Chapter II

Climate change and inequality nexus

Key messages

- Climate change and inequality are locked in a vicious cycle. Initial socioeconomic inequalities determine the disproportionate adverse effects of climate hazards on people at disadvantage. The impact of climate hazards in turn results in greater inequality.
- Climate hazards affect the poor and vulnerable groups disproportionately by (a) increasing their exposure to those hazards, (b) increasing their susceptibility to damage and (c) decreasing their ability to cope with and recover from that damage.
- Existing exposure and vulnerability have been shaped by the economic and political factors, social norms and individual characteristics that put vulnerable groups at a disadvantage. Because of the lack of capacity to cope and recover, vulnerable groups frequently experience a disproportionate loss of life, human capital, assets and income.
- Addressing the root causes of inequalities to enable adaptation and the building of resilience to climate hazards will require a continuum of development policies, planning and practices which result in transformative change and sustainable development.

Introduction

The interlinkages between climate change and inequality need to be understood and addressed here and now. This is a critical aspect This is a critical aspect in the process of strengthening the capacity of countries and people to avoid development reversals from climate hazards. Owing to structural inequalities, loss of life, injury and other health impacts, as well as the damage to and loss of property, infrastructure, livelihoods, service provision and environmental resources caused by climate hazards, are not felt evenly by all people.

The nexus between climate change and inequalities is complex

The nexus between climate change and inequality is complex: there is not only the threat of multiple climate hazards (see chapter I), but also because not all inequalities and their root causes are the same. In fact, inequalities are multi-dimensional and they need to be understood and addressed as such to build resilience to climate hazards and avoid development reversals.

There is need for a better understanding on why climate hazards affect people unevenly owing to structural inequalities. This requires shifting from a narrow focus on identifying only the physical impacts of climate change, towards a broader analysis which also incorporates the socioeconomic impacts of climate hazards.

Initially, the discussion on climate change focused mostly on the physical impacts (i.e., nature). With time, however, the social consequences of climate change received more attention, and evidence regarding the relationship between climate change and poverty began to emerge. Even so, the interlinkages between climate change (and hazards) and multidimensional inequalities have yet to be fully explored. The role of the underlying structural causes of inequalities is also poorly understood. The objective of the present chapter is therefore to bridge these gaps, which will in turn provide the foundation for a discussion centred on the policy challenges related to building resilience to climate hazards.

Climate hazards intersect with multi-dimensional inequalities to generate uneven impacts on people and their livelihoods

The chapter examines the links between climate change and inequalities. More specifically, it shows that they are locked in a vicious cycle, whereby initial socioeconomic inequalities determine the disproportionate adverse effects arising from climate hazards, which in turn results in greater inequality. This discussion is followed by a thorough review of the evidence demonstrating that the multiple dimensions of inequality (as they relate, inter alia, to income, assets, political power, gender, age, race and ethnicity) underlie a situation where disadvantaged groups are more exposed and susceptible to climate hazards and possess less capacity to cope and recover when those hazards have materialized. Further, it is shown that as a result, inequality is exacerbated. The review of the evidence covers different types of hazards in different geographical areas, although it pays particular attention to the experiences associated with Hurricane Katrina in the United States of America, flooding in Bangladesh, and severe water loss and desertification in the Sahel region of Africa. The chapter concludes with a discussion of the policy implications of addressing the root causes of inequalities for adaptation and building resilience to climate hazards.

The social impact of climate change

The initial discussion of climate change was focused on its physical impact

As noted above, the discussion on climate change originally focused on its physical impact. Relatively less attention was paid to the implications of that physical impact for the lives, livelihoods of the people who are most vulnerable and most affected. To quote Skoufias, ed. (2012, p. 2):

> *While the eyes of the world have been riveted on polar bears, Antarctic penguins, and other endangered inhabitants of the Earth's shrinking ice caps, relatively few researchers have turned serious attention — until recent years — to quantifying the prospective long-term effects of climate change on human welfare.*

Part of the problem is that it took time for researchers across different disciplines to develop and then test the methodologies that allowed for a broadening of the focus to include socioeconomic impacts and the need to address them.

Poverty and livelihoods

Over time, the broader social impacts of climate change and their feedback effects garnered more attention. New studies emerged, particularly as biophysical and socioeconomic impacts began to be examined in an integrated manner through the use of specialized modelling techniques (see chap. III).

One early study in this regard (World Bank, 2003), which was launched at the eighth session of the Conference of the Parties to the United Nations Framework Convention on

Climate Change, noted that climate change was making achievement of the Millennium Development Goals difficult by reducing access to drinking water, threatening food security and bringing about adverse health effects.

Many studies examined the social impact of climate change at the global level...

Other studies on the issue followed. The Stern report (Stern, 2006) noted that climate change was expected to increase poverty owing to its effects on agriculture, flooding, malnutrition, water resources and health. The 2007/2008 Human Development Report (United Nations Development Programme, 2008) devoted an entire chapter (2) to a discussion of the vulnerability and risk arising from climate change in an unequal world. The interaction between climate change and human development has also been analysed in Carvajal-Velez (2007), United Nations Economic Commission for Africa (2010) and Hughes and others (2012). Previous reports of the Intergovernmental Panel on Climate Change (IPCC) drew upon this discussion as well.[1]

Similarly, the *Global Monitoring Report 2008: MDGs and the Environment – Agenda for Inclusive and Sustainable Development* (World Bank, 2008) pointed to the potential impacts of climate change on poverty and development. Brainard, Jones and Purvis, eds. (2009) explored a wide range of impacts of climate change on poverty and some recent studies have examined the issue using cross-country data. Skoufias, Rabassa and Olivieri (2011) reviewed several such studies, taking note of the different methodologies used, the units of analysis adopted and the various policy suggestions put forth.

...while others focused on the impact of climate change on poverty and livelihoods in particular countries

Some studies considered the impact of climate change on poverty and livelihoods in particular countries. For example, Paavola (2008) focused on the Morogoro region of the United Republic of Tanzania; Somanathan and Somanathan (2009) on India; and Gentle and Maraseni (2012) on mountain communities in Nepal. Many studies focused on poverty impacts in specific sectors, such as agriculture (see, for example, Ahmed, Diffenbaugh and Hertel (2009); Hertel, Burke and Lobell (2010); Hertel and Rosch (2010); and Müller and others (2011), or in particular settings, such as urban areas (see, for example, Satterthwaite and others (2007); Douglas and others (2008); and Hardoy and Pandiella (2009)). These studies cover a broad range of climate change issues, including crop and structural damage, reduced agricultural output and higher food prices, reduced food security, increased unemployment, general uncertainty, involuntary migration, potential maladaptation, the need for responsive adaptation, rising social inequality, and differences in exposure and susceptibility to climate hazards.

From gathering the broad evidence of the effects of climate change on poverty and livelihoods, research gradually shifted to investigating the mechanisms through which those effects operate. Shared socioeconomic pathways (SSPs), introduced in chapter I, were devised to consider the human development-related aspects of climate change under such different narratives. Using SSPs in an integrated fashion with other methodological tools, Hallegatte and others (2014) identified prices, assets, productivity and opportunities as four key channels through which households may move in and out of poverty, and further examined the effect of climate change on each of them.

1 Considerable research was devoted to studying the potential health impacts of climate change, with a World Health Organization Task Group addressing the issue as early as 1989 (World Health Organization, 1990). The report of the Task Group was later expanded into the volume entitled *Climate Change and Human Health* (McMichael and others, 1996). In 2010, the Interagency Working Group on Climate Change and Health published a report highlighting 11 different pathways through which climate change could be expected to exacerbate detrimental health outcomes (Portier and others 2010).

The IPCC made an important contribution to the discussion on effects of climate on poverty and livelihoods

Further, in its contribution to the periodic IPCC Assessment Reports, Working Group II gradually increased its focus on the human dimensions of climate change impacts. In its contribution to the Fifth Assessment Report, particularly to chapter 13 of part A (see Olsson and others, 2014), Working Group II provided an extensive review of the evidence from all parts of the world, both statistical and anecdotal, regarding the dynamic interaction between climate change and livelihoods and poverty. Leichenko and Silva (2014) provided a synthesis in which they noted that the connections between climate change and poverty are "complex, multifaceted, and context-specific". Hallegatte and others (2016) provides comprehensive guidance on joint solutions through which poverty reduction policies and climate change mitigation and adaptation policies can reinforce each other.

Because of the complexity underlying the physical and socioeconomic impacts of climate change, time was required to develop the integrated climate impact assessment methodologies that have supported the studies described above (see chap. III). However, the nexus between climate change and structural inequalities still requires further research, as the focus has been mainly on poverty-related implications, rather than on the multiple inequalities that may have exacerbated poverty and vulnerability.

From poverty and inequality to structural inequalities

The discussion on the impact of climate change on poverty has more recently been expanded to include consideration of the impact of climate change on inequalities. As noted in Olsson and others (2014, p. 796), the Fourth Assessment Report had already pointed out "that socially and economically disadvantaged and marginalized people are disproportionately affected by climate change". Similarly, in Skoufias, ed. (2012, p. 6) it was observed that "climate change impacts tend to be regressive, falling more heavily on the poor than the rich"; the study also noted (within the context of the effects of climate change on Brazil) that "there is significant geographical variation, with already-poor regions being more affected than prosperous regions" (p. 5).

However, despite the progress highlighted above, the discussion of the interlinkages between climate change and inequalities suffers from three important deficiencies.

Most studies treat inequality as a secondary issue: the focus of concern continues to be poverty

First, most studies treat inequality as a secondary issue: the focus of concern continues to be poverty. Moreover, few studies incorporate equity considerations; and the methodologies are generally not suited to tracing the impacts on specific groups that are particularly vulnerable (see table III.1 in chap. III for more details). Poverty and inequality are indeed clearly interwoven: At a given level of income, a more unequal distribution is likely to raise poverty; and similarly, an increase in poverty, at a given level of income, is likely to be associated with worsening inequality. Furthermore, while studies focused on poverty do take note of income and assets, inequality is in fact multidimensional and is determined by myriad factors which both intersect and are structurally entrenched, including discrimination based on gender, age, ethnicity, race, religion and culture; unequal access to basic services (such as health and education); and unequal opportunities for political participation and exercising a voice in policy decision-making, among others. The structural inequalities resulting from the interaction among these different factors impose a differential impact of climate hazards across population groups.

