing social-economic contexts, which influence sustenance of productive livelihood of people across the world (Blaikie et al. 1994; Bohle 2001; Hilhorst and Bankoff 2004). Given that livelihood refers to the means of obtaining basic necessities for living (such as income, food, water, housing), it is clear that those who depend more on natural resources will face greater climate change specific livelihood vulnerabilities (Reed et al. 2013). In recent years, attempts have been made toward more integrated approaches in analyzing climate change impacts on people's livelihood, which involves both biophysical means and sociopolitical mechanisms (Reed et al. 2013). In fact, climate change impacts are contributing to rise of global poverty and impacting means of basic human necessities including food, clothing, housing, and income (United Nations 2015). However, there is no succinct way of synthesizing how climate change impacts on livelihoods; different scholars have focused on a wide range of overlapping issues. For the purpose of this chapter, climate change impacts on livelihoods have been categorized into two differing parts. Part I deals with how various climate change impacts influence people's livelihoods in rural versus urban regions across the world. Part II discusses some cross-sectoral issues relating to climate change impacts on livelihoods, including agriculture, food security, land use, water resources, and human settlements.

Part I: Climate Change Impacts on Poverty-Driven Livelihood: A Trans-local Analysis

It is now widely acknowledged that climate change is causing major obstacles to poverty reduction (United Nations 2015). In particular, the pressure of global climate change on livelihoods is closely experienced by the societies largely dependent on natural resources. Globally, the increased number and frequency of natural hazards and extreme weather events and the rising number of poor people being affected by such calamities support this assumption (Winsemius et al. 2018; Park et al. 2018). Though in absolute terms wealthier people lose more assets or property from natural hazards, in relative terms poor people experience greater loss of assets and access to basic services while experiencing disasters or adverse climatic events (Hallegatte et al. 2017). Authors including Karim and Noy (2014) and Hallegatte et al. (2017) have documented impacts from natural hazards on poverty and human livelihoods. The authors found that while experiencing stressful situations linked with climate change and other disruptions across the poorer regions of the world, poor households tend to smooth their food consumption at the cost of non-food items or benefits such as healthcare and education (Karim and Noy 2014). Moreover, the impacts of climate change on livelihoods will differ across regions and geographical spaces. Is it argued that the impacts of climate variability and change may have different types of influences on people's livelihoods in rural versus urban regions (Nawrotzki et al. 2015). Because the complex interconnections between rural and urban regions vary largely, the exposure to climate change is not only determined by biophysical components but also by social-economic and political factors (Ofoegbu et al. 2017).

Firstly, climate change will have significant impacts on rural livelihoods due to a greater proximity to natural resources and dependency on local ecosystem services for basic livelihood activities, including farm and non-farm activities (Dasgupta et al. 2014). The rural poor in many countries are highly dependent on agricultural income and other *farming related activities*. Besides farming communities, households residing close to forests in many developing countries are less adaptive to climate change, often due to their lower education level and lack of institutional intervention to help them managing various natural resources (Fisher et al. 2010). Hence, many communities in less developed countries are becoming more vulnerable to the impacts of a disaster on their yields and loss of forest resources. Natural hazards such as floods not only destroyed crops and seed reserve in many agricultural-dependent countries but also sparked food prices shock among rural communities across the world (Cheema et al. 2015).

Niles and Salerno (2018) assessed the association between climate shock and food security in 15 different countries in South Asia, Africa, and Latin America and demonstrated that the recent climate change will not only impact on natural resources but also will pose future threat to food security in the developing world. Despite their vulnerability to drought and flooding, rural people in developing countries often tend to raise more market oriented and less drought resilient breeds of livestock to support their income and economic savings (Nkedianye et al. 2011). Often the rural communities which lack access to infrastructure, basic services, and employment opportunities become largely dependent on local forest resources for income and other livelihood activities (Naidoo et al. 2010; Pailler et al. 2015). However, rising temperatures, changes in precipitation, increased level of flooding, prolonged droughts, and frequency of other natural hazards, including cyclones and sea level rise, are obstructing crop production and plantation growth (FAO 2016). In brief, changing climate and weather patterns have significantly constrained the livelihoods of rural communities in developing countries, causing natural resource degradation and increased levels of social inequality (Gentle and Maraseni 2012).

