Chapter 13. Livelihoods and Poverty

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Executive Summary

This chapter discusses how livelihoods, poverty and the lives of the poor, and inequality interact with climate change, climate variability, and extreme events in multifaceted and cross-scalar ways. It examines how current impacts of climate change, projected impacts up until 2100, and climate change responses affect livelihoods and poverty. The Fourth Assessment Report stated that the socially and economically disadvantaged and marginalized are disproportionally affected by climate change. Yet, climate change is rarely the only factor that affects livelihood trajectories and poverty dynamics; it interacts with a multitude of non-climatic factors, which makes detection and attribution challenging.

Climate change constitutes an additional burden to the rural and urban poor. It acts as a threat multiplier, often with negative outcomes for livelihoods (*very high confidence, based on robust evidence, high agreement*).

- Weather events and climate, ranging from subtle shifts in trends to extreme events, affect poor people's lives directly through impacts on livelihood assets, such as losses in crop yields, destroyed homes, food insecurity, and loss of sense of place, and indirectly through increased food prices and climate policies. [13.2.1, 13.3]
- Changing climate trends provoke shifts in rural livelihoods such as from crop-based to mixed livestock- and forest-based livelihoods or to wage-based labor in agricultural and urban employment. [13.2.1.2]
- Urban and rural transient poor who face multiple deprivations slide into chronic poverty as a result of weather events or extreme events, or a series of events, when they are unable to rebuild their eroded assets (*limited evidence, high agreement*) [13.2.1.3]
- Many weather events that affect poor people remain unrecognized, such as short periods of extreme temperature or minor changes in the distribution of rainfall, due to short time series and geographically sparse, aggregated, or partial data, inhibiting detection and attribution in many low-income countries. [13.2.1]

Climate change worsens existing poverty, exacerbates inequalities, and triggers new vulnerabilities and some opportunities. Poor people are poor for different reasons and thus are not all equally affected, and not all vulnerable people are poor. Climate change interacts with non-climatic stressors and entrenched structural inequalities to shape vulnerabilities (*very high confidence, based on robust evidence, high agreement*).

- Socially and geographically marginalized people exposed to persistent inequalities at the intersection of gender, age, race, class, caste, indigeneity, and (dis)ability are particularly negatively affected by weather events and climate. Context-specific conditions of marginalization shape differential vulnerability. [13.1.2.5]
- Preexisting gender inequalities are increased or highlighted by weather events and climate. Gendered impacts depend on customary and new roles in society, often entailing higher workloads, occupational hazards indoors and outdoors, psychological and emotional distress, and mortality in climate-induced disasters. [13.2.1.5]

- Very scarce evidence exists that demonstrates positive impacts of climate change on the poor, including flood preparedness, collective action, institutional change, and social asset accumulation. Often, the more affluent can better take advantage of shocks and crises, given their flexible assets and power status. [13.1.3, 13.2.1.4]

Climate change will create new poor, in low-income countries and middle- to high-income countries and jeopardize sustainable development. Most severe impacts are projected for urban areas and some regions in sub-Saharan Africa and Southeast Asia (*medium confidence, based on medium evidence, medium agreement*).

- Future impacts of weather events and climate will slow down economic growth and poverty reduction, further erode food security, and trigger new poverty traps, the latter particularly in urban areas. [13.2.2.4, 13.4]
- Climate change will exacerbate multidimensional poverty in low and lower middle-income countries, including high mountain states and countries with indigenous people threatened by sea level rise and relocation, and create new poverty pockets in upper middle- to high-income countries. [13.2.2]
- Urban and wage-labor dependent poor households, as well as regions with high food insecurity, above all in Africa, and high inequality, will be particularly affected due to food price increases. [13.2.2.3, 13.2.2.4]

Policy responses for climate change mitigation or adaptation will result in mixed and potentially detrimental outcomes for poor and marginalized people (*medium confidence, based on low evidence, high agreement*).

- Mitigation efforts such CDM and REDD+, as well as land acquisition for food and biofuel production, show preliminary negative impacts on the poor, particularly indigenous people and (women) smallholders. [13.3.1]
- Insurance schemes, social protection programs, and disaster risk reduction may enhance long-term livelihood resilience among poor and marginalized people, if policies address multidimensional poverty. [13.3.2.2, 13.4.1]
- Climate-resilient development pathways will have only marginal effects on poverty reduction, unless structural inequalities are removed and needs for equity among the poor and non-poor met. [13.3.1, 13.4.2]

13.1. Scope, Delineations, and Definitions: Livelihoods, Poverty, and Inequality

Understanding the impacts of climate change on livelihoods and poverty requires examining the complexities of poverty and the lives of the poor and non-poor as well as the multifaceted and cross-scalar intersections of poverty and livelihoods with climate change. This chapter examines these complexities. First, it presents the concepts of livelihoods, poverty, and inequality, and their relationships to each other and to climate change. Second, it describes observed impacts of weather events and climate on livelihoods and poverty and impacts for 2015-2100 for the urban and rural poor. Third, it discusses impacts of climate change mitigation and adaptation responses on livelihoods and poverty. Finally, it outlines implications for poverty alleviation efforts and climate-resilient development pathways.

Livelihoods and Poverty is a new chapter in the AR5. Although the AR4 WGII contributions mentioned poverty, as one of several non-climatic factors contributing to vulnerability, as a serious obstacle to effective adaptation, and in the context of endemic poverty in Africa (Technical Summary, Chapters 7, 8, 18, 20), no systematic assessment was undertaken. Livelihoods were more frequently addressed in the AR4, predominantly with reference to livelihood strategies and opportunities, diversification, resource-dependent communities, and sustainability, yet a coherent livelihood lens for assessing impacts was lacking. This chapter addresses these gaps and how climate change intersects with other stressors to shape livelihood choices and trajectories, affect the spatial and temporal dimensions of poverty dynamics, and reduce or exacerbate inequalities given differential vulnerabilities.

13.1.1. Livelihoods

Livelihoods (see also Glossary) are understood as the ensemble or opportunity set of capabilities, assets, and activities that are required to make a living (Chambers and Conway, 1992; Ellis *et al.*, 2003). They depend on access to natural, human, physical, financial, social, and cultural capital (assets); the social relations people draw upon to combine, transform, and expand their assets; and the ways people deploy and enhance their capabilities to be, act, and make lives meaningful (Scoones and IDS, 1998; Bebbington, 1999). Livelihoods are dynamic and people adapt to and change with internal and external stressors. Ultimately, successful livelihoods transform assets into income, dignity, and agency, to improve living conditions, a prerequisite for poverty alleviation (Sen, 1981).

Livelihoods are universal. The poor and the rich both pursue livelihoods to make a living. However, the adverse impacts of weather events and climate increasingly threaten and erode basic needs, capabilities, and rights, particularly among poor and disenfranchised people, in turn shaping their livelihoods (UNDP, 2007; Leary *et al*., 2008; Adger, 2010; Quinn *et al*., 2011). Some livelihoods are directly climate-sensitive, such as smallholder agriculture, seasonal employment in agriculture (e.g. tea, coffee, sugar), fishing, pastoralism, and tourism. Climate change also impacts households dependent on informal livelihoods or wage labor in poor urban settlements, directly through unsafe settlement structures or indirectly through rises in food prices.

13.1.1.1. Dynamic Livelihoods and Trajectories

A livelihood lens allows for a multidimensional and grounded analysis of people's complex lives by recognizing the flexibility and constraints with which they construct and adapt their livelihoods, and their dynamic decision making under climatic and other stressors. Livelihood analyses focus on the wider institutional, cultural, and policy contexts as well as shocks, seasonality, and trends, including processes that force poor and vulnerable people onto undesirable trajectories or toward enhanced wellbeing. Better infrastructure and technology as well as diversification of asset and activity portfolios and social support capabilities can boost livelihoods, spreading risks and broadening opportunities (Batterbury, 2001; Ellis *et al*., 2003; Clot and Carter, 2009; Carr, 2013). The sustainable livelihoods framework (Chambers and Conway, 1992) is the most widely-used approach for identifying how specific strategies may lead to cycles of livelihood improvements or impoverishment and critical thresholds beyond which certain livelihoods are radically transformed (Sabates-Wheeler *et al*., 2008). Yet, it has been criticized for not sufficiently explaining the wider structural processes that constrain livelihoods and wellbeing (Scoones, 2009).

13.1.1.2. Multiple Stressors

Livelihoods rarely face only one stressor or shock at a time. The literature emphasizes the synergistic relationship between weather events and climate and a variety of other environmental, social, and political stressors; jointly, they impinge on livelihoods and reinforce each other in the process, often negatively (Reid and Vogel, 2006; Schipper and Pelling, 2006; Tschakert, 2007; IPCC, 2007; Morton, 2007; Easterling *et al*., 2007; O'Brien *et al*., 2008; Eakin and Wehbe, 2009; Eriksen and Silva, 2009; Ziervogel *et al*., 2010). "Double losers" may emerge from simultaneous exposure to climatic change and other stressors such as economic globalization, rapid urbanization, and the spread of infectious diseases, further marginalizing vulnerable groups (O'Brien and Leichenko, 2000; Eriksen and Silva, 2009). Climatic and other stressors affect livelihoods at different scales: the level of spatial (e.g., village, nation) or temporal (e.g., annual, multi-annual) analysis affects detection and attribution of impacts. Impacts, both direct and indirect, are often amplified or weakened at different levels. Global or regional processes interact with local and national processes, often mediated by institutions, to generate locally experienced stressors and shocks (Reid and Vogel, 2006; Thomas *et al*., 2007; Paavola, 2008; Pouliotte *et al*., 2009) (see Figure 13-5 within FAQ 13.2).

Multiple stressors, simultaneous and in sequence, differentially shape livelihood dynamics and trajectories based on inequalities and differential vulnerabilities. More affluent households may be able to capitalize on shocks and crises while poorer households with less flexible opportunity sets are forced to erode their asset bases. Some coping strategies and limited ability to adapt may result in adverse consequences. Such maladaptive actions (see Glossary, Chapters 14, 16) undermine the long-term sustainability of livelihoods and results in downward trajectories, further impoverishment, and poverty traps (Ziervogel *et al*., 2006; Tanner and Mitchell, 2008; Barnett and O'Neill, 2010).

13.1.2. Dimensions of Poverty

Poverty is a complex concept with conflicting definitions and considerable disagreement in terms of framings, methodologies, and measurements. Despite differences in approaches emphasizing distinct aspects of poverty at the individual or collective level, such as income, capabilities, and quality of life (Laderchi *et al*., 2003), poverty is now recognized as multidimensional (UNDP, 1990). Poverty is influenced by social, economic, institutional, political,

and cultural drivers; reversing it requires efforts in multiple domains by promoting opportunities and empowerment, and enhancing security (World Bank, 2001). In addition to material deprivation, poverty considers agency and identity, and a sense of belonging and socio-cultural heritage (O'Brien and Leichenko, 2003). The AR4 identified poverty as "the most serious obstacle to effective adaptation" (Confalonieri *et al*., 2007, p.417).