As emphasized in chapter I, it is important to advance beyond a narrow monetary concept of inequality towards a broad understanding of multiple inequalities and their structural causes. Even in countries with low income poverty, as is the case for many developed countries, climate hazards have a disproportionate impact on individuals and communities facing other forms of discrimination based on race, ethnicity and other characteristics. In countries where poverty is widespread, the people living in poverty suffer disproportionately from climate hazards not only because they are poor but because of their unequal standing in society.

References to inequalities are more frequent in the contribution of Working Group II to the Fifth Assessment Report than in its contribution to previous reports. In the Fifth Assessment Report, Working Group II notes that socially and geographically disadvantaged people, including those facing discrimination based on gender, age, race, class, caste, ethnicity and disability, are particularly affected by climate hazards (Olsson and others, 2014, p. 796). Exacerbation of inequalities which place such people at a disadvantage can occur through disproportionate erosion of physical, human and social assets;[2] Working Group II offers evidence in this regard with respect to those types of assets. Even climate change adaptation expenditures are often found to be driven more by wealth than by need, with the result that those expenditures end up aggravating income and wealth inequality both within and between countries (Georgeson and others, 2016). In addition, some adaptation measures shift risks onto populations already facing greater exposure and susceptibility to climate hazards (Lebel and Sinh, 2009).

Evidence provided on the relationship between climate change and inequalities is often indirect

Second, the evidence on the relationship between climate change and inequalities provided so far is often indirect. In many cases, the discussion remains limited to general statements, or the reference to inequality is only contextual. Often, the evidence provided is location- and impact-specific and extrapolations are made on this basis. Relatively few studies have attempted to examine the effect of climate change on inequalities *directly*.

There is a lack of a unifying analytical framework

Third and most important, there is a lack of the unifying analytical framework necessary for a discussion of the relationship between climate change and inequalities. As a result, the evidence presented is characteristically scattershot. The Fifth Assessment Report itself recognizes this deficiency, noting that "(d)espite the recognition of these complex interactions [between climate change and inequality], the literature shows *no single conceptual framework* that captures them concurrently" (Olsson and others, 2014, p. 803; italics added). That such a problem exists is to a large extent explained by the fact that inequalities have not featured prominently in the most comprehensive climate impact assessments which have shaped the discussion on climate change (see chap. III for further consideration of this issue).

The following sections provide a systematic analysis of the links between different dimensions of inequality and climate change and in this regard offer empirical evidence concerning the main interconnections. This exercise is a critical first step towards bridging the gulf separating climate change policy and development policies.

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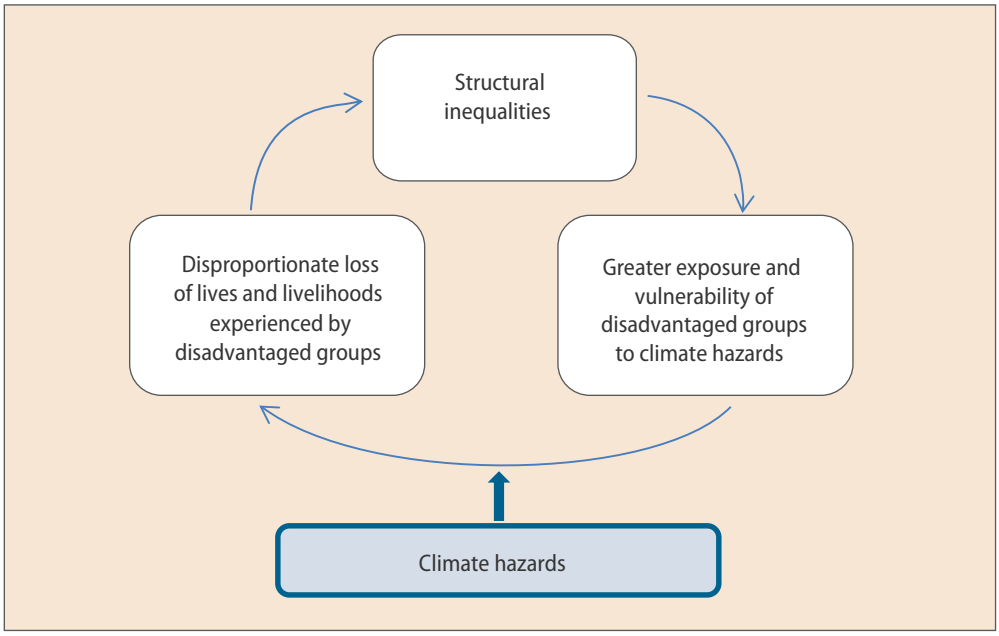
2 In the contribution of Working Group II to the Fifth Assessment Report, the term *asset* refers to "natural, human, physical, financial, social, and cultural capital". Livelihoods are understood to be the "ensemble or opportunity set of capabilities, assets, and activities that are required to make a living" (Olsson and others, 2014, p. 798). The present chapter will continue its exploration with this concept in mind.

Links between climate hazards and inequalities

Climate change and structural inequalities are locked in a vicious cycle

Existing evidence suggests that climate change and structural inequalities are locked in a vicious cycle. To begin with, climate hazards aggravate the pre-existing socioeconomic inequalities that determine poverty, marginalization and social exclusion. Structural inequalities increase the exposure and vulnerability of certain groups of people and communities to climate hazards and through this greater exposure and vulnerability, disadvantaged people and communities experience disproportionate losses in terms of their lives and livelihoods. If left unaddressed, the stress induced by climate hazards will worsen inequalities (in respect of physical, financial, human, social and cultural assets), thus perpetuating the above-mentioned vicious cycle between climate change and inequalities (figure II.1).

Figure II.1
The vicious cycle between climate hazards and inequalities



Source: UN/DESA.

The main focus of the present chapter is on elucidating how inequalities increase the risk of climate hazards among particular groups and providing evidence in this regard, as well as on examining the multiple generators of those inequalities.

Inequalities increase the risk of climate hazards

Structural inequalities increase exposure and susceptibility and decrease people's ability to cope with and recover from the effects of climate change

IPCC situates climate change risk at the intersection of exposure and vulnerability (see chap. I, figure I.4). Exposure refers to the presence of people, livelihoods, infrastructure, or economic, social or cultural assets in places and settings that could be adversely affected. Vulnerability has two facets which need to be distinguished. One is the propensity or predisposition to be adversely affected by climate hazards, which is referred to in this chapter as susceptibility to the damage inflicted by climate hazards. The other is the inability to cope with and recover from that damage. Evidence and analysis show that

structural inequalities increase both the exposure and susceptibility[3] of certain groups of people to climate hazards; structural inequalities also decrease their ability to cope with and recover from damage.

Exposure, susceptibility and the inability to cope and recover are interrelated. However, while exposure and susceptibility apply to situations and processes that are ex ante in nature, the ability to cope and recover apply to situations and processes ex post, that is to say, those in which climate hazards have already materialized.

Structural inequalities increase the exposure of some groups of people to climate hazards, such as flooding, erosion, cyclones and hurricanes, when they live in areas that are more prone to such hazards. The various reasons that make this so are usually associated with the cost of housing, which in some contexts is combined with political and administrative restrictions arising from discriminatory policies. Greater exposure to climate hazards often leads to greater susceptibility as is the case, for example, for people living in areas of flooding whose houses have been built with flimsy materials and often contain a poor drainage infrastructure. Under these conditions, they are not only exposed but also susceptible to climate hazards. Finally, inequalities decrease the ability of disadvantaged groups to cope with and recover from hazards if they lack insurance, if they cannot diversify their income sources and if the provision of public services is insufficient to assist them in their recovery.

Multidimensional channels of inequality

Economic, political and social inequalities increase exposure and vulnerability to climate hazards

People's greater exposure and vulnerability to climate hazards is largely influenced by economic, political and social factors which intersect and create inequalities. In unequal societies, there are large differences in the capacity of people to avoid the devastating impacts of climate hazards.

There are people who can protect themselves from climate hazards through their control of capital which enables them to make choices in respect of investment (Stiglitz, 2012; Dabla-Norris and others, 2015), accumulate wealth (Piketty, 2014), withstand the effects of fluctuations in aggregate demand (Carvalho and Rezai, 2014), influence politics and policies (Page, Bartels and Seawright, 2013; Gilens and Page, 2014) and exert greater control over their participation in the labour force (which is particularly significant in the case of women) (Gonzales and others, 2015) and over employment decisions (Dabla-Norris and others, 2015). By contrast, people with limited economic resources, especially those living in poverty, have less capacity to exercise control over their participation in the labour market and to protect themselves in general (*Report on the World Social Situation 2016*, chap. II), let alone in the face of climate hazards.

Inequalities are also reinforced through the political channel. In this regard, disadvantaged groups have less access to public resources (such as health, education, infrastructure and the judicial system) and fewer opportunities to participate in and influence policy decisions (United Nations, forthcoming, chap. III). They also receive relatively fewer of the public resources needed to respond to climate hazards (Silva, 2016). The existence of entrenched inequalities in the domain of access to power and political representation leads to the adoption of public policies that leave people vulnerable and more exposed to climate hazards.

3 As illustrated in figure I.5, susceptibility and the lack of the ability to cope are the factors that define vulnerability.