In remote rural areas, isolated communities who lack access to market and transport connectivity are more likely to suffer from food crises if local production is impacted by climate change (Safir et al. 2013). In the Philippines, Safir and colleagues (2013) found that food consumption decreased in remote rural areas with decrease in precipitation; however, households residing closer to a highway were not affected by such negative rainfall shock. Extreme weather events such as flood not only damage roads but also affect transport infrastructure, limit food distribution, and obstruct people's access to markets to sell or purchase food. Given that agriculture is the major occupation in many developing countries, climate change will impact agricultural employment, including how people farm their own lands, and work on other people's farms and other enterprises which are directly or indirectly dependent on agriculture (FAO et al. 2014).

Secondly, in urban areas, climate change impacts on livelihoods are complex and often associated with extreme weather events (Revi et al. 2014). Extreme events such as flooding can damage houses, water, and transport infrastructure and cause unemployment. For instance, Rasch (2015) assessed urban vulnerability to flood in 1276 Brazilian municipalities and showed that urban populations who are at the frontier of flood risks in different regions of the country are from lower social-economic backgrounds, with higher unemployment rates and lower household income. Additionally, heat waves can impact both performance and health conditions of workers in manual occupations and adversely affect their financial well-being (Kovats and Akhtar 2008). Extreme weather events also cause food insecurity to low income urban residents because of higher food prices. Urban consumers mainly depend on a combination of food supply networks, whereas a major supply can come from distant locations. Extreme weather events such as flooding can damage roads linking rural and urban areas, disrupt food distribution networks, and cause shortage of food supply (Battersby 2012). Rodriguez-Oreggia et al. (2013) examined effects of natural hazards on poverty at the municipal level in Mexico and found that floods and droughts lead to significant increase in poverty. Other studies also generated similar evidence in various urban settings where the increased number of disasters increased poverty rates to a significant level (Hallegatte et al. 2018).

Historically, many large cities were established near rivers and coastlines because of the benefits of less expensive transportation and market connectivity. The United Nations estimated that by 2030, about 60% of people worldwide will live in cities (United Nations 2006). Cities with an exponentially increasing population in coastal regions such as Central Java are becoming subject to increased levels of livelihood vulnerability due to a lack of income and other socioeconomic difficulties (Handayani and Kumalasari 2015). Hallegatte et al. (2013) also provided a quantification of present and future flood loses in 136 large cities across the world. Their study cautioned that the current standard of resilience in most of the coastal cities against storm surges and flooding are useful to withstand current extreme weather events, whereas future losses and damages are likely to be exacerbated in many coastal cities. Moreover, it is much difficult for resource poor countries to manage urban hazards due to a lack of long-term planning and implementation (IMF 2017). In the long run, various climatic disruptions are likely to bring compounded impacts on less resilient cities where the devastating loss can take long-term toll on people and property such as land degradation, loss of natural resources, unemployment, and increased health expenditure due to post AU6 disaster traumas (UN-HABITAT 2014). In brief, the increasing population in the context of recent climate change is exacerbating stress and pressure on urban livelihoods; disadvantaged people who work in primary sectors are likely to become immediate victims of environmental degradation in urban areas (Handayani and Kumalasari 2015).

Nevertheless, it is also critically important to consider the cross-scale interactions between rural and urban regions while considering climate change impacts on livelihood. Urban areas are typically dependent on natural resources including land, water, and energy. Large-scale supply chains have been widely used for rural-urban dependency for food supply and energy resources (Güneralp et al. 2013). Climate-related shocks and extreme weather events frequently affect such supply chains and commodity flows from rural to urban areas (Satterthwaite et al. 2008). AU7 For example, the extended drought periods in the Mississippi river area resulted in reduced water flow which significantly interrupted barge traffic and delayed commodity flows within the United States (Morton et al. 2014). Again, adverse climatic conditions can increase local unemployment and cause unmanageable financial pressure at the household level. This situation can attract a large number of people to migrate to cities from rural areas, where migration can be chosen as an alternative livelihood strategy. However, in cities, social inequalities between local residents and new migrants can increase frustration and social unrest, which may also spur urban violence (Østby 2015). The latter part of this chapter will discuss how disadvantaged migrants become exposed to new sets of risks after migrating to cities.