13.1.2.1. Framing and Measuring Multidimensional Poverty

Over the last six decades, conceptualizations of poverty have become increasingly broader, poverty measurements more multifaceted, and spatial and temporal analyses more nuanced. Attention to multidimensional deprivations – hunger, illiteracy, unclean drinking water, lack of access to health services and electricity, and social isolation (WHO, 2006) – has shifted the analytical lens to the dynamics of poverty and its institutionalization within social and political norms. However, given these shifting conceptualizations over time, reliable measurement remains challenging. This, in turn, complicates attribution of climate change impacts and responses on the world's poor.

In climate change literature, poverty and poverty reduction have been predominantly defined through an economic lens, reflecting various growth and development discourses (Hirschman, 1988; Sachs, 2006; Collier, 2007). Less attention has been paid to relational poverty, produced through material social relations and in relation to privilege and wealth (Sen, 1976; Mosse, 2010; Alkire and Foster, 2011; UNDP, 2011a; Chen and Ravallion, 2012). Yet, such framing allows for addressing the social and political contexts that generate poverty and vulnerability to climate change (McCright and Dunlap, 2000; Bandiera *et al*., 2005; Leichenko and O'Brien, 2008). Many climate policies to date favor market-based responses using sector-specific and economic growth models to counter trends that may slow down the achievements of the 2000 Millennium Development Goals (MDGs). For instance, the World Bank encourages "mitigation, adaptation, and the deployment of technologies" that "allow[s] developing countries to continue their growth and reduce poverty" (World Bank, 2010, p.257). A relational approach highlights the integral role of the poor in all social relations (Pogge, 2009; O'Brien *et al*., 2010; Gasper, 2010; UNRISD, 2010; St.Clair and Lawson, 2013), challenging earlier constructions of the poor as an underclass, undeserving, and with inadequate moral values (O'Connor, 2002; Mosse, 2010). It also emphasizes equity, human security, and dignity (UNRISD, 2010; Deacon and Cohen, 2011; Haarstad and St Clair, 2011). Akin to the capabilities approach (Sen, 1985; Sen, 1999; Nussbaum, 2001; Alkire, 2005; Nussbaum, 2011), the relational approach stresses the needs, skills, agency, and aspirations of poor people while tackling structural causes of poverty, inequalities, and uneven power relations.

The IPCC AR4 (Yohe *et al*., 2007) highlighted that – with *very high confidence* – climate change will impede nations' ability to alleviate poverty and achieve sustainable development, as measured by progress towards the MDGs. Empirical assessments of the impact of climate change on MDG attainment are limited (Fankhauser and Schmidt-Traub, 2011), and the failure to reach these goals by 2015 has significant non-climatic causes (e.g. Hellmuth and IRI, 2007; UNDP, 2007). To date, global indicators for seven out of the eight MDGs, including income poverty, have improved since 1990. However, at a country level, only half of all countries are on track for income poverty reduction. The 2010 UNDP Multidimensional Poverty Index, measuring intensity of poverty based on patterns of simultaneous deprivations in basic services (education, health, and standard of living) and core human functionings, states that 1.7 billion people are multidimensionally poor, a far higher number than the 1.29 billion (World Bank, 2012a) indicated by the income-centered International Poverty Line (IPL) set at $1.25/day.

[INSERT FIGURE 13-1 HERE
Figure 13-1: Multidimensional poverty and income poverty, with linear regression relationship (dotted line) and shaded 95% confidence interval based on 96 countries (HDR, 2011). The map inset shows the Poverty Gap Index score in Viet Nam, aggregated at district level, expressed as ratio of poverty line of yearly expenditure per capita).]

13.1.2.2. Geographic Distribution and Trends of the World's Poor

Geographic patterns of poverty are uneven and shifting. In 1990, most of the world's $1.25 poor (93%) lived in low-income countries (LICs). By 2008, the majority of the poor (>70%) resided in lower and upper middle-income countries (LMICs and UMICs), in part because some LICs such as India, Nigeria, and Pakistan evolved to MIC

status. To date, one billion people live under $1.25/day in MICs and a second billion between $1.25 and $2, with an additional 320m and 170m in the LICs, respectively. Of the approximately 2.4 billion living under $2/day, half live in India and China. By 2020, 60-80% of world poverty at $1.25and 40-55% at $2 will be concentrated in sub-Saharan Africa with the rest in South Asia (Sumner, 2010; Sumner *et al*., 2012). Using the $1.25/day poverty line suggests that at least 70% of the poor live in rural areas in developing countries (IFAD, 2011), despite worldwide urbanization. Yet, this poverty line considerably understates urban poverty since it overlooks the high costs of food and non-food needs in many urban contexts (Mitlin and Satterthwaite, 2013). Estimates of poverty by use of national accounts means (see Chapter 19) suggest low poverty levels by 2025 as these estimates project $2 poverty to be eliminated in large MICs such as India and Indonesia, whereas surveys means (e.g. Chen and Ravallion, 2012; Sumner *et al*., 2012; Sumner, 2012a) project a $2 poverty split between current LICs and MICs at least until 2030.

This shift in distribution of global poverty toward MICs challenges the orthodox view that most of the world's extreme poor live in the poorest countries, and suggests that substantial pockets of poverty can persist in areas with higher levels of average per capita income. Understanding the shift in the geography of poverty is vital for attributing climate change impacts on poverty. For example, both climate finance and research focusing on climate impacts and vulnerabilities are largely directed towards LICs. Less attention is paid to the poor in MICs and HICs, where poverty and income inequality are rising (OECD, 2011; Gower *et al*., 2012).

13.1.2.3. Spatial and Temporal Scales of Poverty

Poverty is also socially distributed, across spatial and temporal scales. Not everybody is poor in the same way. Spatially, factors such as access to and control over resources and institutional linkages from individuals to the international level affect poverty distribution (Anderson and Broch-Due, 2000; Murray, 2002; O'Laughlin, 2002; Rodima-Taylor, 2011). Even at the household level, poverty differs between men and women and age groups, yet data constraints impede systematic intra-household analysis (Alkire and Santos, 2010). The distribution of poverty also varies temporally, typically between chronic and transient poverty (Sen, 1981; Sen, 1999). Chronic poverty describes an individual deprivation, per capita income, or consumption levels below the poverty line over many years (Gaiha and Deolalikar, 1993; Jalan and Ravallion, 2000; Hulme and Shepherd, 2003). Transient poverty denotes a temporary state of deprivation, and is frequently seasonal and triggered by an individual's or household's inability to maintain income or consumption levels in times of shocks or crises (Jalan and Ravallion, 1998).

Individuals and households can fluctuate between different degrees of poverty and shift in and out of deprivation, vulnerability, and wellbeing (Leach *et al*., 1999; Little *et al*., 2008; Sallu *et al*., 2010). Poor people often find themselves in poverty traps – situations in which escaping poverty becomes impossible without external assistance due to unproductive or inflexible asset portfolios (Barrett and McPeak, 2006). A poverty trap can also be seen as a "critical minimum asset threshold, below which families are unable to successfully educate their children, build up their productive assets, and move ahead economically over time" (Carter *et al*., 2007 p.837). As of 2008, a total of 320 to 443 million of people were trapped in chronic poverty (Chronic Poverty Research Centre, 2008), leading Sachs (2006) to label <$1.25/day poverty as a trap in itself. Poverty traps at the national level are often related to poor governance, reduced foreign investment, and conflict (see Chapter 10).

13.1.3. Inequality and Marginalization

Specific livelihoods and poverty alone do not necessarily make people vulnerable to weather events and climate. The socially and economically disadvantaged and the marginalized are disproportionately affected by the impacts of climate change and extreme events (*robust evidence*) (Kates, 2000; Paavola and Adger, 2006; Adger *et al*., 2007; Cordona *et al*., 2012). These include the poor and indigenous people in North America (Field *et al*., 2007) and Africa (Boko *et al*., 2007). Inequality is a useful lens for examining why multidimensional poverty continues to exist, and in some cases has increased, despite poverty reduction efforts. Vulnerability, or the propensity or predisposition to be adversely affected (Field *et al*., 2012a) by climatic risks and other stressors, emerges from the intersection of different inequalities, and uneven power structures, and hence is socially-differentiated (Sen, 1999; Banik, 2009; Field *et al*., 2012a). Vulnerability is often high among indigenous people, women, children, the

elderly, and disabled people due to multiple deprivations that inhibit the poor and marginalized from managing daily risks and shocks (Eriksen and O'Brien, 2007; Ayers and Huq, 2009; Boyd and Juhola, 2009; Barnett and O'Neill, 2010; O'Brien *et al*., 2010; Petheram *et al*., 2010; OECD, 2011), and may present significant barriers to adaptation.

Global inequality is persistent. In 2007, the top quintile of the world's population received 83% of total the income whereas the bottom quintile took in 1% (Ortiz and Cummins, 2011). Within most countries, income inequality has increased as economic activity and sector-specific growth constrains the productive capacity of the poor who disproportionately bear the externalities of economic growth such as environmental degradation (UNRISD, 2010; UNDP, 2011b). An inequality lens also highlights growing poverty in MICs and HICs (Gower *et al*., 2012; Gough, 2012; Taylor and Xiaoyun, 2012; Sumner, 2012b). Recognizing how inequality and marginalization perpetuate multidimensional poverty is an essential prerequisite for climate-resilient development pathways (see 13.4).

13.1.4. Interactions between Livelihoods, Poverty, Inequality, and Climate Change

This chapter opens its analytical lens from a conventional focus on poor developing countries as the prime victims of climate change to a broader understanding of livelihood and poverty dynamics and inequalities across spatial and temporal scales, revealing the highly unequal impacts of climate change. It highlights the bidirectional relationship between climate change and poverty. Addressing structural inequalities that create and sustain poverty and vulnerability (Huq *et al*., 2005; Schipper, 2007; Lemos *et al*., 2007; Boyd and Juhola, 2009; Williams, 2010; Perch, 2011) is "a prerequisite for sustainability in the context of climate change" (Field *et al*., 2012a, p.20). Uneven social relations that disproportionally burden the poorest with the brunt of climate change's negative impacts, if ignored, contribute to maladaptation (Barnett and O'Neill, 2010).

Poverty and persistent inequality are the "most salient of the conditions that shape climate-related vulnerability" (Ribot, 2010, p.50), affect livelihood options and trajectories, and create conditions in which people have few assets to liquidate in times of hardship or crisis (Mearns and Norton, 2010). The poor and marginalized usually have the least buffer to face even modest climate hazards and suffer most from successive events with little time for recovery. They are the first to experience asset erosion, poverty traps, and barriers and limits to adaptation. As shown in sections 13.2 and 13.3, climate change is an additional burden to the poor (*very high confidence*), and it will force some poor from transient into chronic poverty and create new poor (*high confidence*).