The social channel interacts with the economic and political channels to limit the provision of both private and public resources to those most in need of them. In particular, marginalization and social exclusion lead to a reduction of social capital and access to community resources.[4] The social channel works in a number of ways, including through the establishment of social norms which determine that women and minorities are to engage in certain occupations, and through the effects of discrimination and exclusion. Certain groups are able to exercise control over common property based on their social position vis-à-vis other marginalized groups. As noted above, these norms and distinctions also interact with the mechanisms of other channels to determine who is to be deemed capable of participating in economic and political activities. This curtailing of access thereby limits the opportunities of marginalized individuals and groups to build up their own supply of resources and to access public resources.

The following sections review the empirical evidence, as contained in the literature, on the relationship between pre-existent socioeconomic inequalities and their impact on the exposure, susceptibility and ability to cope and recover of people and communities at disadvantage. The evidence often concentrates on extreme weather events whose timing has sharp cut-off points, which makes those events suitable for "before and after" impact studies. While slow-onset hazards also have devastating consequences for livelihoods, their impact is more difficult to capture, as it is often blurred by other sources of socioeconomic vulnerability. Slow-onset hazards pose a major challenge to the policymakers and correct identification of their impact on people's livelihoods is critical for the design of actions appropriate to building resilience. Notwithstanding, the uneven effects of slow-onset hazards do find empirical support in the existing literature.

Inequalities and exposure to climate hazards

Exposure to climate hazards often depends on the location of dwelling and location of work

Exposure to the adverse effects of climate change is generally determined by the location of one's dwelling and the location of one's work to secure a livelihood. Intersecting economic, political and social factors play a role in determining those locations. The ways in which these factors operate demonstrate that degrees of resilience to climate hazards are not equal. Asset positions and livelihoods determine whether people can afford to move away from areas of risk in the face of climate hazards. The problem of exposure is particularly acute in densely populated and land-scarce countries (e.g., Bangladesh, India and the Philippines, among many others) and affects both rural and urban areas. As households with higher incomes bid up the price of real estate, those with lower incomes are forced into living spaces and geographical areas that are more exposed.

The confluence of economic and political factors

Vulnerable population groups frequently live in marginal areas and…

Often, economic and political factors interact and influence the location decision and exposure outcome. Low-income groups and those subject to other forms of discrimination are frequently forced to live in marginal areas as a result of restrictions on available land and housing units. This may occur through official or unofficial restrictions or other socially devised constructions.

4 For a full discussion of the concept of social exclusion, see *Report on the World Social Situation 2016* (United Nations, forthcoming), chap. I.

Inequality also gives shape to the administrative regulations that influence where some people will reside and whether they will experience exposure in climate hazard-prone areas (United Nations Human Settlements Programme (UN-Habitat), 2003). For example, it was not only economic but also administrative restrictions that had led to the concentration of large numbers of disadvantaged people in Irrawaddy Delta, the lowest-lying expanse of land in Burma, which was hard hit by Cyclone Nargis in 2008 (Mutter, 2015).

In the case of slums, there are interaction effects: social exclusion may drive the members of some groups into slums, with slum dwelling then becoming the basis for further social exclusion (Arimah, 2011).

As a result of combined economic and racial inequalities, African Americans living in poverty constituted the majority of the residents of vulnerable low-lying sections of the city of New Orleans. By contrast, the wealthier residents were more likely to live — literally — on higher ground. Both economic and politically mediated influences of inequality, including discriminatory practices, joined in producing this particular spatial distribution of the population. In consequence, the impact of Hurricane Katrina was felt disproportionately by populations that were African American (Brookings Institution, 2005; Logan, 2006). Indeed, people in areas damaged by the hurricane were twice as likely to be African American as not (Brookings Institution, 2005).

The phenomenon of Katrina also attests to the role of inequality as shaped through the political channel. For example, the districts inhabited primarily by wealthy households had better protective infrastructure, even if their elevation was also low; by contrast, in areas where residents were poor, less attention was paid to protection. In fact, it can be argued that the Industrial Canal, which bounds the Lower Ninth Ward to the west, was constructed in that particular area because of the limited political power of its residents. While it is true that other components of the critical infrastructure failed during the hurricane, it was parts of the Industrial Canal that were among the first to do so (Mutter, 2015).

The experience of floods in Bangladesh provides another illustration of how the effects of climate change are aggravated by inequalities. Given that Bangladesh is a delta, the overflowing of its rivers onto the floodplains is a natural and expected phenomenon; climate change, however, is aggravating inland flooding in several ways.[5] Approximately 20.3 per cent of the population, amounting to almost 30.5 million people, is expected to be affected by river floods in a given year, with a significant portion of gross domestic product (GDP) to be decreased by inland flooding. Different scenarios demonstrate that the population exposed to this phenomenon will increase, with climate change being one of the drivers of this trend (Luo and others, 2015; World Bank, 2013; Dasgupta and others, 2010).

…when hit by a climate hazard, they are disproportionately affected

In general, low-income and other disadvantaged groups in Bangladesh face greater exposure to flooding as a result of their having settled in areas that are more flood-prone. Twenty-five per cent of poor households, for example, were exposed to the effects of Cyclone Aila in 2009, versus 14 per cent of non-poor households (Akter and Mallick, 2013). Further, 75 per cent of people living in poverty were exposed to the 1998 floods, compared with 71 per cent of the non-poor (del Ninno and others, 2001).

Given the ethnic homogeneity of the population of Bangladesh, discrimination of a political and administrative nature plays a less important role in forcing people to live in areas — either inland riverine or coastal — that are prone to flooding. The compelling motive is therefore for the most part an economic one. In Bangladesh, the most densely

5 For more details on the ways in which climate change is aggravating flooding in Bangladesh, see, for example, Islam and others (2014) and Rana and others (2011).

populated country in the world, land is scarce. As a result, people with low incomes flock to the areas that are the most risk-prone and hence less in demand among the more advantaged sections of the population.

Similarly, economic factors force people to live in flood-prone sections of urban areas. In examining the factors motivating people to migrate from rural areas to the slums of Dhaka city, Ullah (2004) found that the search for employment, lack of land, easier access to the informal sector and overall extreme poverty were the most relevant. Similarly, the United Nations Children's Fund (2009) noted that the lack of comprehensive land planning coupled with the pressures of economic migration has led to a considerable expansion of the slum populations in Bangladesh. In most cases, the slums are located in relatively low-lying areas that are exposed to flooding.

Demographic trends

Many of the disadvantaged population in developing regions live in low-elevation coastal and flood-prone zones, and…

A significant proportion of the population in developing regions live in low-elevation coastal zones and 100-year floodplains, and their number is increasing both in absolute terms and as a share of the population (Neumann and others, 2015; see also chap. I). A large proportion of the populations of low-elevation coastal zones is rural: 84 per cent in Africa, 80 per cent in Asia, 71 per cent in Latin America and the Caribbean and 93 per cent in the least developed countries. Rural areas are in general poorer, more remote and the inhabitants tend to be marginalized, particularly with respect to access to services and infrastructure. In general, the ecosystems of coastal and near-shore habitats are expected to have greater exposure to the effects of climate change and climate variability (Barbier, 2015). It is also instructive to note that more people now live in deltas, which are frequently subject to both coastal flooding due to sea-level rise and river flooding due to higher precipitation (see chap. I, table I.2). Researchers find that a greater proportion of the people living in the precarious parts of deltas belong to disadvantaged groups (Luo and others, 2015; Brouwer and others, 2007). Generally, it is the people living in poverty and other disadvantaged groups that find themselves compelled to live in those areas, despite their awareness of the inherent risks associated with such exposed locations.

…they are affected as well by increased salinity intrusion

In addition to experiencing flooding and erosion, the people living in coastal areas and deltas must confront salinity intrusion, a process that is exacerbated by climate change (Dasgupta and others, 2014; Rabbani, Rahman and Mainuddin, 2013). Salinization can cause a considerable decrease in agricultural productivity; increased aridity leading to a greater need for irrigation can bring about secondary salinization, thereby aggravating the impact of this problem (Pitman and Läuchli, 2002). Shameem, Momtaz and Rauscher (2014) estimate that 70 per cent of the farmers in some coastal areas gave up farming partially or fully owing to high levels of salinity. Due to their concentration in coastal areas and deltas, disadvantaged groups are thus more exposed to the salinity intrusion caused by climate change.

Greater exposure of disadvantaged groups to climate hazards is not limited to rural areas. A similar phenomenon can be observed in urban areas. For example, Braun and Aßheuer (2011) have found that slum dwellers in Dhaka are more likely to live in areas prone to natural hazards and similar findings are presented in Morin, Ahmad and Warnitchai (2016) for Manila. In general, many slums are located in low-lying land at high risk of flooding. As reported by Petley (2010), Painter (2007) and Sepúlveda and Petley (2015), it

has been found that in many countries, including those in South and East Asia and Latin America and the Caribbean, disadvantaged groups build their dwellings at the bottom of hill slopes, thereby exposing them to mud slides, which are becoming more frequent owing to climate change.

About 40 per cent of the Earth's land surface comprises, and 29 per cent of the world's population lives in, arid, semi-arid and dry sub-humid zones, which are facing additional challenges owing to climate change. There is a larger concentration of the poor and other disadvantaged groups of people (such as pastoralists and ethnic minorities) in these areas.

Cross-country data show the greater exposure of disadvantaged people to water scarcity

Two thirds of the global population are estimated to live under conditions where water scarcity is severe for at least one month per year (Mekonnen and Hoekstra, 2016). Water scarcity is expected to increase as the climate changes. For example, under scenarios where emissions growth rates are not reduced, the number of people exposed to droughts could rise by 9-17 per cent by 2030 (Winsemius and others, 2015). Exposure to drought is higher in rural compared with urban areas (43 per cent versus 32 per cent). This implies a greater exposure to drought of disadvantaged groups, which make up a larger portion of the rural population. Climate change is also expected to increase the frequency and intensity of heat waves, with particular effects on the elderly, who are more susceptible, as further explained below (Kovats and Hajat, 2008; Luber and McGeehin, 2008; Olsson and others, 2014).