Part II: Climate Change Impacts on Livelihood: Cross-Sectoral Analyses

Climate change is affecting many sectors within the larger contexts of human-environment systems (Rockstrom et al. 2009). Sectors most critically affected by climate change include agriculture, forest, biodiversity, coast, energy, transportation, water resource, and society (Harrison et al. 2015). Many studies produced independent in-depth analysis on each of these sectors and issues related to climate change; however, such analysis ignored significant interconnections between various sectors (Harrison et al. 2015). Ignoring cross-sectoral issues can undermine the actual impacts of climate change on both biophysical and human systems. For instance, changes in land use impact water quality and resources, which can ultimately impact food security, flood defense, and coastal settlements (Holman et al. 2008). The cross-sectoral risks of climate change will therefore influence human living conditions, human settlements, and food security. To date, a limited number of studies have focused on cross-sectoral impacts of climate change (England et al. 2018). The following section will review cross-sectoral analysis on the effects of climate change on people's livelihoods.

Impacts on Agricultural Production, Groundwater Reserve, and Food Security

Climate change impacts such as increased heat waves, droughts, floods, and storms lead to significant impacts on global agricultural production (FAO 2016). Since the actual impacts of climate change vary from one region to another, and also within a region (Vermeulen 2012), many countries and poorer regions are suffering from disproportionate effects of food shortage and other agrarian crises (Swaminathan 2012). The rise of mean temperatures will disturb the duration of crop life cycles in South Asia and sub-Saharan Africa – regions already suffering from widespread hunger and poverty (Maharjan and Joshi 2013). In Latin American countries such as Mexico, increase in minimum and maximum temperatures due to climate change is reducing wheat yields (Lobell et al. 2005). Moreover, considering the highest emission trajectory situation by 2050, crop yields in Asia may decrease by 5–30% (Maharjan and Joshi 2013). The rainfed agriculture in South and Southeast Asia may become the hardest hit of this situation. According to FAO estimates on future demands for food consumption, by 2050, annual cereal production will be required to increase by up to 70% higher than 2006 levels (Alexandratos and Bruinsma 2012). AU8 Nonetheless, climate change is not the only factor impacting on food security; rapid population growth and economic and political changes that are taking place globally may have heterogeneous influence on food production across the world (Alexandratos and Bruinsma 2012).

Higher temperatures and changes in precipitation (especially where rainfall declines) will require increased groundwater-based irrigation in agriculture (FAO 2008). However, the expanded irrigation schemes for agriculture are driving enormous water stress in many regions of the world (FAO 2017). In the last century, the land area brought under agricultural irrigation has increased more than six times globally, from 40 million hectares in 1900 to above 260 million hectares at present (Chartzoulakisa and Bertaki 2015). This imposes pressure on availability and quality of groundwater given that many agricultural producers switched to machine-assisted groundwater-based irrigation. Further, the demand for agricultural irrigation may rise up to an additional 13.6% by 2025 (Rosegrant and Cai 2002 Chartzoulakisa).

Besides affecting species, ecosystems, rivers, and surface water users, concerns of groundwater depletion for agriculture include increased financial stress and debt burden for small holders in both developing and developed countries (McDonald and Girvetz 2014; Kabir et al. 2018). AU9 For instance, in the northern drought prone areas of Bangladesh, expansion of groundwater-based irrigation and introduction of high yield variety of seeds increased crop production. However, the charged prices for such government-run irrigation facilities resulted in excessive production costs for small holders and other sharecroppers (Kabir et al. 2018a). In order to manage extra cost of groundwater irrigation, farmers often borrow money from multiple sources or micro-credit institutions at the local level, which further compounds their household financial stress (Kabir et al. 2018a). Similarly, the irrigation schemes constructed so far in sub-Saharan Africa are difficult for the marginalized households to handle due to higher unit cost for water and significant income inequalities within irrigation communities (Manero 2017). Mcdonald and Girvetz (2014) estimated that in the United States, climate change would increase average irrigation costs in the states already experiencing dry climate, which will add extra pressure on farming households. As the World Food Program (2017) cautioned, the risks of food insecurity may increase up to

20% due to climate change by 2050 unless necessary efforts are placed to enable the world's vulnerable agricultural regions to better adapt to extreme weather events, including drought and flooding.