The complex interactions among weather events and climate, dynamic livelihoods, multidimensional poverty and deprivation, and persistent inequalities create an ever-shifting context of risk. Climate change, climate variability, and extreme events synergistically add on to and often reinforce other environmental, social, and political calamities (Field *et al*., 2012a). Despite the recognition of these complex interactions, the literature shows no single conceptual framework that captures them concurrently, and few studies exist that overlay gradual climatic shifts or rapid-onset events onto livelihood risk spaces. Hence, explicit attention to how livelihood dynamics interact with climatic and non-climatic stressors is useful for identifying processes that force poor and vulnerable people onto undesirable trajectories and trap them in destitution, constitute critical thresholds beyond which a certain livelihood is no longer feasible, or offer escape routes toward enhanced wellbeing. Figure 13-2 illustrates these dynamics.

[INSERT FIGURE 13-2 HERE
Figure 13-2: Livelihood dynamics under simultaneous climatic, environmental, and socioeconomic stressors and shocks leading to differential risk spaces and livelihood trajectories over a lifetime.]

13.2. Assessment of Climate Change Impacts on Livelihoods and Poverty

This section reviews the evidence and agreement about the relationships among climate change, livelihoods, poverty, and inequality. It first describes observed impacts to date (13.2.1) and then projected impacts (13.2.2). The focus on climate change effects on livelihood decision making and trajectories, spatial distributions of poverty and shifts from transient to chronic poverty, and differential vulnerability and poverty traps due to intersecting inequalities demonstrates the multifaceted interactions between weather events and climate and non-climatic

stressors. Building on deductive reasoning and theorized linkages among climate change, livelihoods, and poverty, this section draws on a wide range of empirical studies and simulations to provide evidence across multiple scales, contexts, and social and environmental processes to assess climate change impacts. Cases of observed impacts often rely on qualitative data, and sometimes lack methodological clarity and rigorous detection and attribution.

13.2.1. Evidence of Observed Climate Change Impacts on Livelihoods and Poverty

Weather events and climate impact the lives and livelihoods of millions of poor people (Field *et al.*, 2012b). Even minor changes in precipitation amount or temporal distribution, short periods of extreme temperatures, or localized weather events can have serious impacts on livelihoods (Douglas *et al.*, 2008; Ostfeld, 2009; Midgley and Thuiller, 2011). Many such events remain unrecognized given that standard climate observations typically report precipitation or temperature by month, season, or year, thus obscuring changes that directly impact decision making, for instance, in agriculture (Tennant and Hewitson, 2002; Barron *et al.*, 2003; Usman and Reason, 2004; Douglas *et al.*, 2008; Salack *et al.*, 2012; Lacombe *et al.*, 2012). This difficulty in detection and attribution is compounded by a lack of long-term continuous and dense networks of climate data in many LICs (UNECA, 2011) and, as shown for the Sumbanese in Eastern Indonesia, by phenomenological experiences of events such as drought (Orr *et al.*, 2012).

13.2.1.1. Impacts on Livelihood Assets and Human Capabilities

Climate change, climate variability and extreme events interact with numerous aspects of people's livelihoods. This section presents empirical evidence of impacts on natural, physical, financial, human, and social and cultural assets.

Weather events and climate impact *natural assets* on which certain livelihoods depend, such as rivers, lakes, and fish stocks (*robust evidence*) (Thomas *et al.*, 2007; Nelson and Stathers, 2009; Osbahr *et al.*, 2010; Bunce *et al.*, 2010a; Bunce *et al.*, 2010b; D'Agostino and Sovacool, 2011) (see Chapters 3, 4, 5, 6, and 30). During the 20th century, water temperatures increased in Lake Tanganyika and winds decreased (Verburg and Hecky, 2009; Adrian *et al.*, 2009; Tierney *et al.*, 2010). Thus, studies since the late 1970s have observed a 20% drop in primary production and a 30% decline in fish, a key protein source in the area; these drops may exceed effects of overfishing and other human impacts (O'Reilly *et al.*, 2003). The Middle East and North Africa (MENA) face dwindling water resources due to less precipitation and rising temperatures combined with mounting water demand due to population and economic growth (Tekken and Kropp, 2012), resulting in rapidly decreasing water availability, expected to be 30-70% less per person in 2025 (Sowers *et al.*, 2011). In MENA (Sowers *et al.*, 2011), the Andes and Himalayas (Orlove, 2009), the Caribbean (Cashman *et al.*, 2010), Australia (Alston, 2011), and in cities (Satterthwaite, 2011), policy allocation often favors more affluent consumers, at the expense of less powerful rural and/or poor users.

Weather events and climate also erode farming livelihoods (see Chapters 7, 9), via declining crop yields (Hassan and Nhemachena, 2008; Apata *et al.*, 2009; Sissoko *et al.*, 2011; Sietz *et al.*, 2012), at times compounded by increased pathogens, insect attacks, and parasitic weeds (Stringer *et al.*, 2007; Byg and Salick, 2009), and reduced availability of and access to non-timber forest products (Hertel and Rosch, 2010; Nkem *et al.*, 2012), and biodiversity and medicinal plants (Van Noordwijk, 2010). For agropastoral and mixed crop-livestock livelihoods, extreme high temperatures threaten cattle (Hahn, 1997; Thornton *et al.*, 2007; Mader, 2012; Nesamvuni *et al.*, 2012) ; in Kenya, for instance, people may shift from dairy to beef cattle and from sheep to goats (Kabubo-Mariara, 2008).

The most extreme form of erosion of natural assets is the complete disappearance of people's land on islands and in coastal regions (McGranahan *et al.*, 2007; Solomon *et al.*, 2009; Perch and Roy, 2010) (see Chapter 5). Densely populated coastal cities with high poverty counts such as Alexandria and Port Said in Egypt (El-Raey *et al.*, 1999), Cotonou in Benin (Dossou and Glehouenou-Dossou, 2007), and Lagos and Port Harcourt in Nigeria (Abam *et al.*, 2000; Fashae and Onafeso, 2011) have already been affected by floods and are at risk of submersion, while resettlements are planned for the Mekong River Delta and the Limpopo River (de Sherbinin *et al.*, 2011).

Damage to *physical assets* due to weather events and climate is well documented for poor urban settlements, often built in risk-prone floodplains and hillsides susceptible to erosion and landslides. Impacts include homes destroyed

by flooding water and disrupted water and sanitation services. Flooding has adversely affected large African cities (e.g., Accra, Nairobi, Kampala, and Lagos), mainly due to inadequate drainage and increasing precipitation in dense settlements (Douglas *et al*., 2008), and informal settlements in Latin American cities (Hardoy and Pandiella, 2009; Hardoy *et al*., 2011). Loss of physical assets in poor areas after disasters is often followed by looting (Hardoy and Pandiella, 2009) and displacement due to loss of property (Douglas *et al*., 2008). Increasing flash floods attributed to climate change (Sudmeier-Rieux *et al*., 2012) have severely damaged physical assets in the Himalayas, such as terraces, orchards, stream embankments, and roads (Hewitt and Mehta, 2012; Azhar-Hewitt and Hewitt, 2012).

Erosion of *financial assets* during periods of increased climate stress result from loss of farm income and jobs (Hassan and Nhemachena, 2008; Iwasaki *et al*., 2009; Alderman, 2010; Jabeen *et al*., 2010; Alston, 2011) and increased costs of living (Gabrielsson *et al*., 2012). Urban flooding in Lagos slums undermines job opportunities (Adelekan, 2010). Income losses due to weather events are compounded by expenses for agricultural inputs (seeds, equipment), school tuition, uniforms, and books, and health expenses throughout the year (Thomas *et al*., 2007).

Equally important, albeit frequently overlooked, is the damage to *human assets* as a result of weather events and climate, such as increased food insecurity, undernourishment, and chronic hunger due to failed crops (*medium evidence*) (Misselhorn, 2005; Patz *et al*., 2005; Funk *et al*., 2008; Gentle and Maraseni, 2012) or spikes in food prices most severely felt among poor urban populations (Ahmed *et al*., 2009; Hertel and Rosch, 2010). During the Ethiopian drought (1998-2000) and Hurricane Mitch in Nicaragua (1998), poorer households tended to engage in asset smoothing, reducing their consumption to very low levels to protect their assets, whereas wealthier households sold assets and smoothed consumption (Carter *et al*., 2007). In such cases, the poor further erode nutritional levels and human health while desperately holding on to their limited assets. Dehydration, heat stroke, and heat exhaustion, from exposure to heat waves undermine people's ability to carry out physical work outdoors and indoors (Semenza *et al*., 1999; Kakota *et al*., 2011) (see Chapter 11). Psychological effects from extreme events include sleeplessness, anxiety and depression (Byg and Salick, 2009; Keshavarz *et al*., 2013), loss of sense of place and belonging (Tschakert *et al*., 2011; Willox *et al*., 2012), and suicide (Caldwell *et al*., 2004; Alston, 2011) (*medium evidence*).

Finally, weather events and climate also erode *social and cultural assets*. A series of climatic and non-climatic stressors and changing trends disrupt informal social networks of the poorest, elderly, women, and women-headed households, preventing mobilization of labor and reciprocal gifts (Osbahr *et al*., 2008; Buechler, 2009), as well as formal social networks, including social assistance programs (Douglas *et al*., 2008). Indigenous people (see Chapter 12) witness their cultural points of reference disappearing (Ford, 2009; Green *et al*., 2010; Bell *et al*., 2010).

13.2.1.2. Impacts on Livelihood Dynamics and Trajectories

Weather events and climate also affect livelihood trajectories and dynamics in livelihood decision making, often in conjunction with cross-scalar socio-economic, institutional, or political stressors. Shifting in and out of hardship, vulnerability, and wellbeing on a seasonal basis is not uncommon. To a large extent, these shifts from coping and hardship to recovery are driven by annual and inter-annual climate variability. Figure 13-3 illustrates an annual "wheel of hardship" for the Lake Victoria Basin in East Africa (Gabrielsson *et al*., 2012).

[INSERT FIGURE 13-3 HERE
Figure 13-3: 'Wheel of hardship' – a generalized seasonal calendar depicting livelihood conditions and stress based on experiences of smallholder farmers in the Lake Victoria Basin in Kenya and Tanzania (Gabrielsson *et al*., 2012).]