Cross-country data also point to the greater exposure of disadvantaged people to water scarcity. According to Christenson and others (2014), exposure to water scarcity is much greater in countries with a lower human development index (HDI) value than in those with a high HDI value: 50 per cent of countries with a low HDI value are exposed compared with 14 per cent of countries with a very high HDI value. Given the higher rates of households engaged in agricultural production in rural areas and low-income countries, a further increase in the exposure of these households to droughts can be expected.

Gender and livelihood patterns

Gender-based inequalities play an important role in determining exposure to climate hazards

Inequalities that are rooted in gender differences play a role in determining the degree of exposure to climate hazards. The inequalities associated with the norms, social role and socioeconomic status imposed on women together with other forms of inequality account for the particular exposure and vulnerability of women to climate hazards (Neumayer and Plümper, 2007). Gendered differentials in access to resources, power and processes of decision-making, including on the allocation of resources and responsibilities within the household, make women particularly vulnerable to climate hazards. In other words, it is the intersection of various dimensions of inequalities, including those associated with gender, that produce the differential outcome, as noted by Perez and others (2015).

Women often face the issue of lower asset positions. This is particularly the case in rural areas, where access to land tenure, formal rental land markets and credit tends to be more restricted for women. Particularly in Africa, women are employed overwhelmingly in agricultural activities that are most at risk from the deleterious effects of climate change. As a result of drought and deforestation, women are spending more time sourcing food, fuel and water for the household, which is traditionally the responsibility of women in rural areas. Some evidence also indicates that it is women and children who are most affected by natural disasters. For example, the majority of victims of Hurricane Katrina were African

American women and their children, a group whose members are more likely to be poor, to lack health care and to earn low wages (Gault and others, 2005; Williams and others, 2006).

More broadly, in many countries, a large proportion of female working-age spouses are not economically active or are working without remuneration. Within the context of the Plurinational State of Bolivia, for example, this is the single most important factor associated with high vulnerability to shocks, not least of all those that are climate-related (see chap. III, box III.3).

Certain occupations increase people's exposure to climate hazards

Along similar lines, certain occupations increase people's exposure to climate hazards. For example, members of fishing communities living near rivers or the coast are more exposed to flooding, erosion, cyclones and other such climate hazards; and they are particularly vulnerable to those hazards in the absence of effective adaptation. There is also evidence that the culturally defined farming responsibilities of women in Nepal limit their ability to adapt to climate change through adjustments in their livelihoods, which thereby increases the risk of their exposure to future climate hazards (Silva, 2016).

There are many regions of the world at risk of experiencing climate hazards where the livelihoods of disadvantaged groups depend on agriculture. This is the case for the Sahel region of Africa, which suffered a dramatic change in climate in the period between the early 1970s and the late 1990s, with a decline in average rainfall of more than 20 per cent (Hulme and others, 2001).[6] Desertification is estimated to be spreading at the southern edge of the Sahel by 6-10 kilometres per year, as water stress increases as a result of climate change (Silva, 2016). The region is also notable for having considerable climate variability, with relatively extreme shifts between wetter and drier periods (Ben Mohamed, 2011). Much of the region also has a high frequency of droughts, over longer timescales.[7]

Pastoralist populations of the Sahel region are facing greater exposure to climate change impacts

The problem is that much of the agricultural activity in the Sahel region is rain-fed, particularly for asset- and income-poor farmers. According to the evidence, the greater exposure of poorer households to droughts in the region varies by country, with Ethiopia, Nigeria and Senegal showing significant increases, and Burkina Faso and the Niger showing minor and moderate non-poor biases, respectively (Winsemius and others, 2015). The overall proportions of people exposed to drought are expected to rise considerably across much of West Africa under high-emissions scenarios (ibid.). At the same time, some parts of the Sahel are expected to see increases in rainfall, which will likely result in the expansion of agriculture and the further displacement of pastoralists (Brooks, 2006). In other areas, such as in Mali, changes in rainfall patterns are anticipated to increase the exposure of significant portions of the population as certain areas become more arid, with significant effects on livelihoods and undernutrition (Jankowska, Nagengast and Perea, 2012). Pastoralist populations — the Tuareg, for example, in the Niger — are also subject to high levels of location-based exposure to climate change impacts (Silva, 2016). Poor access to labour markets by these populations, coupled with the rural locations of livelihoods, limits the ability of some of them to relocate to less-exposed locations (ibid.).

6 While initially the change in climate was attributed to overgrazing and other direct human effects leading to land degradation and desertification, more recently it has been established that the change in rainfall patterns was largely due to broader changes in global surface temperatures (Brooks, 2006).

7 Despite these trends, there is still considerable debate regarding the prospective effects of climate change, with some areas expected to see increased desertification, other areas expected to see increased rainfall, and some others presenting a picture of uncertainty (Met Office Hadley Centre, 2010).

Inequalities and susceptibility to climate hazards

At a similar level of exposure, the disadvantaged groups are more susceptible to the damage caused by climate hazards

Even if they experienced the same level of exposure as the rest of the population, which runs counter to reality, disadvantaged groups would in general be more susceptible to damage from the adverse effects of climate hazards. Of the people living in the same floodplain, those residing in houses constructed with flimsy materials are more susceptible to damage from floods than those in houses put together sturdily. Similarly, poor farmers and pastoralists are more susceptible to changing rain patterns because they lack the resources to adapt.

Income, assets and livelihoods

Lack of income and of asset diversification make people more susceptible

Susceptibility increases when there is lack of income and asset diversification in absolute and relative terms. Wodon and others, eds. (2014) report that households in the lowest income bracket in five countries of the Middle East and North Africa—Algeria, Egypt, Morocco, the Syrian Arab Republic and Yemen—experienced higher losses of income, crops, livestock and fish caught as a result of adverse effects of climate change than did rich households. Lost income reported for the lowest-income households was more than double the proportion for the richest (46 per cent versus 21 per cent). Similarly, Gentle and others (2014) found that poor households in the Middle Hills region of Nepal are more susceptible to damage from climate hazards than wealthy ones. Hill and Mejia-Mantilla (2015) have shown that, because of limited options for changing crop patterns, limited ability to apply water saving technology and limited access to agricultural extension services and water storage sources, the farmers belonging to the lowest income bracket in Uganda lost greater shares of income from limited rainfall than did average farmers.

Patankar (2015) has shown that families in Mumbai within low-income brackets repeatedly require repairs to their homes in order to secure them against flood damage, with the cumulative cost as a proportion of income often proving to be much greater than the corresponding proportion for the rich. It is noteworthy that despite their lower levels of exposure to Hurricane Mitch, a considerably higher proportion of households in Honduras belonging to the lowest income bracket reported asset loss (31 per cent) compared with the corresponding proportion of those belonging to the higher income brackets (only 11 per cent) (Carter and others, 2007).

In Bangladesh, 42 per cent of people living in poverty reported loss of household income as a result of flooding versus 17 per cent of the non-poor (Brouwer and others, 2007); and people living in poverty also reported a greater number of houses with structural damage in the wake of Cyclone Aila. Furthermore, people living in poverty also reported higher levels of damage in dollar terms. This paradoxical outcome was the result of the fact that the houses of people living in poverty were constructed using very flimsy materials; as a result, those houses suffered considerably greater damage than did the houses of richer households, which had been built with sturdier materials (Hallegatte and others, 2016).

Flooding can be damaging in a multiplicity of ways. For example, flooding may wash away crops and livestock, in addition to destroying houses, and disadvantaged groups suffer disproportionately from these effects as well. In addition, they suffer to a greater extent from indirect market-based effects. For instance, many of the disadvantaged groups living in flood-prone areas in Bangladesh belong to fishing communities. Evidence suggests that they take an additional hit to their incomes when prices fall, as a result of the increased availability of fish made possible by the flood waters (Rahman, 2009).

People with fewer assets, worse health and less education are more susceptible to the effects of climate hazards

In the Sahel region of Africa, the livelihood of considerable portions of the population comes from farming or raising livestock. Given the predominantly rain-fed nature of these activities, farmers and pastoralists are particularly susceptible to the impact of climate hazards (Heinrigs, 2010). Lower-income households, and those whose members have fewer assets, poorer health and less education, along with those headed by women, have all been shown to be more susceptible to the effects of climate hazards in that region, particularly the effects of desertification (Adepetu and Berthe, 2007). Poor farmers and pastoralists tend to be more susceptible in general, given their limited ability to mobilize the resources necessary to adapt to lower levels of rainfall. That existing unequal arrangements already prioritize the access to water of large landholders over that of family farmers means that reductions in available water due to climate change will only exacerbate this inequality (Cotula, 2006). In addition, imbalances in political power, which have resulted in unstable land tenure as well as institutional and market failures, reinforce the marginalization of some groups (Silva, 2016). Further, desertification, the increased number of droughts and land degradation have been implicated in greater income inequality as well as decreased food security (Abdi, Glover and Luukkanen, 2013).

Lack of access to formal financial markets makes disadvantaged people more susceptible to climate-related damage

Susceptibility of lower-income households is also compounded by other limitations. Lack of access to formal financial markets, for example, makes people particularly vulnerable to shocks, including those from climate-related events, as is particularly the case for people who cannot build diversified asset portfolios and have restricted access to savings and insurance instruments. As a result, they are forced to channel the bulk of their savings into single assets. For example, the savings of low-income urban dwellers tend to take the form of housing stock, which is vulnerable to floods (Moser, 2007). Similarly, low-income persons in rural areas often keep their savings in the form of livestock, which are susceptible to droughts (Nkedianye and others, 2011), in contrast with the members of wealthier households, who are able to diversify their assets, both spatially and financially, and are therefore less susceptible to the damage arising from the adverse effects of climate change. Owners of financial assets may in fact face drought exposure similar to that experienced by the low-income rural poor whose assets take the form of livestock. However, since financial assets are far less likely than livestock to be affected by lack of water, the owners of financial assets are less susceptible to the damage caused by the decline in water availability. The greater levels of damage as well as the more limited diversification of savings and assets feed into a greater inequality of assets as a result of climate hazards. The greater susceptibility of disadvantaged groups can therefore usher in a future of widening of inequality, as children of families living in poverty are left with diminished assets and fewer opportunities and thus a reduced future capacity to improve their livelihoods.