Impacts on Surface Water Resources and Livelihoods

Climate change is affecting timing and location of precipitation, which is causing reduction of water flows and water levels in a number of rivers across the world (Kangalawe 2017). This directly results in a decrease of water availability for agriculture and other household needs. Moreover, climate change and other human interventions have resulted in changes in river water quality and temperature which is associated with uncountable loss in aquatic biodiversity. For instance, Bello et al. (2017) estimated impacts of climate change on water temperature in Malaysia and illustrated that most of the suburban rivers will become ecologically unsuitable to a range of aquatic species in the near future, compared with the rivers in rural areas. Again, warmer ocean surface temperatures along with increased temperature in the atmosphere can lead to increased wind speed and change the number, duration, and intensity of tropical storms (Bates et al. 2008). A list of infamous cyclones with destructive powers caused major flooding, destruction of property and natural resources, and loss of lives in the last few decades (Bates et al. 2008). These also posed major challenges for recovery efforts in the developing and developed world, with long-term impacts including chronic poverty, food insecurity, and lack of access to basic necessities.

Nevertheless, climate change impacts such as ocean acidification, rise in water temperatures, and water hazards also affect fish production, supply, distribution, and consumption, thereby affecting the livelihood of 500 million people in developing countries who are dependent on fishing and aquaculture (FAO 2009). The impacts of climate change affect fish habitat and population both in marine and freshwater systems (Ipinjolu et al. 2014). Declining water resources are linked with declining fish catch in the lakes and rivers for communities dependent on fishing (Kangalawe 2017). Moreover, coastal fishing communities are at the front line of global sea level rise. Fishing communities in low-lying countries such as Maldives and Tuvalu are vulnerable to sea level rise and involuntary displacement (ADB 2017). Coastal fishing communities in Bangladesh are vulnerable to sea level rise, flooding, and increased frequency of tropical cyclones. Again the communities with large human population and heavily dependent on a diet of fish are highly vulnerable to climate change (FAO et al. 2014). For instance, fishing communities in the Mekong river in Southeast Asia are already experiencing salt water intrusion. The population of the Mekong river basin is above 60 million people, for whom fish and mollusks provide 80% of their protein intake (Sarkkula et al. 2009). In brief, climate change will affect aquatic environments, including changes in water quantity, quality, and freshwater biodiversity. The assessed and perceived impacts also include loss of income and food security as experienced by various affected regions and communities.

Impacts on Land Resources and Livelihoods in Low-Lying Regions

Evidence shows that increased carbon emissions during the last two centuries raised global mean temperatures and associated melting of ice sheets and sea level rise. Globally, about 600 million people currently live in low elevated coastal areas which are at the frontier of sea level rise (Dasgupta et al. 2014). Increased salinity from salt water intrusion is causing greater impacts on livelihoods, public health, and coastal ecosystem (IPCC 2012). Moreover, when degradation of land resources take place, it poses higher risks to social-economically disadvantaged people due to scarcity of food, income, and shelter (Bohle 2001).Scientific projections also indicate that by 2050, the progressing inundation from sea level rise may impact livelihoods of about one billion people around the world (Dasgupta et al. 2014). Additionally, land degradation attracts more people to overexploit the remaining productive lands, which results in further degradation. In the long run, the overexploitation of land resources can cause desertification and loss of biodiversity in the existing lands.