Shifts in livelihoods often occur due to changing climate trends, linked to a series of environmental, climatic, and political stressors (*robust evidence*). Farmers may change their crop choices instead of abandoning farming (Kurukulasuriya and Mendelsohn, 2007) or take on more lucrative income-generating activities (see Figure 13-2). Around Mali's drying Lake Faguibine, livelihoods shifted from water-based to agro-sylvo-pastoral systems, as a direct impact of lower rainfall and more frequent and more severe droughts (Brockhaus and Djoudi, 2008). Diverse indigenous groups in Russia have changed their livelihoods as result of Soviet legacy and climate change; for example, many Viliui Sakha have abandoned cow-keeping due to youth out-migration, growing access to consumer goods, and seasonal changes in temperature, rainfall, and snow (Crate, 2013). Under certain converging shocks and

stressors, people adopt entirely new livelihoods. After Hurricane Stan (2005), land-poor coffee farmers in Chiapas, Mexico, turned from specializing in coffee to being day laborers and subsistence farmers (Eakin *et al.*, 2012). In South Africa, higher precipitation uncertainty raised reliance on livestock and poultry rather than crops alone in 80% of households interviewed (Thomas *et al.*, 2007). In South India and southern Africa people migrated to the coasts, switching from climate-sensitive farming to marine livelihoods (Coulthard, 2008; Bunce *et al.*, 2010a; Bunce *et al.*, 2010b). In West Africa, shifting seasonality of rains hamper crop and water management of small-scale farmers (Yengoh *et al.*, 2010a; Yengoh *et al.*, 2010b; Armah *et al.*, 2011; Karambiri *et al.*, 2011; Lacombe *et al.*, 2012).

13.2.1.3. Impacts on Poverty Dynamics: Transient and Chronic Poverty

Limited evidence documents the extent to which climate change intersects with poverty dynamics, yet, there is *high agreement* that shifts from transient to chronic poverty due to weather and climate are occurring, especially after a series of weather or extreme events (Scott-Joseph, 2010). Households in transient poverty may become chronically poor due to a lack of effective response options to weather events and climate, compared with more affluent households (see Figure 13-2). Often, multiple deprivations drive these shifts, with socially and economically marginalized groups particularly prone to slipping into chronic poverty. Limited and maladaptive responses such as sending younger children to work may contribute (Tanner and Mitchell, 2008). Women-headed households, people in informal settlements, children, and indigenous communities are particularly at risk, due to compounding stressors such as lack of governmental support, urban infrastructure, and formal land tenure (see 13.2.1.5 and Chapter 12).

Urban poor in Africa, Asia, and Latin America may slip from transient to chronic poverty given the combination of population growth and flooding threats in low-elevation cities and growth and water stress in drylands (Balk *et al.*, 2009), along with other multiple deprivations (Mitlin and Satterthwaite, 2013). Poverty shifts also occur in response to food price increases, though the strength of the relationship between weather events and climate and food prices is still debated (see Chapter 7 and 13.3.1.4). Urban poor are particularly at risk since they are almost exclusively net buyers of food (Cranfield *et al.*, 2007; Cudjoe *et al.*, 2010; Ruel *et al.*, 2010). In rural areas, those dependent on natural resources may also slip from transient to chronic poverty, for instance when access to forests is restricted, e.g., under conservation efforts or conflicts, and alternative income-generating resources such as non-timber forest products become unavailable, particularly for women-headed households (Shackleton *et al.*, 2007; Fisher *et al.*, 2010). In southern Africa, Misselhorn (2005) showed in a meta-study of 49 cases of food insecurity that climatic drivers and poverty were the two dominant and interacting causal factors. Poor pastoralists have collapsed into chronic poverty when livestock assets have been lost (Thornton *et al.*, 2007). Many of these shifts remain undetected, incompletely captured in poverty data and adaptation monitoring. The bulk of attention is oriented toward extreme events, rapid-onset disasters, and subsequent impacts on livelihoods and the poor. Subtle changes are rarely tracked, making quantification of long-term trends and attribution difficult.

13.2.1.4. Poverty Traps and Critical Thresholds

Poverty traps arise when climate change, variability, and extreme events make the poor even poorer. Yet, attribution remains a challenge. Among the urban poor, poverty traps have been reported especially for wage laborers who erode their financial capital due to increases in food prices (Ahmed *et al.*, 2009; Hertel and Rosch, 2010) and for those in informal settlements exposed to floods and landslides, with nowhere else to go and no governmental support (Hardoy and Pandiella, 2009). In rural areas, poverty traps are reported when poverty impacts of climate change persist over decades, mainly due to recurring stress on ecological systems and environmental degradation, such as in the Sahel (Kates, 2000; Hertel and Rosch, 2010; Sissoko *et al.*, 2011; UNCCD, 2011), and when people are unable to rebuild assets after a series of stresses (Eriksen and O'Brien, 2007; Sabates-Wheeler *et al.*, 2008; Sallu *et al.*, 2010). Poverty traps and destitution are also described in pastoralist systems, triggered through droughts, restricted mobility due to conflict and insecurity, adverse terms of trade, and the conversion of grazing areas to agricultural land, such as for biofuel production (Eriksen and Lind, 2009; Homewood, 2009; Eriksen and Marin, 2011). Other poverty traps result from heavy debt loads due to the inability to repay loans and distress sales (Renton, 2009; Ahmed *et al.*, 2012) and persistent discrimination through legal structures and formal institutions, especially for women and other marginalized groups (Campbell *et al.*, 2009; McDowell and Hess, 2012). Culturally-induced

poverty traps also exist, such as forced kin solidarity in farming systems in Ethiopia, due to which more affluent farmers avoid investing in soil fertility, which would protect against climate shocks (Di Falco and Bulte, 2012).

Despite *limited evidence*, there is *high agreement* that critical thresholds, or irreversible damage (Heltberg *et al*., 2009), result from the convergence of various factors, many of which are not directly related to climate change. For instance, the poor often rely on social networks, including reciprocal gifts and exchanges, to protect themselves from shocks and crises such as droughts (Little *et al*., 2006). Yet, given limited assets and ability to mobilize labor and food, particularly for smaller and women-headed households and the elderly, the exhaustion of these reciprocal ties can indicate an imminent slipping into poverty traps or chronic poverty (Pradhan *et al*., 2007; Osbahr *et al*., 2008). Injuries, disabilities, disease, psychological distress, for instance from accidents following flood events, critically lower poor people's main asset, labor (Douglas *et al*., 2008), and may plunge poor individuals and households deeper into deprivation, forcing some over critical thresholds into chronic poverty.

Few studies illustrate positive livelihood trajectories as a result of climate change or climate-induced shocks, and they tend to refer to more affluent and powerful constituencies while very scarce evidence exists of poor people escaping poverty traps (see Box 13-1). In Honduras, for example, Hurricane Mitch (1998) helped the poor to bring about institutional changes, more equitable land distribution, and better flood preparedness (McSweeney and Coomes, 2011). In Lake Victoria Basin, collective actions have emerged as a result of HIV/AIDS and climate change, enhancing social asset accumulation (Gabrielsson and Ramasar, 2012).

13.2.1.5. Implications for Inequality

Climate variability and change as well as climate-related disasters contribute to and exacerbate inequality, both in urban and in rural areas, in LICs, MICs, and HICs. Mounting inequality is not just a side effect of weather and climate but of the interaction of related impacts with multiple deprivations at the context-specific intersections of gender, race, class, caste, indigeneity, age, and (dis)ability, embedded in uneven power structures, also known as intersectionality (Shields, 2008; Nightingale, 2011). In many cities in Latin America, upper middle- and high-income people living in flood-prone areas or high-risk slopes can afford insurance and lobby for protective policies, in contrast to poor residents (Hardoy and Pandiella, 2009). In northern welfare states, in the aftermath of the financial crisis, modified social policies and fiscal regimes amplify unevenly distributed climate impacts (Gough, 2012). This section illustrates how climate impacts intersect with inequality, primarily along the lines of gender, age, and indigeneity, cross-referencing other dimensions of inequality covered in other chapters.

_____ START BOX 13-1 HERE _____

Box 13-1. Climate and Gender Inequality: Complex and Intersecting Power Relations

Preexisting ***gender inequality*** is increased or highlighted as a result of weather events and climate-related disasters intertwined with socioeconomic, institutional, cultural, and political drivers that perpetuate differential vulnerabilities (*robust evidence*) (Lambrou and Paina, 2006; Brouwer *et al*., 2007; Shackleton *et al*., 2007; Adger *et al*., 2007; Carr, 2008; Demetriades and Esplen, 2008; Galaz *et al*., 2008; Osbahr *et al*., 2008; Buechler, 2009; Hardoy and Pandiella, 2009; Nightingale, 2009; Renton, 2009; Terry, 2009; Dankelman, 2010; MacGregor, 2010; Alston, 2011; Arora-Jonsson, 2011; Resurreccion, 2011; Zotti *et al*., 2012). While earlier studies have tended to highlight women's quasi-universal vulnerability in the context of climate change (e.g. Denton, 2002), this general thrust can mask the complex and intersecting power relations and other deep structural and place-based causes of inequality (Nightingale, 2009; UNFPA, 2009; Arora-Jonsson, 2011). Moreover, the construction of economically poor women as vulnerable victims is a one-dimensional narrative that denies women's agency and emphasizes their vulnerability as their intrinsic problem (MacGregor, 2010; Manzo, 2010; Arora-Jonsson, 2011).

Gendered livelihood impacts: Men and women are affected by climate variability and change, albeit differentially. Campbell *et al*. (2009) and Resurreccion (2011), in case studies from Vietnam, found increased workloads for both partners linked to weather events and climate, contingent on socially accepted gender roles: men tend to work longer hours during extreme events and women take on extra responsibilities during disaster preparation and recovery (e.g.,

storing food and water and taking care of the children, the elderly, and the sick) and when their husbands migrate. In Cambodia, Khmer men and women accepted culturally-taboo income-generating activities under duress, when rice cropping patterns shifted due to increased temperatures and more irregular rainfall (Resurreccion, 2011). The ten-year drought in Australia's Murray-Darling Basin differentially affected men and women, due to their distinct roles within agriculture (e.g. Eriksen *et al*., 2010). Alston (2011) noted social disruption and depression, most profound in areas with almost total reliance on agriculture, no substitute employment, and limited service infrastructure (Table 13-1). Climate variability amplifies food shortages in which women consume less food and suffer from water-borne diseases and reproductive tract infections following floods (Neelormi *et al*., 2008; Campbell *et al*., 2009). In Nepal, shifts in the monsoon season, longer dry periods, and decreased snowfall force Dalit girls and women ('untouchable' caste) to grow drought-resistant buckwheat and provide more day labor to the high caste Lama landlords while Dalit men seek culturally-taboo patronage protection to engage in cross-border trade (Onta and Resurreccion, 2011).