Comparing the impact of flood hazards on street children, residents of low-income urban settlements and residents of wealthy neighbourhoods in Manila, Zoleta-Nantes (2002) found that the susceptibility of lower-income households was compounded by limited access to government and community resources, including water, sanitation and health services.

In parts of Punjab, Pakistan, neglect of some of the areas that are vulnerable to flooding has become institutionalized, the justification being that those areas should not be prioritized for development because of the risk from flooding. In the absence of policies aimed at relocating them or building their resilience to climate change, the members of these communities are being further exposed and will be susceptible to future impacts of flooding (Sindhu, Ensor and Berger, 2009).

Gender and age

Gender is a driver of susceptibility, particularly when it intersects with other socioeconomic factors, and in that context highlights important inequalities. A study of Turkana pastoralists found that gender, marital status, length of residency in a region, level of education and (lack of) access to extension services and early warning information were dominant factors in determining susceptibility, particularly given that the population lives predominantly below the poverty line. As a result of the impact of these factors, members of households headed by women, along with those characterized by a low educational level, a shorter time of residency and less access to extension services and early warning systems, were disproportionately susceptible to adverse effects of climate change (Silva, 2016).

Lower-caste families, women and other marginalized groups are more susceptible to the impact of climate change

Macchi, Gurung and Hoermann (2015) have noted that lower-caste families, women and other marginalized groups in Himalayan villages in north-west India and Nepal are more susceptible to effects of climate change and are also less able to adapt. Using household surveys and village focus-group studies conducted across nine countries in Africa, Perez and others (2015) found that a number of issues affecting women — including limited control of land (in terms of both quantity and quality), less secure tenure, less access to common property resources, less cash with which to obtain goods and services, and less access to formally registered public and private external organizations that foster agriculture and livestock production — make them more susceptible than men to impacts from climate hazards. Those issues arise from feedback effects between social norms that limit women's participation in some economic and social activities and the generally lower socioeconomic status of women that results from those limitations. Their lower socioeconomic status then limits the ability of women to access other services or to accumulate resources that would be beneficial in counteracting those social norms. Those women therefore get caught in a "disadvantage trap". Sherwood (2013) found that prolonged drought created just such traps for women in Gituamba, Kenya. In some locations, women's marital status, apart from the issues mentioned above, can be a driver of unequal access to resources. For example, Silva (2016) has found that widows and divorced women in many parts of the rural United Republic of Tanzania had less access to water resources. Similarly, Olsson and others (2014, p. 796) note that climate hazards increase and heighten existing gender inequalities because in many cases, women have to perform tasks, such as fetching water from afar or gathering fuelwood from forests, that entail a greater exposure to climate effects (Egeru, Kateregga and Majaliwa, 2014).

Within the context of flood-prone areas in Bangladesh, women are the most susceptible group owing to the fact that some of their socially determined livelihood activities, such as cleaning, washing and caring for children and the elderly, make them disproportionately susceptible to the effect of contaminated water (Rabbani, Rahman and Mainuddin, 2009). Issues of land tenure and elite capture of resources are other important factors associated with susceptibility in the flood-prone areas of Bangladesh (ibid.).

Apart from gender, age is another important determinant of susceptibility to climate hazards. For example, IPCC reports that flood-related mortality in Nepal among girls (13.3 per 1,000) was twice as high as that for women; similarly, the mortality was also higher for boys than for men (Olsson and others, 2014, pp. 807-808). These differential impacts apply across a variety of disadvantaged groups. For example, it was found that in Viet Nam, the elderly, widows and people with disabilities, in addition to single mothers

and women-headed households with small children, were most vulnerable to floods, storms and slow-onset events such as recurrent droughts (ibid., pp. 808-809). One of the main reasons for differential susceptibility across age groups is the difference in the ability to withstand disease and other adverse health effects of climate change.

The experience of Hurricane Katrina in New Orleans also brought to the fore this susceptibility differential across age groups. Overall, the elderly were the most impacted by the hurricane, as they were less able to relocate and were more susceptible to health-related impacts. More elderly white residents died, but when demographic differences are taken into account,[8] it was elderly African Americans who were the most affected (Mutter, 2015).

Ethnicity and race

The degree of susceptibility often depends on ethnicity and race

The degree of susceptibility often depends on ethnicity and race. Matin and others (2014) provide evidence showing that dominant ethnic groups are able to control resource management and resource use at the expense of other ethnic groups, thereby exacerbating the susceptibility of the latter. In Myanmar, poor and minority farmers who make up the bulk of the population in the Irrawaddy Delta, an area that had significantly greater exposure to Cyclone Nargis in 2008, were more susceptible to damage owing to a lack of effective warning systems and infrastructure. It is no wonder that they suffered most in terms of loss of lives, incomes and assets as a result of the cyclone. In this case, the lack of effective warning systems was, in part, the result of the discrimination faced by those ethnic groups in respect of resource allocation (Mutter, 2015).

Afro-Latinos and indigenous groups in Latin America have a higher degree of susceptibility to climate effects

IPCC has noted the important role of the social positions of different groups in determining susceptibility to the impact of climate change. For example, in many areas of Latin America, Afro-Latinos and indigenous groups were found to experience a higher degree of susceptibility to climate effects (Olsson and others, 2014, p. 810). Moreover, differential susceptibility to the effects of climate change among different races is found in both developing and developed countries, although in both country groups, low-income status is often intertwined with race and ethnicity status.

African Americans living in poverty and other disadvantaged groups were, relatively, the most susceptible to the damage inflicted by Hurricane Katrina. The housing stock in New Orleans at the time was considerably older than average, with 41 per cent of houses in 2003 having been built before 1949, partly as a result of historic preservation-related laws (Shrinath, Mack and Plyer, 2014). As the houses of African Americans living in poverty and of other disadvantaged groups were not only old but also fragile, they were totally damaged by inundation. In addition, a considerable portion of the population of the city were living in renter-occupied housing units — and the rate was higher among low-income and African American households — which were more susceptible to damage (Masozera, Bailey and Kerchner, 2006; Logan, 2006).

8 While the proportion of elderly white residents was greater than that of elderly African American residents in the city at the time, the fact remains that fewer African Americans, based on their differential health outcomes overall, reach ages at which they can be classified as elderly. When this factor along with the city's proportion of African Americans versus that of white residents is taken into account, it becomes clear that elderly African Americans were the most affected compared to their share of total population.

Susceptibility to health damage

People living in poverty are more susceptible to the diseases that some climate hazards help spread

One of the important ways in which inequality increases the susceptibility of disadvantaged groups is through the health-related effects of climate hazards. Hallegatte and others (2016) have found that for several reasons, people living in poverty are more susceptible to the diseases that many climate hazards help to spread, including malaria and the water-borne diseases that cause diarrhoea. For one thing, they live closer to malaria-breeding grounds. Further, they have more limited access to piped water sources, which forces them, during floods, to drink water containing pathogens. For example, residents of low-income slums in Mumbai have indicated greater levels of flooding during the monsoon season, resulting in an increase in the number of reports of disease outbreaks (ibid.). In the wake of the 1998 floods in Bangladesh, there were higher reported rates of diarrhoea among groups with lower income, lower levels of education and lower-quality housing without access to tap water (Hashizume and others, 2008).

Children and the elderly are particularly susceptible to adverse health effects

Children and the elderly are particularly affected by the adverse health effects of climate hazards. This is not surprising, given their relative fragility. Hallegatte and others (2016) have reported a greater incidence of ailments among children following floods in Ho Chi Minh City. Kovats and Akhtar (2008) noted outbreaks of leptospirosis among children following flooding in Mumbai. Lloyd, Kovats and Chalabi (2011) estimated that the effects of climate change on crop yields will lead to an increase in undernutrition, resulting in turn in higher rates of child stunting, particularly in sub-Saharan Africa and South Asia. The majority of the victims of Cyclone Aila in Bangladesh were children and the elderly, groups that have difficulty achieving rapid mobility (Rabbani and Huq, 2016).

Similarly, disadvantaged people suffer more adverse health effects from heat waves and high temperatures, because they cannot afford heat alleviating amenities, including proper housing ventilation and air conditioning. Heat waves have significant effects on the elderly, particularly as they are already more likely to suffer from chronic illnesses, such as coronary heart disease and respiratory diseases, which can be exacerbated by heat (Hutton, 2008).

Elderly people are also more susceptible to a greater magnitude of health effects from floods and, in addition, are less able to relocate in the event of disasters (ibid.). For example, as elderly residents of Limpopo, South Africa, lacked access to the labour necessary to construct their houses to enable them to withstand flooding, their dwellings suffered greater damage (Khandlhela and May, 2006).

As noted above, it was the elderly in New Orleans who were the most impacted by the hurricane, as they were less able to relocate and were more susceptible to health-related impacts. In general, poorer and minority populations were less able to relocate in response to the pre-storm warnings and were therefore more likely to suffer injuries and death. The lack of ownership of, or access to, a means of transportation was a significant factor affecting the probability of evacuation and relocation (Colton, 2006; Masozera, Bailey and Kerchner, 2006). Another significant factor was the lack of the financial and social resources needed to secure a dwelling to relocate to. As a result of all of these factors, low-income and African American inhabitants suffered greater levels of loss and damage than the wealthier and white households.

Effects on health were noted as a particular concern with regard to the impacts of climate change on indigenous populations, already located in marginal areas, in Latin America. Those effects were exerted through changes that allowed diseases to spread in areas where they could not have thrived previously. As a result, rates of respiratory and

diarrhoeal diseases increased. Climate change also adversely affected the nutritional status of those populations, thereby worsening their health status (Kronik and Verner, 2010). The time devoted to household labour by women also increases as a result of climate hazards and this has a direct effect on child nutrition (Silva, 2016).