One least researched area while examining climate change impacts on lands involves riverbank erosion, which refers to the wearing away of the bank of a river or stream. Riverbank erosion is a recurring natural hazard in low-lying regions of the world. Hydraulic actions, such as the changing direction of river streams and water, create pressure against the banks and cause riverbank erosion. Heavy rainfall and flooding can also increase the intensity of riverbank erosion. Melting of glacier can also raise water levels, increase intensity of water currents, and further influence riverbank erosion. Moreover, it is now argued that climate change will increase rainfall and precipitation in some regions of the world, which will exacerbate the intensity of riverbank erosion in the near future (MoEF 2009). When land areas are removed by river streams, it impacts human lives, crops, livestock, housing, forests, private property, and infrastructure (Mollah and Ferdaush 2016). Low-lying countries in the Bengal Delta, including Bangladesh and some parts of India, are highly vulnerable to riverbank erosion (Mollah and Ferdaush 2016). Riverbank erosion is the major reason why the landless population is growing in Bangladesh. Moreover, the perceived level of damage is higher for the poor people who lose their land for the first time due to riverbank erosion. As a result, farmers can become totally landless once they experience riverbank erosion. These people are forced to migrate to a new location, which do not provide them with access to similar assets and land resources. As a livelihood coping strategy, many adopt new skills and occupations, where farmers can become day laborers or street vendors (Rahman et al. 2015).

Impacts on Human Settlement and Livelihoods: Rural-Urban Migration

Although the deterministic relationship between climate change impacts and human migration is yet unsettled in academia and policy domains, numerous evidence shows that anthropogenic climate change is altering the livelihood options of people in their habitual residence (Jayawardhan 2017). A number of influential studies (Tacoli 2009; Piguet et al. 2011; McLeman 2017) have attributed the increased rate of involuntary migration taking place across the world to the impacts of climate change. Myers (1995) projected that by 2050, about 200 million people will be displaced in response to the unmanageable impacts on livelihoods, linked to climate change and other natural hazards. The Global Estimation Report (2014) claimed that in 2013, approximately 22 million people around the world were newly displaced due to the pressure of natural hazards, whereas many of those incidents were linked with climate change (IDMC 2014). In Asia, the number of displacement incidents increased significantly in the past decade along with a rising number of incidents of natural hazards (IOM 2010). For instance, in 2013, 17 out of 20 largest displacement incidents worldwide were noticed in Asia. Typhoon Haiyan, the strongest cyclone ever recorded at land caused over 7,000 death and displaced about four million people in central Philippines (The Daily Telegraph 2013). In the same year, cyclone Mahasen displaced about one million in the coastal areas of Bangladesh and approximately 35,500 people from Rakhine state in Myanmar (The Guardian 2013). In many cases, those who have been displaced due to such extreme weather events have lost livelihood opportunities in their usual places of residence (Biermann and Boas 2010). Moreover, the existing government and nongovernment organizations and funding mechanisms in many affected countries are hardly equipped to restore basic livelihood opportunities to affected places (Biermann and Boas 2010).

In many resource poor country settings, the decision to migrate is often taken as an intuitive reaction to the climatic shock on people's livelihoods. Recent studies including Stojanov et al. (2016) contributed to the understanding of the relation between climate change impacts on livelihood and migration as an autonomous response at the community level. Studies also illustrated the pressure of climate variability and its impacts on pastoralists' livelihood in southern Ethiopia (Ayal et al. 2018), seasonal migration of agricultural labors during drought in the Sahel region (Black et al. 2011), and local migration as a prevalent livelihood strategy to cope with drought in northeast Brazil (Barbieri et al. 2010). Studies also suggested that recent climate change is severely impacting the agricultural sector and acting as migration push factors in many agricultural regions of the world. Islam and Hasan (2016) found that about 54% of the Cyclone Aila affected migrants in Bangladesh attributed their migration to damages to their homes and cultivable lands. Previously, Mallick and Vogt (2012) found that after Cyclone Aila, adults from households with the lowest monthly income had the highest migration rate from the affected coastal areas in Bangladesh compared with all others. Kabir et al. (2018b) demonstrated that unmanageable financial stress such as institutional microcredit burden is significantly influencing small holders' decision to migrate for long-term from the northern drought prone areas of Bangladesh. However, the majority of Bangladesh's disadvantaged rural population tend to adopt repetitive patterns of short-term or seasonal migration to supplement their livelihoods during lean periods (Martin et al. 2014). Involuntary migration can be a disruptive process, often involving financial, social, and emotional risks for the disadvantaged migrants and their family members; hence, it is often the last form of response to be attempted (McLeman 2017).