Feminization of responsibilities: Increased workloads due to weather events and climate are often unevenly distributed, adding to already long lists of women's labor and caring duties (Nelson and Stathers, 2009; MacGregor, 2010; Petrie, 2010; Arora-Jonsson, 2011; Kakota *et al*., 2011; Resurreccion, 2011). The additional work for women, as shown in South Africa, takes a psychological and physical toll (Babugura, 2010). In Ghana, some husbands prevent their wives from engaging in additional agricultural production as a response to gradually shifting rainfall seasonality, thereby undermining both women's agency as well as overall household wellbeing (Carr, 2008).

Occupational hazards: Increasing cases of heat death are reported among male workers on sugarcane plantations in El Salvador due to kidney failure (Peraza *et al*., 2012) and heat-related indoor work emergencies in Spain among young (<50) able-bodied urban men (García-Pina *et al*., 2008) while anecdotal evidence suggests that women tea pickers in Malawi, Kenya, India, and Sri Lanka suffer and die from heat stress as payment by quantity undermines rest breaks (Renton, 2009) (see Chapter 11). In cases of male outmigration due to unsustainable rural livelihoods, women in Bangladesh face unsafe working conditions, exploitation, and loss of respect (Pouliotte *et al*., 2009).

Emotional and psychological distress: Climate-related disasters or gradual environmental deterioration can affect women's mental health disproportionally due to their multiple social roles (UN ECLAC, 2005; Demetriades and Esplen, 2008; Babugura, 2010; Hargreaves, 2013). Increased gender-based violence within households is reported as a social consequence of weather events and climate, including incremental climate change, not just disasters, due to greater stress, family conflict, and disrupted safety nets, in Australia (Alston, 2011; Parkinson *et al*., 2011; Whittenbury, 2013), the U.S. (Jenkins and Phillips, 2008; Anastario *et al*., 2009), and LICs such as Vietnam (Campbell *et al*., 2009) and Bangladesh (Pouliotte *et al*., 2009). In Nepal, human trafficking of girls and women may have increased by 20-30% during political conflict and floods and droughts (Nellemann *et al*., 2011).

Mortality: During floods, social conditioning often constrains poor women's mobility as many are not allowed to learn how to swim (Demetriades and Esplen, 2008); yet, in Nicaragua, it forced middle-class women to stay in risk-prone houses (Bradshaw, 2010). More women die in hurricanes and floods when they are socio-economically disadvantaged and the disasters exacerbate existing patterns of discrimination (Neumayer and Plümper, 2007; Ray-Bennett, 2009). Evidence from Hurricane Mitch and other disasters shows a higher mortality rate among men in the case of culturally-imposed roles as heroic life-savers (Röhr, 2006; Campbell *et al*., 2009; Resurreccion, 2011).

[INSERT FIGURE 13-4 HERE
Figure 13-4: Intersecting dimensions of inequality.]

[INSERT TABLE 13-1 HERE
Table 13-1: Gendered impacts of Australia's ten-year drought.]

_____ END BOX 13-1 HERE _____

Medium evidence highlights impacts of climate stresses and extreme events on *children* (Cutter *et al*., 2012; O'Brien *et al*., 2012). Children in urban slums suffer from inadequate water supplies and malnutrition, which exacerbates impacts from heat stress, while excessive rain heightens water-borne diseases (Bartlett, 2008). Flood-related mortality in Nepal was twice as high for girls as for women (1.33% versus 0.6%) and also higher for boys than for

men, and for young children in general six times higher than before the flood (Pradhan *et al.*, 2007). Lower caloric intake due to two back-to-back droughts and price shocks in Zimbabwe in the 1980s has resulted in physical stunting among children and reduced lifetime earnings (Alderman, 2010). In Mali, the incidence of child food poverty increased from 41% to 52% since the 2006 food price increases (Bibi *et al.*, 2010).

Health impacts of weather events and climate differentially affect *the elderly* and *socially isolated* (Frumkin *et al.*, 2008). In Vietnam the elderly, widows, and disabled people, in addition to single mothers and women-headed households with small children, were least resilient to floods and storms and slow-onset events such as recurrent drought (Campbell *et al.*, 2009). In Australia, older citizens have shown feelings of distress as a result of familiar landscapes altered by drought, loss of home gardens, social isolation, and physical harm related to heat stress and wild fires (Pereira and Pereira, 2008; Horton *et al.*, 2010; Polain *et al.*, 2011). Elderly citizens in the U.K. may experience higher vulnerability to heat waves due to misinformation propagated through bonding networks (Wolf *et al.*, 2010). Studies in Europe, U.S., U.K., Japan, Korea, and New Zealand report higher heat-related mortality among the elderly, children, and persons of lower socio-economic status (Baccini *et al.*, 2008). Much evidence, though anecdotal, suggests differential damages of Hurricane Sandy in New York (2012).

Inequality and disproportionate effects of climate-related impacts also occur along the axes of *indigeneity* and *race*. Examples include low-income African-American residents of New Orleans after Hurricane Katrina (Elliott and Pais, 2006), Afro-Latinos and displaced indigenous groups in urban Latin America (Hardoy and Pandiella, 2009), and the indigenous in the Russian North (Crate, 2013) and Bolivia's highlands (Andersen and Verner, 2009; Valdivia *et al.*, 2010; McDowell and Hess, 2012). See Chapter 12 for diverse impacts on indigenous cultures and lifestyles.

13.2.2. Understanding Future Impacts of Climate Change on Livelihoods and Poverty

Future climate change, as projected through modeling, will continue to affect poor people in rural and urban areas, both in the global North and South, alter their livelihoods, and make efforts to reduce poverty more difficult (*high confidence*). Studies reveal a broad range of future impacts, depending on the climatic, agro-economic, and demographic models employed, their key variables, time frame, ranging from 2016-2100, and spatial scale, varying from a country's agro-ecological zones to the global. Only some projections include adaptation.

Projections emphasize the complexity and heterogeneity of future climate impacts, including winners and losers in close geographic proximity. Anticipated impacts are expected to interact with multiple stressors, most notably social vulnerability (Iglesias *et al.*, 2011), low adaptive capacity and subsistence constraints under extreme poverty (Liu *et al.*, 2008), natural resource dependence (Adano *et al.*, 2012), population increases (Müller *et al.*, 2011), weak institutional support (Menon, 2009; Xu *et al.*, 2009; Skoufias *et al.*, 2011a; Skoufias *et al.*, 2011b), ethnic conflict and political instability (Challinor *et al.*, 2007; Adano *et al.*, 2012), large-scale land conversions (Assuncao and Cheres, 2008; Thornton *et al.*, 2008), and inequitable trade relations (Challinor *et al.*, 2007; Jacoby *et al.*, 2011).

13.2.2.1. Projected Impacts by Geographic Region

Climate change will exacerbate vulnerability and in turn further entrench poverty (*very high confidence*). Wheeler (2011) employs an extensive dataset to analyze climate risk and coping ability by country. The 20 countries most at risk of extreme weather in 2015 will include those with considerable poverty, although not all poor people will be at risk. Of these top 20, seven are LICs (Bangladesh, Ethiopia, Kenya, Madagascar, Mozambique, Somalia, and Zimbabwe), eight are lower MICs (Bolivia, Djibouti, Honduras, India, Philippines, Sri Lanka, Vietnam, and Zambia), four are upper MICs (China, Colombia, Cuba, and Thailand), and one is a HIC (Hong Kong). For the top five (China, Djibouti, India, Kenya, and Somalia), climate contributes between 46.4% and 87.5% to a 2008-2015 increase in national vulnerability, in contrast to income, urbanization, and regulation. Highest vulnerability to sea level rise by 2050, based on low-elevation coastal zones, areas of storm surge zones, and population density, is expected for India, China, Indonesia, and the Philippines (all MICs) and Bangladesh (LIC), while Qatar, Bahamas, and Bahrain (all HICs) show the highest percentage of vulnerable population (>30%). India and Indonesia are projected to experience a 80% and 60% increase, respectively, in the sizes of their populations vulnerable to sea

level rise, housing a combined total of over 58 million of the most vulnerable people by 2050; an increase of six million people vulnerable to sea level rise in China will bring its total to 22 million, and Bangladesh's vulnerable population is predicted to grow to 27 million people – more than double its 2008 size (Wheeler, 2011).

Geographically, highly vulnerable regions are those exposed to sea-level rise and extreme events overlaid with high concentrations of multidimensional poverty, including pockets of poor people in MICs: mega-deltas in Bangladesh, Thailand, Myanmar, and Vietnam (Eastham *et al.*, 2008; Wassmann *et al.*, 2009), watersheds in the Himalayas (Xu *et al.*, 2009), ecologically-fragile areas in China (Taylor and Xiaoyun, 2012), drylands (Anderson *et al.*, 2009; Piao *et al.*, 2010), mountain areas (Beniston, 2003; Valdivia *et al.*, 2010; Gerlitz *et al.*, 2012; McDowell and Hess, 2012; Gentle and Maraseni, 2012), river deltas subject to resource extraction (Syvitski *et al.*, 2009), and coastal areas with severe ecosystem deterioration in eastern and southern Africa (Bunce *et al.*, 2010a; Bunce *et al.*, 2010b).

13.2.2.2. Anticipated Impacts on Economic Growth and Agricultural Productivity

The majority of projected impact studies focus on the anticipated consequences of climatic changes and shocks on agricultural productivity, mainly in Africa, Asia, and Latin America and primarily focus on impacts on economic growth, changes in food prices and food security, and, subsequently, extrapolated changes in poverty head counts.

For future poverty head counts impacted by climate change, the literature shows disagreement. Tubiello et al. (2008) project that, by 2080, the number of undernourished people could increase by up to 170 million, using the A2 SRES scenarios, and up to a total of 1,300 million people assuming no CO_2 fertilization. In contrast, Skoufias et al. (2011b), using 2055 predictions based on the Nordhaus (2010) ICE model, state that under business as usual and optimal abatement, poverty (measured at $2/day) could be reduced by 800 million people, due to annual, global, and real per capita growth rate of 2.2% up to 2055. However, lower probability extreme events would reverse this trend, and mitigation under optimal abatement typically excludes the poor (Skoufias *et al.*, 2011b). One study of Zambia illustrates the range of potential shifts in poverty headcounts based on climate change and responses. Thurlow et al. (2009) estimate that by 2016, Zambia's poverty headcount would increase by 300,000 people under average climate variability, and by 650,000 under a worst ten-year rainfall sequence.

Projections of future climate change impacts on GDP use non-disaggregated poverty data. For instance, Mendelsohn et al. (2006) use dynamic coupled ocean–atmosphere models and market response functions to simulate the distribution of climate impacts for 2100. Independent of the climate scenarios, poor countries, mainly in Africa and Southeast Asia, will face the largest losses (0.2-1.2% reduction in GDP) and, under experimental models, up to 23.8% drop in GDP; in contrast, the richest quartile will encounter both positive and negative effects, ranging -0.1% to +0.2% GDP, and up to a 0.9% GDP increase under experimental models. Changes in GDP reflect climate-sensitive economic sectors, especially water and energy, with poor nations in low latitudes already facing high temperatures and thus more vulnerable to decreased agricultural productivity with increased warming.