The greater susceptibility to health effects frequently undermines the income and asset position of disadvantaged groups not only in the short term but also in the long run. In the short term, they may suffer from loss of productivity, employment and income. An example for the Plurinational State of Bolivia shows that income poverty increases when climate-related productivity shocks strike, as labour wages (upon which disadvantaged groups most rely) are hit adversely in absolute terms and also in relation to the rents of other factors of production (see chap, III, box III.2). In the long run, disadvantaged groups suffer from loss of human capital (through lost school days and the development of chronic conditions such as stunting) and a lower rate of income growth (Somanathan and others, 2014; Li and others, 2016; Zivin and Neidell, 2014).

Inequalities and the ability to cope and recover

Fewer resources are available to disadvantaged groups for coping and recovery

Ability to cope and recover is the third channel through which inequalities aggravate the impact of climate hazards on disadvantaged groups. The situations and processes to which exposure and susceptibility apply are ex ante, while those to which coping and recovery refer are ex post. The persistence of multiple inequalities implies that disadvantaged groups will have access to fewer of the resources required to take coping and recovery measures. Those resources generally take any of four forms: (a) households' own resources, (b) community resources, (c) resources provided by non-governmental organizations, private companies or citizens and (d) public resources provided by the government. Disadvantaged groups are likely to lack some — if not all — of the resources that are necessary for coping and recovery. As a result, their situation worsens after a climate hazard has materialized.

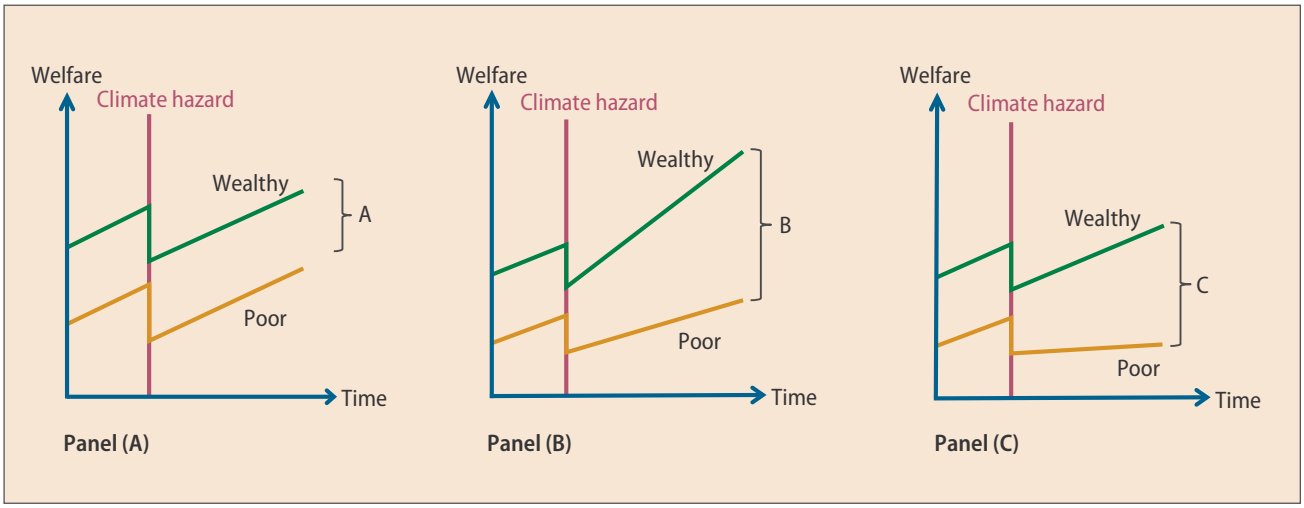
Recovery trajectories

Differences in the recovery trajectories of advantaged and disadvantaged groups lead to greater inequalities

In this analysis, the recovery trajectories of different groups matter. In the wake of a climate hazard, the rate of recovery is not the same across the population owing to existing inequalities and can ultimately become an important factor in terms of a further worsening of inequalities. If, hypothetically, both rich and poor households recover at the same rate, the welfare gap may remain constant (see figure II.2, panel A). On the other hand, if rich households are able to recover faster and increase their income further (panel B) or if poorer households see their welfare growth decline (panel C), then the welfare gap will increase. This will likely worsen existing inequalities.

How matters proceed in the real world is better represented by a situation where (a) owing to existing inequalities, either the rich have a faster rate of recovery or the poor have a lower rate of recovery, or both, and (b) as a consequence, inequality generally increases in all cases. There is considerable evidence that people affected by multiple inequalities undergo slower recoveries from more pronounced impacts (Verner, ed., 2010; Carter and others, 2007; Kraay and McKenzie, 2014; Jalan and Ravallion, 2001). These differential recovery rates contribute to an increase in the welfare gap. Lack of resources forces people living in poverty and other disadvantaged groups to cope with climate hazards in ways so detrimental as to put their future adaptive capacity at risk (Barbier, 2010; Barrett, Travis and Dasgupta, 2011; McDowell and Hess, 2012).

Figure II.2
Differential rates of recovery from climate hazards of wealthy and poor households



Source: Based on Mutter (2015) technical appendix 1.
Note: The slopes of the recovery curves for the wealthy and poor illustrate how inequality changes over time. Inequality remains constant (panel A) or increases based on the effect of the shock on the recovery path of the wealthy (panel B) or on that of the poor (panel C).

Coping capacity using own resources

Differences in an individual's or a household's own resources are obviously an important factor with respect to the ability to cope and recover from climate hazards. Thus, the ability to accumulate assets can play an important role in this regard. For example, in northern Burkina Faso, the ability among farmers to accumulate land and livestock played an important role in facilitating their ability to diversify income sources and improve adaptive capacity to climate hazards. The fact that increasing land prices and growing land scarcity limited younger farmers' ability to accumulate resources added to intergenerational poverty (Silva, 2016). In the Nkayi region of Zimbabwe, farms without cattle, which are poorer than farms with cattle, may eventually end up worse off with respect to climate change if they do not adapt so as to ensure resilient farming (see chap. III).

Importance of insurance

The fact that disadvantaged groups have less access to insurance makes recovery difficult

An important issue related to coping and recovery is that of insurance. Availability of insurance plays an important role in determining how different groups of the population fare when climate hazards actually materialize. Regrettably, not all groups have the same access to insurance. Lack of own resources often prevent people living in poverty and disadvantaged groups from buying necessary insurance. For example, Verner (2010) has reported that in Latin America, the asset losses of households with higher income levels are much more likely to be insured than those of low-income households.

Microinsurance offers the possibility of extending insurance coverage to those at the lower end of asset and income distributions (Mosley, 2015). This insurance modality is generally targeted towards disadvantaged groups and tends to focus on particular risks, most frequently those related to health. More recently, it has been extended to crops, although provision is based not on actual crop damage (estimates of which can be subjective, thereby

causing moral hazard-related problems) but on objective information generally related to rainfall, on which crop production crucially depends. Beneficial impacts of these schemes have been reported; for example, the BASIX rainfall insurance scheme operating in India has been shown to increase both investments by clients and stability of income. However, unlike microcredit, microinsurance schemes still face formidable challenges and have yet to achieve wide coverage.

The choice between human and physical capital

In coping with climate hazards, people facing multiple inequalities often have to make the difficult choice between protecting their human capital (health and education) and preserving their physical capital. In view of the absence of health insurance, these households face large expenses when hit by diseases in the wake of climate hazards. To meet these expenses, they often sell their physical assets, which frequently undermines their future efforts to reap income earnings (Clarke and Dercon, 2015).

It has been reported that while poor households in Ethiopia were forced to sell assets during periods when their finances were stressed by drought, this was not the case for the more well-off households (Little and others, 2006). After the famines in Ethiopia during the period 1984-1985, a decade was required for asset-poor households to bring livestock-holding back to pre-famine levels (Dercon, 2004). On the other hand, poor households sometimes reduce their consumption in order to avoid asset sales and preserve productive assets (Carter and others, 2007). This reduction in consumption, however, can have deleterious health and education outcomes, particularly for children. It also results in the perpetuation of inequality for future generations (Baez, de la Fuente and Santos, 2010; Maccini and Yang, 2009).

In the wake of the 1998 floods in Bangladesh, poorer households, as compared with wealthier households, were forced to borrow greater fractions of their income and at higher rates in order to survive and rebuild (del Ninno and others, 2001). This resulted in greater debt burdens, thus limiting poorer households' efforts to build assets and human capital. In view of their limited ability to cope and recover, disadvantaged groups in flood-prone areas of Bangladesh often face the choice between selling assets or reducing consumption. Poor households that were exposed to the 1998 floods reduced their caloric intake by 11 per cent. As a result, 48 per cent of poor households were reported to be food-insecure, in contrast with 16 per cent of all households (ibid.). People at disadvantage lose their physical or their human capital in the face of such hazards. Rabbani, Rahman and Mainuddin (2009) found that during periods of flooding, women prioritize the consumption of men and children by consuming less food and water themselves.

Along similar lines, there could be long-term effects on the education of children if they are taken out of school as a means of coping with climate hazards, even if this is only as the result of a temporary shock. It was found that in Mexico, children experiencing such a situation were 30 per cent less likely to complete primary school than those children that stayed in school (de Janvry and others, 2006). In sub-Saharan Africa, asset-poor households are more likely to provide their children with lower-quality nutrition and are less likely to take sick children for a medical consultation following weather shocks, which can have long-term impacts on those children and their prospects for development (Hallegatte and others, 2016). In addition, it has been found that lower-income households that were exposed to weather-related risks become more risk-averse, which can impact their future

income and asset accumulation. These households are more likely to choose low-risk, low-return activities where income is more predictable, as opposed to investing in higher-income activities that entail a higher risk (ibid.). All of these patterns are linked to worse outcomes for disadvantaged households which as a result may translate into increased inequalities.