Nevertheless, involuntary rural-urban migration often replaces one set of risks with another, especially when urban destinations are poorly equipped to provide basic human necessities to the new migrants. Thus, migrants affected by climate change at their places of origin may become exposed to a second level of stress at urban destinations, where new hazards may reinforce existing vulnerabilities (McNamara et al. 2016). Urban areas are particularly exposed to unique climatic risks including urban heat island effects, impervious surfaces exacerbating flooding, and sea level rise in coastal cities (Doherty et al. 2016). In the fourth assessment report, the IPCC also warned that heat related mortality in urban areas will be increased in some regions as one of the consequences of the recent global warming (IPCC 2008). Since appropriate housing is not reachable for disadvantaged migrants in cities, the majority of the low income migrants in many cities live in slums or squatter settlements (Elsey et al. 2016). Due to a lack of education, access to social networks, and appropriate skills, the slum dwellers are often forced to accept low-paying but difficult jobs in the informal economy (Pawar and Mane 2013). Although desperate efforts to improve their livelihoods are placed, the urban extreme poor lacks saving opportunities, access to basic services, and access to credit (Elsey et al. 2016). Moreover, due to the higher living costs in cities, many migrants living in urban slums leave their children at their rural residences in the custody of other family members. Ajaero and Onokala (2013) found that due to the pressure of sending remittance to the family members in rural areas, disadvantaged migrants living in cities suffer from low real income. Such a double financial pressure also limits their ability to access other basic needs including healthcare benefits when needed. In brief, increased financial expenditure, unhealthy living conditions, and lack of access to basic services are key issues for disadvantaged migrants in cities which are also associated with their lower capacity to recover from disasters and adapt to urban climate change impacts.

Moving Forward

This chapter focused on the interactions between climate change effects and human livelihoods through trans-local (between rural and urban) and cross-sectoral analyses. As rural and urban areas are strongly interconnected and interdependent, climate change is likely to exacerbate cross-scale interactions between these two regions. Again, understanding cross-sectoral impacts of climate change on livelihoods is critical because such insights will develop capacities of decisionmakers with holistic views on climate change impacts, instead of considering single sectors in isolation (Harrison et al. 2015). Given that the Sustainable Development Goals adopted by the United Nations member states in 2015 cover 17 broad and interdependent goals ranging from "zero hunger" to "climate actions," a lack of sufficient response to climate change impacts will persistently erode the basis of these goals (Rodriguez et al. 2018). The rapid urban growth in the Global South, loss of agricultural yields, risks of hunger and undernutrition, land degradation, loss of biodiversity, increased water stress, and loss of human settlements among others are exacerbating existing livelihood vulnerability of the poor and disadvantaged people to climatic changes and other extreme weather events. Hence, tackling livelihoods sustainability demand, the practitioners stress the importance of such multidimensional climate change challenges, become well equipped with essential climate change adaptation planning, and recognize that different sectors will pose concomitant challenges for development managers due to various social-economic, environmental, and climatic uncertainties.

The examples presented in this chapter are not unique to climate change effects. However, these should be helpful to understand the climate change effect on people's livelihoods to a wide range of social-ecological settings and changes. To implement adaptation interventions that enhance support to the most vulnerable, it is imperative to improve our understanding of both how people are likely to be affected by climate change and other natural hazards and how they may possibly react to such circumstances. In order to properly understand future livelihood risks associated with climate change, more interdisciplinary research is necessary. This includes research that focuses on (i) climate change impacts on human-environment systems and future social-ecological challenges; (ii) how individuals are likely to deal with different adverse climatic situations; and (iii) increasing developing countries' capacity to monitor climate change effects to better understand cross-sectoral impacts.

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