A growing body of literature estimates future changes in agricultural production and food prices due to climate change, variability, and extreme events, primarily in the global South (Slater *et al.*, 2007; Thomas *et al.*, 2007; Assuncao and Cheres, 2008; Burke *et al.*, 2011). Mixed trends are projected for major staples for all continents until the mid of the 21st century (see Chapter 7). By mid-century the production of coarse grains in Africa may be reduced by 17-22 % due to climate change; the well-fertilized modern seed varieties seem more susceptible to heat stress than traditional ones (Schlenker and Lobell, 2010). By 2080, a significant decrease in land productivity is expected for sub-Saharan Africa (-14% to -27%) and Southeast Asia (-18% to -32%), coupled with increase in water demand, while lowest risks are projected for North America, Europe, East Asia, Russia, and Australia (Iglesias *et al.*, 2011).

13.2.2.3. Implications for Livelihood Assets, Trajectories, and Poverty Dynamics

Projections of future climate change impacts on livelihood assets highlight the erosion of financial capital as a result of increased food prices (Thurlow *et al.*, 2009; Seo *et al.*, 2009; Ahmed *et al.*, 2009; Hertel *et al.*, 2010; Jacoby *et al.*, 2011; Skoufias *et al.*, 2011b), human assets due to decline in nutritional status (Liu *et al.*, 2008), and natural

assets due to lower agricultural productivity (Thurlow *et al*., 2009; Jones and Thornton, 2009; Skoufias *et al*., 2011b). They also show a substantial increase in future heat-related mortality (Basu and Samet, 2002; McGregor *et al*., 2006; Sherwood and Huber, 2010; Huang *et al*., 2011), increasing infectious disease transmission rates (Green *et al*., 2010), and other health impacts (see Chapter 11). Impacts on social and cultural assets have received little attention. Exceptions address losses of social identity and cultural connections with land and sea among indigenous populations threatened by sea level rise and potential relocation (Green *et al*., 2010) and conflicts between ethnic and/or religious groups (Adano *et al*., 2012) (see Chapter 12). Poor households with limited social networks will be worst off, including in places such as Nepal (Menon, 2009) and Indonesia (Skoufias *et al*., 2011a).

Climate change is also projected to cause shifts in livelihood trajectories. Simulated probabilities of failed seasons, using current daily rainfall data and 2050 projections in the length of growing period, show transitions from cropping to livestock in marginal cropping areas in Africa (Thomas *et al*., 2007; Jones and Thornton, 2009). By 2050, expanding vector populations, especially tsetse, and a >20% reduction in the length of the growing period, as simulated under HadCM3 and A1F1, are expected for livestock-dependent livelihoods and mixed crop-livestock livelihoods in semi-arid to arid Africa and Asia, combined with increasing water scarcity and loss in stovers due to maize substitution (Thornton *et al*., 2007), which will stress livelihoods of poor farmers and pastoralists.

Future climate change impacts on disaggregated poverty are mainly addressed through projected changes in food prices and price-induced earnings associated with impacts on agricultural production (Schmidhuber and Tubiello, 2007). Changes in price-induced earnings lower the welfare of low-income households, particularly urban and wage-labor dependent households that use a large income share to purchase staple crops. For instance, a one-time maximum extreme dry event, simulated for 1971-2000 and 2071-2100 using the IPCC-SRES A2 scenario for a sample of 16 developing countries, shows a 95-110% increase in poverty for urban wage populations in Malawi, Zambia, and Mexico, while self-employed farming households consolidate assets and face the smallest increase in vulnerability (Ahmed *et al*., 2009). Similarly, under low productivity scenarios assuming rapid temperature increase by 2030, poverty among the agricultural self-employed in 15 LICs and MICs may drop due to benefits from selling surplus production at higher prices, by as much as 40% in Chile and the Philippines; however, higher food prices may lead to a drop in national welfare, as steep as 55% in South Africa (Hertel *et al*., 2010). In most developing countries the poverty headcount is expected to decline in some occupational strata and increase in others; only in most African countries are yield impacts expected to be too severe to allow any benefits (Hertel and Rosch, 2010).

13.2.2.4. Impacts on Transient and Chronic Poverty, Poverty Traps, and Thresholds

Existing projections do not provide robust evidence to estimate whether shifts from transient to chronic poverty are expected to occur as a result of climate change, and to what extent. However, a predicted increase in the number of urban poor, especially wage laborers, suggests that a large number may shift from transient to chronic poverty due to high exposure to food price increases, or find themselves in a poverty trap, especially under scenarios with long-duration climatic shifts and prolonged droughts (Ahmed *et al*., 2009; Hertel *et al*., 2010). In Zambia, for example, almost half of the 650,000 new poor under the worst historic 10-year period projected until 2016 are expected to be in urban areas (Thurlow *et al*., 2009). In Tanzania, Ahmed et al. (2011), based on a high precipitation volatility GCM, predict up to 1.17 million new poor into the 21st century. Shifts in and out of poverty may occur by 2050 for small-scale coffee farmers in Central America, because of suitable coffee growing areas moving to higher altitudes, especially when constrained by unequal access to agro-technical and climatic information (Laderach *et al*., 2011).

Poor countries will experience greater poverty as a result of climate change and extreme events (*high confidence*), due to location and low-latitude high temperatures (Mendelsohn *et al*., 2006), anticipated further decline in adaptive capacity combined with reductions in agricultural productivity (Iglesias et al., 2011), greater inequality and deep-rooted poverty (Jones and Thornton, 2009), and lower levels of education and large numbers of young dependents (Skoufias *et al*., 2011c). Although robust projections on poverty traps are lacking, they may be associated with emerging hotspots of hunger, such as those projected for Tanzania, Mozambique, and the Democratic Republic of Congo (DRC) by 2030 (Liu *et al*., 2008). Based on SRES scenarios, Devitt and Tol (2012) simulate coupled climate change- and conflict-induced poverty traps up until 2100 for the DRC and several other sub-Saharan countries.

Some climate change projections (see WG1 Chapters 11, 12 and 14) indicate the possibility of large impacts from climate change that may exceed thresholds beyond which detrimental shocks to livelihoods and poverty may occur, unless strong adaptation and/or mitigation responses are implemented in a timely manner. In parts of Africa, particularly the Sahel, and the Indian sub-continent, the risk of heat stress may become acute toward the end of the century, preventing people from practicing agriculture (Patricola and Cook, 2010; Dunne *et al.*, 2013). Since women do most of the agricultural work, they will suffer disproportionally from heat stress; for instance, in Africa, women carry out 90% of hoeing and weeding and 60% of harvesting work (Blackden and Wodon, 2006 p. 18). In the glacier-dependent Himalayan region, excessive runoff and flooding will threaten livelihoods (Xu *et al.*, 2009). Relocation would represent a critical threshold for indigenous groups, due to sea level rise for the Torres Strait Islanders between Australia and Papua New Guinea (Green *et al.*, 2010) and permafrost degradation and increased and seasonally erratic precipitation for the Viliui Sakha in the Russian North (Crate, 2013).

13.3. Assessment of Impacts of Climate Change Responses on Livelihoods and Poverty

Climate change responses interact with social and political processes to affect sustainable development and climate resilient pathways (Chapter 20), and in turn, livelihoods and poverty. Climate mitigation and adaptation responses include formal policies by governments, NGOs, bilateral and multilateral organizations as well as actions by individuals and communities. This section reviews evidence of impacts of mitigation responses (13.3.1) and of adaptation responses (13.3.2) in the context of livelihood and poverty dynamics and inequalities. This section draws upon empirical evidence, some of which is preliminary as several policies are still in their infancy.

13.3.1. Impacts of Mitigation Responses

This section assesses the observed and potential impacts of four climate change responses on livelihoods and poverty: the two mitigation responses most significant for poverty alleviation under the UNFCCC, the CDM and REDD+, and two mitigation responses outside of the UNFCCC, voluntary carbon offsets and biofuel production. Many synergies between climate change mitigation policies and poverty alleviation have been identified in the literature (Klein *et al.*, 2005; Ürge-Vorsatz and Tirado Herrero, 2012), but evidence of positive outcomes is limited. Policies aimed at mitigating climate change are often detrimental to poor people and their livelihoods (*high confidence*) (Collier *et al.*, 2008; Böhm, 2009; Hertel and Rosch, 2010).

13.3.1.1. The Clean Development Mechanism (CDM)

The CDM (see 21.6.1.4) aims to promote social, economic, and environmental dimensions of sustainable development through progress along 15 indicators including poverty alleviation. CDM projects as diverse as low-cost energy services in India, micro-hydro projects in Bhutan and Peru, efficient firewood use in Nigeria, and biogas digesters in China, are expected to generate livelihood benefits and employment, and reduce poverty among beneficiaries, according to the UNFCCC secretariat (UNFCCC, 2011; UNFCCC, 2013). However, most of the statistical information in official reports on CDM is based either on project documents or on surveys of projects.

The assessment of the CDM in the peer-reviewed literature is more cautious and pessimistic than UNFCCC, and two reviews (Olsen, 2007; Michaelowa and Michaelowa, 2011) contend that the current CDM design is neither pro-poor nor contributes to sustainable development. Shortcomings include obstacles and ethical dilemmas in carbon trading (Liverman, 2009; Newell and Bumpus, 2012), difficulties with implementation (Borges da Cunha *et al.*, 2007; Minang *et al.*, 2007; Gong, 2010), and procedural limitations (Lund, 2010). Case studies suggest that CDM may favor carbon offset goals over poverty reduction goals (Wittman and Caron, 2009), undermine local and non-governmental voices (Shin, 2010; Corbera and Jover, 2012), compete with the informal sector (Newell and Bumpus, 2012), and accentuate uneven development by threatening local livelihood security (Boyd and Goodman, 2011). Only a few CDM programs have shown positive impacts for poor communities, such as one in Peru that enhanced health and employment (Boyd and Juhola, 2009) and some in India supporting community-designed plans to strengthen participation of marginalized groups (Subbarao and Lloyd, 2011; Boyd and Goodman, 2011).

13.3.1.2. Reduction of Emissions from Deforestation and Forest Degradation (REDD+)

Reducing emissions through carbon forestry as part of UN REDD+ may adversely affect the livelihoods of poor people. Experience with forest carbon projects to date is inadequate to permit broad generalizations about the effects of REDD+ on livelihoods and poverty (Cotula *et al*., 2009; Hayes and Persha, 2010; Springate-Baginski *et al*., 2010). In a study of 20 forest carbon projects in Latin America, Africa and Asia, only five had conducted some form of assessment of the outcomes or impacts, demonstrating a lack of rigor in project evaluation (Caplow *et al*., 2011).