Diversification capacity and adaptive strategies

Often, capacity to cope and recover depends on the ability to diversify income sources

The ability to diversify income sources improves people's capacity to adapt to climate hazards, improving their capacity to cope and recover as illustrated in various examples from the Sahel region in Africa. Households deriving their livelihoods from agriculture and a sizeable pastoralist population coexist in this region, as already noted. Interestingly, some perceive the rise of pastoralism in the region as an adaptive mechanism designed to "respond to a rapidly changing, and increasingly unpredictable environment" (Marshall and Hildebrand, 2002) and past movements appear to have been driven by "arid crises" (di Lernia, 2006). However, pastoralists in some countries have been marginalized within the context of efforts to achieve economic development (Holthuijzen and Maximillian, 2011).

There is also conspicuous horizontal inequality. In Mali, for example, this exists between minority pastoralist populations (such as the Tuareg, Fula and other Arab-Berber groups) and majority agricultural ethnic groups (sub-Saharan tribes such as the Mande) (Straus, 2011). Tuareg communities in the Niger have experienced long-standing marginalization, amplified by French colonial policies which privileged agricultural communities' access to land. Furthermore, the traditional strategies for coping with extreme weather conditions in these communities have become less effective with the onset of climate change, thereby increasing the precariousness of their situation (Silva, 2016). In addition, population growth and urbanization have increased pressure on food supplies, which has led to projections of food insecurity for more than 40 per cent of the population (Verhagen and others, 2003).

Wealthier households in some regions have been better able to diversify and adapt

In general, in the Sahel of West Africa, "[w]ealthier and larger farm households are more likely to be in a position to implement adaptive strategies, such as storage of food, technical measures to increase and stabilize food production, either by expansion of the land resources or by intensification, or outside agriculture through marketing of non-agricultural products, or selling services and/or labour to reduce or avoid future likelihood of stress and food shortages" (Dietz and Verhagen, eds., 2004).

In food producing regions in Burkina Faso, adverse rainfall conditions have contributed to household participation in non-farm activities (D'haen, Nielsen and Lambin, 2014). This is an adaptive response, but the change in livelihoods can potentially have spillover effects. Wealthier households in Burkina Faso take advantage of these circumstances through the gaining of access to cheaper farm labour supplied by poorer households that are experiencing hardship (Silva, 2016). Climate change is also anticipated to have effects on the location and viability of particular livelihoods. For example, changing rainfall patterns in Mali are expected to lead to a changed perception of which crops are viable and which households are vulnerable (Jankowska, Nagengast and Perea, 2012). It can be expected that, with wealthier households being better able to diversify their crop mixture and with their increased access to water sources, there will be an exacerbation of inequality (Mertz and others, 2011). At the same time, despite other agricultural adaptation measures, 39 per cent of the Burkinabè population remains susceptible to considerable impacts from rainfall variation, forcing the adoption of migration as another adaptation strategy (Barbier and others, 2009). There are

also instances of conflicting interests in coping and adaptation strategies. In the Niger, for example, water resources have been prioritized for agricultural populations to the detriment of pastoralists (Snorek, Renaud and Kloos, 2014). Thus, in the Sahel region, climate change is aggravating horizontal inequalities in addition to increasing inequality in terms of income and assets.

Common property, ecosystems and social resources

For many low-income people, access to common property resources is vital for coping with and recovering from climate hazards

Access to common property resources shared by the community can play an important role in coping and recovery strategies. People living in poverty may treat access to ecosystems as a de facto asset to the extent that they may use goods derived from local ecosystems, such as crops, timber and fish, either for self-consumption or for the purpose of smoothing income shocks (Barbier, 2010). For example, coastal populations in Bangladesh with closer proximity to mangrove reserves were better able to cope in the wake of Cyclone Aila (Akter and Mallick, 2013). Women's more limited access to common property resources has been noted as a factor that aggravates the difficulty of their situation in the wake of climate hazards (Perez and others, 2015).

A survey of the literature on climate change and ecosystem services shows that resource stocks such as fish and timber that are growing continuously are less sensitive to weather fluctuations than annual crops (Howe and others, 2013). The use of these types of ecosystem resources can therefore act as coping mechanisms during periods of reduced income. Effects of climate change on these ecosystems will therefore affect the livelihood and coping capacity of the low-income people who rely on them to generate income, thus exacerbating inequality. It has been reported that households within tropical and subtropical smallholder systems derive a considerable fraction of their income from ecosystems, ranging from about 55 per cent in South Asia to 75 per cent in sub-Saharan Africa. In these communities in Latin America and South and East Asia, those in the top quintile rely on those services to a lesser degree than those in all other quintiles, meaning that the highest-income residents are least exposed to the impact of climate hazards on such ecosystems (Noack and others, 2015). At the same time, overextraction of fish and timber can lead to resource exhaustion and ecosystem damage (Hallegatte and others, 2016).

Through the availability of and access to social capital, households that have limited access to other resources can be provided with the means to cope with climate hazards. For example, Braun and Aßheuer (2011) found that social capital plays an important role with respect to the ability to cope with floods in Dhaka. There is also evidence that pre-existing power imbalances within villages may result in adaptation responses that exacerbate inequalities. In Malawi, members of households with less land often adapt to climate hazards by working for wealthier families as farm labourers, often under exploitative conditions, which thereby increases local-level inequality and reinforces subsequent susceptibility of the labouring households to the impact of erratic rainfall, droughts and flooding (Silva, 2016).

The role of public resources

Public resources are critical for coping and recovery but they must be available to those who need them most

While the use of public resources can be critical for coping and recovering, its characteristics are frequently a function of the political dynamics of the society. Women farmers in many countries, for example, do not have equal access to climate adaptation funds when compared with male and larger-scale farmers (Silva, 2016).

Similar phenomena were observed in New Orleans in the wake of Hurricane Katrina. Lakeview is one of the neighbourhoods with the lowest elevation in Orleans Parish, and yet it was able to recover faster than other areas, partly owing to its relative wealth (Mutter, 2015). Households with low income and low credit ratings (factors that apply to a greater degree to African Americans in New Orleans) were more likely to have their application for a home loan for disaster recovery rejected (Masozera, Bailey and Kerchner, 2006). In the absence of dedicated efforts to support the reconstruction efforts of the most vulnerable in New Orleans, pre-existing inequalities were aggravated. This also resulted in considerable demographic shifts. Those able to return were better positioned in the labour market compared with non-returnees (Groen and Polivka, 2008).[9] There is evidence that income inequality in New Orleans, measured by the ratio of the income of the top 5 per cent to that of the bottom 20 per cent, increased between 2000 and 2013 (Shrinath, Mack and Plyer, 2014).[10]

The evidence shows that adaptation efforts are often driven by wealth rather than by need. Wealthier cities spend relatively more on adaptation despite the fact that poorer cities are more vulnerable. In addition, the outcomes of adaptation may reinforce existing social inequalities. For example, local chiefs in Mozambique were able to maintain disproportionate access to prime land, capital and social power in post-flood resettlement locations (Silva 2016). Furthermore, resources for adaptation, such as research on crop varieties, are often dominated by politically connected and wealthier groups. For example, the focus of research in the area of saline-tolerant rice crops in Sri Lanka has been directed towards large-scale rice growers, with less attention paid to marginalized groups such as the farmers of Hambantota (Weragoda, Ensor and Berger, 2009).

Policy implications

Structural inequalities push people towards greater exposure and susceptibility while lowering their ability to cope with and recover from climate hazards

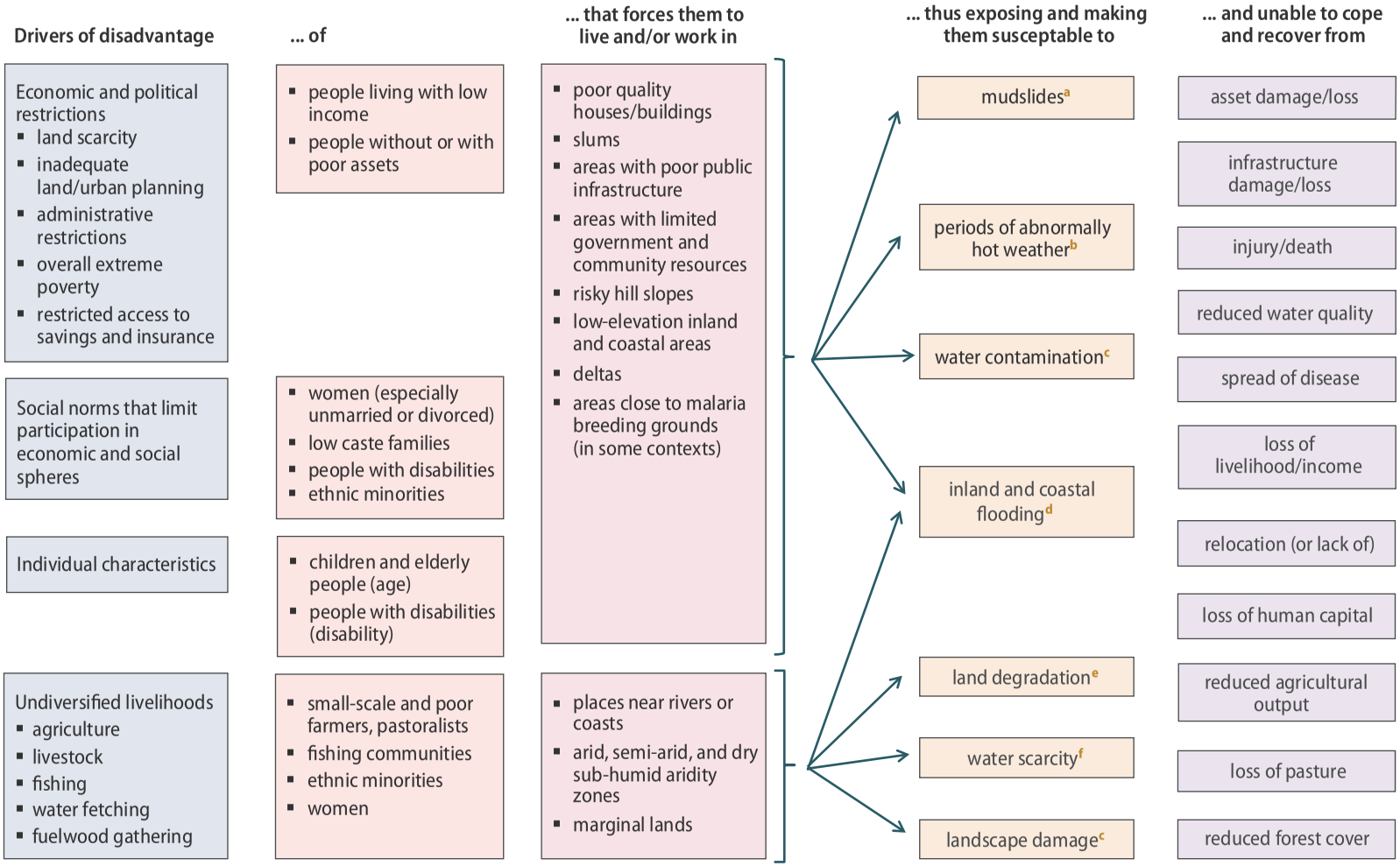
The comprehensive empirical evidence derived from the literature reviewed above, albeit not fully complete, points to the fact that the combination of economic and political restrictions, social norms and individual characteristics put large groups of people at a disadvantage in regard to their area of residence and their livelihood, thus exposing them to mud slides, periods of abnormally hot weather, water contamination, flooding and other climate hazards (see figure II.3). Groups whose livelihoods specifically depend on climate-sensitive natural resources and who do not possess the capacity to diversify into climate-resilient livelihoods are exposed and vulnerable to land degradation, water scarcity and landscape damage, among other hazards. Because of a lack of capacity to cope and recover, these disadvantaged groups frequently experience loss of human lives and human capital, assets and income. In the face of deteriorating ecosystems, people who rely on them for a living are at risk of falling into poverty traps.

9 Almost 100,000 African American residents had not returned to Orleans Parish (i.e., to the city of New Orleans not the New Orleans metropolitan area) by 2013, versus about 11,500 white residents. This changed the racial composition of the city. The proportion of African Americans in the city's population declined from 66.7 per cent in 2000 to 59.1 per cent in 2013 (Shrinath, Mack and Plyer, 2014).

10 While some have argued that those who did not return were better off in their new locations, in terms of employment, education and health-care opportunities (Deryugina and others, 2014; Imberman, Kugler and Sacerdote, 2012), such an analysis is beyond the scope of this *Survey*.

Figure II.3

Drivers of exposure and vulnerability to climate hazards through the lens of the empirical evidence



Source: UN/DESA.

a Caused by heavy rainfall.

b Caused by heatwaves.

c Caused by flooding from excessive rainfall.

d Caused by excessive rainfall and sea-level rise, respectively.

e Caused by increased salinity (in coastal areas), erosion, desertification, drought and long-term water scarcity.

f Caused by drought.

The implications of the present analysis are twofold. On the one hand, structural inequalities lie at the core of an understanding of vulnerability to climate hazards. On the other hand, addressing the root causes of inequalities to enable adaptation and the building of resilience to climate hazards will require a continuum of policies, planning and practices which include immediate assistance in the wake of climate hazards, disaster risk reduction measures and policies for adaptation to a changing climate, as well as good development policies focused on reducing inequalities. These specific measures will be effective in reducing climate change vulnerability only if they are part of longer-term transformative strategies for sustainable development.

Addressing the root cause of inequalities that aggravate exposure and vulnerability will require a continuum of policies…

Policies designed to build climate resilience should be pursued simultaneously and aimed at reducing immediate vulnerability, at the same time that they enable incremental transformative changes for achievement of longer-term objectives. Such policies are "low regret" in nature and the underlying logic is compatible with approaches for managing the risks of climate change through adaptation, as proposed by IPCC (see appendix II.1, table A.II.1).

…as part of a transformative agenda for long-term adaptation and mitigation

Policies designed to reduce immediate vulnerability include interventions for poverty alleviation and income diversification; disaster risk reduction (through, e.g., early warning systems, shelters and infrastructure improvements); and adaptation strategies (e.g., introduction of new crop varieties, water management techniques and ecosystem management).

Policies will be low-regret if, irrespective of the (uncertain) evolution of climate change, through their incremental nature they help build resilience to climate hazards and meet development objectives. In some instances, in fact, incremental policies may actually be a precondition for change. For example, a policy that targets expanded access to resilient crops in previously fertile lands that became desert can improve the livelihoods of small-scale and poor farmers. A policy expanding the access to health care and cooling technology, making them more affordable for all, can reduce the pernicious effects of heat waves, particularly on the elderly. Not only will these policies together help facilitate adaptation but they will also contribute to addressing the root causes of inequality and poverty. Improving infrastructure, health care and sanitation will not only minimize exposure and vulnerability to climate hazards, such as those presented in figure II.3, but also enable sustainable development.

Policies should aim at strengthening institutions to ensure a greater role for disadvantaged groups

A focus on building climate change resilience by decreasing the vulnerability of those who are most exposed also provides a unique opportunity to tackle institutional deficits particularly the existing governance systems and cultural conditions, that perpetuate inequalities. Transformative policies can aim for shifts in production and consumption behaviours to encourage sustainable practices. Policies can also target reforms in political, social, cultural and ecological decision-making in order to open up space for the participation of population groups usually excluded.

In facing the challenges posed by this continuum of development policies, policymakers and all stakeholders potentially affected will have to build an iterative and flexible policy decision-making process. Integrated assessments that challenge the expertise of traditional development thinking and policy will be necessary as a means of informing the process (see chap. III). At the same time, policies will have to be coherent and well integrated, with the involvement of relevant stakeholders in identifying the risks and helping to implement the solutions (see chap. IV).

Appendix II.1

Table A.II.1

Approaches to managing the risks of climate change through adaptation

Overlapping approaches	Category	Examples
Vulnerability and exposure reduction (throughout development, planning and practices)	Human development	Improved access to education, nutrition, health facilities, energy, safe housing and settlement structures, and social support structures; reduced gender inequality and marginalization in other forms
	Poverty alleviation	Improved access to and control of local resources; land tenure; disaster risk reduction; social safety nets and social protection; insurance schemes
	Livelihood security	Income, asset and livelihood diversification; improved infrastructure; access to technology; increased decision-making power; changed cropping, livestock and aquaculture practices; reliance on social networks
	Disaster risk management	Early warning systems; hazard and vulnerability mapping; diversifying water resources; improved drainage; flood and cyclone shelters; building codes; storm and wastewater management; transport and road infrastructure improvements
	Ecosystem management	Maintaining wetlands and urban green spaces; coastal afforestation; watershed and reservoir management; reduction of other stressors on ecosystems and of habitat fragmentation; maintenance of genetic diversity; manipulation of disturbance regimes; community-based natural resource management
	Spatial or land-use planning	Provisioning of adequate housing, infrastructure and services; managing development in flood-prone and other high-risk areas; urban planning and upgrading programmes; land zoning laws; easements; protected areas
	Structural/ physical	Engineered- and built-environment options: sea walls and coastal protection; flood levees; water storage; improved drainage; flood and cyclone shelters; building codes; storm and wastewater management; transport and road infrastructure improvements; floating houses; power plant and electricity grid adjustments
		Technological options: new crop and animal varieties; indigenous, traditional and local knowledge, technologies and methods; efficient irrigation; water-saving technologies; desalinisation; conservation agriculture; food storage and preservation facilities; hazard and vulnerability mapping and monitoring; early warning systems; building insulation; mechanical and passive cooling; technology development, transfer and diffusion
		Ecosystem-based options: ecological restoration; soil conservation; afforestation and reforestation; mangrove conservation and replanting; green infrastructure (e.g., shade trees, green roofs); controlling overfishing; fisheries co-management; assisted species migration and dispersal; ecological corridors; seed banks, gene banks and other ex situ conservation; community-based natural resource management
		Services: social safety nets and social protection; food banks and distribution of food; municipal services, water and sanitation; vaccination programmes; public-health services; enhanced emergency medical services
Adaptation (including incremental and transformational adjustments)	Institutional	Economic options: financial incentives; insurance; catastrophe bonds; payments for ecosystem services; pricing water to encourage universal provision and careful use; microfinance; disaster contingency funds; cash transfers; public-private partnerships
		Laws and regulations: land zoning laws; building standards and practices; easements; water regulations and agreements; laws to support disaster risk reduction; laws to encourage insurance purchasing; defined property rights and land tenure security; protected areas; fishing quotas; patent pools and technology transfer
		National and government policies and programmes: national and regional adaptation plans including mainstreaming; sub-national and local adaptation plans; economic diversification; urban upgrading programmes; municipal water management programmes; disaster planning and preparedness; integrated water resource management; integrated coastal zone management; ecosystem-based management; community-based adaptation
	Social	Educational options: awareness raising and integrating into education; gender equity in education; extension services; sharing indigenous, traditional and local knowledge; participatory action research and social learning; knowledge-sharing and learning platforms
		Informational options: hazard and vulnerability mapping; early warning and response systems; systematic monitoring and remote sensing; climate services; use of indigenous climate observations; participatory scenario development; integrated assessments
		Behavioural options: preparation and evacuation planning; migration; soil and water conservation; storm drain clearance; livelihood diversification; changed cropping, livestock and aquaculture practices
Transformation	Spheres of change	Practical: social and technical innovations, behavioural shifts or institutional and managerial changes that produce substantial shifts in outcomes
		Political: political, social, cultural and ecological actions consistent with reducing vulnerability and risk and supporting adaptation, mitigation and sustainable development
		Personal: individual and collective assumptions, beliefs, values and world views influencing climate-change responses

Source: Adapted from IPCC (2014d), table SPM 1.