Some studies show favorable results in terms of poverty alleviation (Ferraro *et al*., 2011) and are optimistic about REDD+ (Kanowski *et al*., 2011; Rahlao *et al*., 2012) but raise concerns about its future developments (Hodgdon *et al*., 2012; Rana *et al*., 2012). Others have voiced concerns about negative impacts on the poor (Phelps *et al*., 2010; Larson, 2011; Van Dam, 2011; McDermott *et al*., 2011; Börner *et al*., 2011; Rahlao *et al*., 2012; Neupane and Shrestha, 2012; Mahanty *et al*., 2012) and on indigenous peoples (Shankland and Hasenclever, 2011). Latent negative impacts include exclusion of local populations from forest use, and the undermining of local ownership in the processes of documenting the state of their forests due to external monitoring and verification mechanisms (Gupta *et al*., 2012). Benefit flows may be unevenly distributed with regards to ethnicity (Krause and Loft, 2013), gender (UN-REDD, 2011; Peach Brown, 2011) or simply not target the poor (Hett *et al*., 2012). Also, the absence of a global REDD+ mechanism means that progress on REDD+ may occur as much through voluntary bilateral and public-private processes as through multilateral, regulatory requirements (Agrawal *et al*., 2011). Without a global agreement and mandated emissions reductions, the price of carbon will remain uncertain and vary greatly across different carbon forestry projects (Bailey *et al*., 2011), to the advantage of carbon credit buyers rather than the poor.

The 2010 Cancun Agreements highlight safeguards for governments to observe in REDD+ implementation, such as respect for the interests, knowledge, rights, and sustainable livelihoods of local communities and indigenous people. The extent to which these safeguards will be observed in practice is unclear due to the early implementation state of REDD+ in most countries as well as the uncertainty of the future of the global carbon market (Lohmann, 2010).

13.3.1.3. Voluntary Carbon Offsets

The voluntary carbon offset (VCO) market is significant from a livelihoods and poverty perspective because it typically targets smaller projects and may be better at reaching poor communities, though it is modest in size compared to the regulated market (~ 1%). Also, those involved in the VCO market, namely individuals, companies, organizations, and countries that have not ratified the Kyoto Protocol, are often more willing to pay for carbon offsets with co-benefits such as poverty alleviation (MacKerron *et al*., 2009).

Activities under VCO are dominated by renewable energy, primarily wind power (30%), forestation projects, including REDD (19%), and methane destruction in landfills (7%) (Peters-Stanley and Hamilton, 2012). It is too early to tell whether these VCO projects are successful in terms of poverty alleviation and other social goals, and results to date are highly mixed (Jindal *et al*., 2008; Swallow and Meinzen-Dick, 2009; Jindal, 2010; Estrada and Corbera, 2012; Stringer *et al*., 2012). Reported benefits include livelihood diversification, increased disposable income, biodiversity conservation, and strengthening local organizations, while exacerbated inequalities and loss of access to local resources are known negative impacts (Estrada and Corbera, 2012). A study in Kenya, Senegal, and Peru shows reduced losses of soil fertility in three soil carbon sequestration projects, but also the inability of the poorest farmers to participate and only marginal impacts on poverty reduction (Antle and Stoorvogel, 2009). Out of 78 projects in 23 countries in sub-Saharan Africa, only one promoted local social, economic, and environmental benefits while the rest focused mainly on efficiency of emission reductions (Karavai and Hinostroza, 2013).

13.3.1.4. Biofuel Production and Large-Scale Land Acquisitions

Biofuel production, often linked to large-scale transnational land acquisitions (LSLA), constitutes a mitigation response that raises two major livelihoods and poverty concerns: food price increases and dispossession of land (see Chapters 4, 9). LSLA have soared since 2008 (Von Braun *et al*., 2009; Deininger *et al*., 2011; Borras Jr *et al*., 2011), partly linked to climate change responses (*high agreement*). Production of biofuels is considered the primary driver, but there may be links to climate change through increasing food prices (Daniel, 2011), food insecurity (Robertson and Pinstrup-Andersen, 2010; Rosset, 2011; Sulser *et al*., 2011), and the potential that carbon markets, e.g. REDD+, may increase land prices (Cotula *et al*., 2009; Zoomers, 2010; Anseeuw *et al*., 2012). According to Anseeuw (2012), LSLA goals globally are primarily biofuels (40%), food (25%) and forestry (3%), with significant regional variation. The recent IPCC special report on renewable energy highlighted the uncertainties around the role of biofuels in food price increases and risks of deteriorating food security with future deployment of bioenergy (Edenhofer *et al*., 2011).

Increasing demand for biofuels shifts land from food to fuel production, which may increase food prices (Collier *et al*., 2008), disproportionally affecting the poor (Von Braun and Ahmed, 2008; Ruel *et al*., 2010; Bibi *et al*., 2010). Despite high agreement that biofuel production plays a role in food prices, little consensus exists on the size of this influence. Statistical analyses of the influence of biofuels on the 2007/08 food price increase range from 30% (Von Braun and Ahmed, 2008) to 70% (Mitchell, 2008), while economic modeling suggests a smaller direct role (<30%) (Aksoy and Isik-Dikmelik, 2008; Elobeid and Hart, 2008; Baffes and Haniotis, 2010; Ajanovic, 2011). Several studies link the 2007/08 price spike to speculation in agricultural futures markets (Runge and Senauer, 2007; Gilbert and McLeman, 2010; Ghosh, 2010) driven partly by potential future profits from biofuels (Trostle *et al*., 2011).

LSLA have also triggered a land rush in LICs, which affects livelihood choices and outcomes. New competition for land dispossesses smallholders, displaces food production, degrades the environment, and pushes the poor onto more marginal lands less adaptable to climatic stressors (Cotula *et al*., 2009; Borras Jr *et al*., 2011; Rulli *et al*., 2013; Weinzettel *et al*., 2013). The expansion of bioenergy, and biofuels in particular, increases the corporate power of international actors over governments and local actors with harmful effects on national food and agricultural policies (Dauvergne and Neville, 2009; Glenna and Cahoy, 2009; Hollander, 2010; Mol, 2010; Fortin, 2011; Jarosz, 2012), further marginalizing smallholders (Ariza-Montobbio *et al*., 2010; De Schutter, 2011; Neville and Dauvergne, 2012). There is growing apprehension that increased competition for scarce land undermines women's access to land and their ability to benefit economically from biofuel investment (Molony, 2011; Arndt *et al*., 2011; Chu, 2011; Julia and White, 2012; Behrman *et al*., 2012; Perch *et al*., 2012). Concerns differ to some extent among regions, with the greatest risk for negative outcomes for smallholders in Africa (Borras *et al*., 2011).

Mainstream economic modeling suggests optimism that biofuels may boost investment, employment, and economic growth, in LICs such as Mozambique (Arndt *et al*., 2009) and MICs such as India (Gopinathan and Sudhakaran, 2011) and Thailand (Silalertruksa *et al*., 2012), yet limited evidence exists on potential benefits being realized. A major government initiative to promote jatropha cultivation in India has failed (Kumar *et al*., 2011) and in some cases has left rural people worse off (Bastos Lima, 2012) whereas in Malawi it offered supplemental livelihood opportunities (Dyer *et al*., 2012) . Even though income and employment in Brazil may have increased due to ethanol production (Ferreira and Passador, 2011), structural inequalities in the sector remain (Peskett, 2007; Hall *et al*., 2009; Bastos Lima, 2012). Biofuel production in itself will not transform living conditions in rural areas without being integrated into development policies (Hanff *et al*., 2011; Jarosz, 2012; Dyer *et al*., 2012).

13.3.2. Impacts of Adaptation Responses on Poverty and Livelihoods

Even well-intentioned adaptation projects (see Chapters 14-16) and efforts may have unintended and sometimes detrimental impacts on livelihoods and poverty, and may exacerbate existing inequalities. This section assesses the effects of autonomous and planned adaptation and formal insurance schemes on the livelihoods of poor populations.

13.3.2.1. Impacts of Autonomous and Planned Adaptation Strategies on Livelihoods and Poverty

Autonomous adaptation strategies, such as diversification of livelihoods (Smith *et al*., 2000; Mertz *et al*., 2009), migration (McLeman and Smit, 2006; Tacoli, 2009) (see Chapter 12), storage of food (Smit and Skinner, 2002; Howden *et al*., 2007), communal pooling (Linnerooth-Bayer and Mechler, 2006), market mechanisms (Halstead and O'Shea, 2004), saving, credit societies, and systems of mutual support (Andersson and Gabrielsson, 2012) have been found to have positive effects on poverty reduction in certain contexts, or at least prevent further deterioration as a result of a weather events and climate, especially when supported by policy measures (Adger *et al*., 2003; Urwin and Jordan, 2008; Stringer *et al*., 2009). Yet, some autonomous strategies such as diversification and storage are often unavailable to the poorest, who lack the required resources or surplus (Smithers and Blay-Palmer, 2001; Osbahr *et al*., 2008; Seo, 2010). In some cases, risk reduction strategies involve a trade-off with higher-income options (Hazell and Hess, 2010; Alpizar *et al*., 2011; Benson *et al*., 2012). Moreover, autonomous adaptation strategies can increase vulnerability for others or be subject to local elite capture (McLaughlin and Dietz, 2008; Bhattamishra and Barrett, 2010). For example, richer farmers in Mozambique with access to irrigation benefited from higher producer prices and ready availability of casual labor from poorer farmers during the 2002/03 drought (Eriksen and Silva, 2009). There is no evidence regarding the effect of autonomous responses of the poor in MICs and HICs.

Few rigorous assessments of the effects of pilot adaptation projects exist outside of organizations' own assessments (Mapfumo *et al*., 2010; Nkem *et al*., 2011) or evaluations of the extent to which planned adaptation activities have been implemented or integrated into development (Gagnon-Lebrun and Agrawala, 2006; Gigli and Agrawala, 2007). An assessment of the only completed GEF/WB-funded adaptation project, in the Caribbean, Colombia, and Kiribati, did not directly appraise the effects on poverty and livelihoods. Other projects, though, such as in India's Karnataka Watershed, increased agricultural productivity, income, and employment, benefiting the poorest and landless and improving equity (IEG, 2012). New insights emerge from ecosystem-based adaptation (see Chapters 15, 16).

13.3.2.2. Insurance Mechanisms for Adaptation

Insurance mechanisms (see Glossary) reflect the tendency that some formal adaptation measures reach the wealthier more easily while prohibitive costs may prevent poor people from accessing such mechanisms. Nonetheless, public and private insurance systems have been proposed by the World Bank and UNFCCC as an adaptation strategy to reduce, share, and spread climate change-induced risk and smooth consumption, especially among poor households (Mechler *et al*., 2006; Hertel and Rosch, 2010; Akter *et al*., 2011; Benson *et al*., 2012). Formal insurance schemes can potentially provide a way out of poverty traps (Barnett *et al*., 2008) caused by the years-long process for a household to rebuild assets after climate shocks (Dercon, 2006; Hertel and Rosch, 2010).

Poor people tend not to be insured via formal institutions, though strategies such as risk spreading, social networks, local credit, asset markets, and dividing herds between kin act as informal risk management mechanisms (Barnett *et al*., 2008; Pierro and Desai, 2008; Giné *et al*., 2008; Hertel and Rosch, 2010). Unable to access insurance, poor people are often forced to invest in low-risk, low-return livelihood activities, which makes accumulating assets to escape chronic poverty very difficult (Elbers *et al*., 2007; Barnett *et al*., 2008). As a response, new insurance mechanisms such as micro-insurance directed at low-income people, and weather index insurance for crops and livestock, have emerged, but have shown mixed results (Barnett *et al*., 2008; Mahul *et al*., 2009; Akter *et al*., 2011; Matsaert *et al*., 2011; Biener and Eling, 2012). Experiences from South Asia and several African countries illustrate positive effects of micro-insurance although affordability may limit the potential for the poorest (Yamauchi *et al*., 2009; Hochrainer-Stigler *et al*., 2012). Another reason for the slow uptake is that farmers may not fully understand the merits and function of the new insurance schemes (Giné and Yang, 2009; Patt *et al*., 2010).

13.4. Implications of Climate Change for Poverty Alleviation Efforts

This section considers the implications climate change has for poverty alleviation efforts and what they may mean for current and future pathways for sustainable development. Evidence from observed and projected interactions between climate, poverty reduction, and development highlights how addressing climate change and poverty may

result in diminished success or productive synergies with respect to eradicating poverty, managing risk, pursuing sustainable development, and designing climate-resilient pathways, which are "evolutionary processes for managing change within complex systems to reduce disruptions and enhance opportunities" (see Glossary). This section builds on the findings from 13.1 to 13.3 and stresses the need to attend to the complexity of livelihood dynamics, multi-dimensional poverty, and intersecting inequalities to successfully navigate climate-resilient development pathways.

Observed impacts of weather events and climate on livelihoods and poverty and impacts projected from the sub-national to the global level suggest that livelihood resilience, poverty alleviation, and development are already undermined and will continue to be eroded into the future (*high confidence*). Climate change will slow down the pace of poverty reduction, jeopardize sustainable development, and further erode food security (*high confidence*) (Stern, 2009; Hope, 2009; Thurlow *et al*., 2009; Iglesias *et al*., 2011; Skoufias *et al*., 2011b). Currently poor and food-insecure regions will continue to be disproportionately affected into the future (*high agreement*) (Challinor *et al*., 2007; Lobell *et al*., 2008; Assuncao and Cheres, 2008; Liu *et al*., 2008; Thornton *et al*., 2008; Menon, 2009; Jones and Thornton, 2009; Nordhaus, 2010; Jacoby *et al*., 2011; Burke *et al*., 2011; Skoufias *et al*., 2011a; Adano *et al*., 2012). Poorer countries will experience continued decline in adaptive capacity, which will hamper development (*high confidence*). Iglesias *et al*. (2011), for instance, project increasing inequality among continents in the case of progressively severe climate change scenarios. Posey (2009) highlights lower adaptive capacities in communities with greater concentrations of racial minorities and low-income households than in more affluent communities, due to multidimensional inequality and marginalization. Although there is *high agreement* about the heterogeneity of future impacts on poverty, few studies consider more diverse climate change scenarios (Skoufias *et al*., 2011b) or the potential of four degrees and beyond (New *et al*., 2011). The World Bank (2012b, p.65) states that "climate change in a four degree world could seriously undermine poverty alleviation in many regions."

13.4.1. Lessons from Climate-Development Efforts

Two key models have attempted to integrate climate and poverty concerns into development efforts: mainstreaming adaptation into development priorities and pro-poor adaptation (see also Chapters 14-16). Lessons from "adaptation as development," in which development is seen as the basis for adaptation, and "adaptation plus development," in which development interventions address future climate threats (Ayers and Dodman, 2010), typify the disagreement in policy spheres about what sustainability constitutes (Le Blanc *et al*., 2012) and the practical gulf between climate change policy and development spheres (Ayers and Dodman, 2010). To date, observed and projected climate change impacts are not systematically integrated into poverty reduction programs, although such integration could result in substantial resilience to covariate and idiosyncratic shocks and stresses (Béné *et al*., 2012). At the same time, science and policy emphasis on rapid-onset events, sectoral impacts, and poverty statistics has diverted attention from threats to sustainability and resilient pathways. Even where legal reforms to secure the rights of the poor exist, as in Mexico's Climate Law, inequalities persist (MacLennan and Perch, 2012). Without addressing the climatic, social, and environmental stressors that shape livelihood trajectories, including poverty traps (see Figure 13-2), and the underlying causes of poverty, persistent inequalities, and uneven resource access and institutional support, adaption efforts and policies will be nothing more than temporary fixes. At the same time, poverty alleviation alone will not necessarily lead to more equality (Pogge, 2009; Milanovic, 2012). Box 13-2 provides insight into three examples.

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Box 13-2. Lessons from Social Protection, Disaster Risk Reduction, and Energy Access

Social protection (SP): Considerable challenges emerge at the intersection of climate change adaptation, disaster risk reduction, and social protection. SP programs include public and private initiatives that transfer income or assets to the poor, protect against livelihood risks, and raise the social status and rights of the marginalized (see Glossary). Cash transfer programs are among the principal instruments used by governments for poverty alleviation (Barrientos and Hulme 2008; Niño-Zarazúa 2010). There is *medium agreement* among scholars and practitioners that SP helps the chronically poor reduce risk and protect assets during crises (Devereux *et al*., 2010; Barrientos, 2011; Dercon, 2011; Devereux *et al*., 2011). However, at the regional and municipal level, SP does not address local government

capacity to ensure risk reduction by providing water, sanitation, drainage, health care, and emergency services. Also, SP does not strengthen local collective capacity to proactively address climate change risks and take action.

SP that supports pro-poor climate change adaptation and disaster risk reduction by strengthening the resilience of vulnerable populations to shocks is labeled "adaptive social protection" (ASP) (Davies *et al*., 2009). ASPs have almost exclusively focused on LICs and some MICs rather than on poor people in HICs. Few studies exist on the effectiveness of ASP for addressing incremental climatic changes and rapid-onset events, and the changing nature of climate risks, embedded in an understanding of dynamic livelihood trajectories (Heltberg *et al*., 2009; Arnall *et al*., 2010; Bee *et al*., 2013). For instance, the Productive Safety Net Program in Ethiopia, one of the more successful SPs, had positive effects on household food consumption and asset protection (Devereux *et al*., 2006; Slater *et al*., 2006). Yet, this and programs such as Brazil's *Bolsa Familia* and *Bolsa Verde* offer few concrete pathways to tackling systemic vulnerabilities and inequalities that inhibit effective responses to severe shocks, though they stress the role of local governments in addressing livelihood security and resilience in the long term rather than focusing on short-term disaster relief (Gilligan *et al*., 2009; Conway and Schipper, 2011; Béné *et al*., 2012; UNDP, 2012).

Disaster risk reduction (DRR): The development and application of DRR (see Glossary) has been among the most important routes for generating attention from local governments and civil society about the risks of extreme weather, and came to the fore as the concentration of disaster deaths from extreme weather in LICs and MICs became evident (United Nations 2009, 2011). Now, DRR is increasingly employed as an adaptation measure, for example through community-based climate risk reduction (Tompkins *et al*., 2008; Meenawat and Sovacool, 2011; McSweeney and Coomes, 2011; Field *et al*., 2012b) and has helped identify DRR roles for local governments (IFRC 2010). Yet, sometimes disaster management-oriented adaptation can favor property and investments of the relatively richer and divert attention and funding from measures that address the poor, as suggested in a case study of Vietnam (Buch Hansen, 2013). The effectiveness of DRR in supporting pro-poor climate change adaptation will depend on governance structures to address changing risk contexts in policies and investments while responding to the needs and priorities of their low-income population. Experiences from Hurricane Katrina and the Tōhoku earthquake and tsunami exhibit the additional and multiplier effect of a disaster on top of underlying structural inequalities. Their persistence years later, as shown with Katrina (Schwartz, 2007; Zottarelli, 2008; Fussell *et al*., 2010), further stresses the need for expanded analyses beyond the events themselves and the recognition of the many factors that perpetuate the vicious cycle of poverty, multidimensional deprivation, and inequality.

Energy access: Energy is critical for rural development (Barnes *et al*., 2010; Kaygusuz, 2011; Kaygusuz, 2012) and for alleviation of urban poverty (Parikh *et al*., 2012). One proposed climate-resilient pathway is to increase renewable energy use, which has the potential to boost energy access for billions of people who currently have no access to safe and efficient energy, while cutting GHG emissions from rising non-renewable energy consumption (Casillas and Kammen, 2010; Edenhofer *et al*., 2011). Benefits include better health (see Chapter 11), employment, and cost savings relative to fossil fuels (Edenhofer *et al*., 2011; Jerneck and Olsson, 2012). Yet, *limited evidence* exists that renewable energy creates more jobs than conventional energy (Karakezi *et al*., 2006; Akella *et al*., 2009).

_____ END BOX 13-2 HERE _____

13.4.2. Toward Climate-Resilient Development Pathways

Given the multiple challenges at the climate-poverty-development nexus, debates increasingly focus on transforming the development pathways themselves toward greater social and environmental sustainability, equity, resilience, and justice, calling for a fundamental shift toward climate-resilient development pathways (see Chapter 20). This perspective acknowledges the major shortcomings in dominant global development pathways, above all rising levels of consumption and emissions, privatization of resources, and limited capacities of local governments and civil society to counter these trends (Pelling, 2010; Eriksen *et al*., 2011; O'Brien, 2012; UN, 2012a).

At Rio+20 in 2012, an Open Working Group was created by the UN General Assembly to develop Sustainable Development Goals (SDGs) building on the Millennium Development Goals (MDGs), which are criticized for not explicitly addressing the root causes of poverty, inequality, or climate change (Melamed, 2012; UN, 2012b) and the

anticipated failure to reach MDG 1 (eradicate extreme poverty and hunger by 2015), with or without climate change (Tubiello *et al*., 2008). Early SDG debates reveal a stronger focus on eradicating extreme poverty and environmental problems facing the poor (UN, 2012a). This framing of development acknowledges shared global futures that require collective action from the richest, not merely promoting welfare for the poorest, to address both climate change and poverty (Ayers and Dodman, 2010; UN, 2012a; UN, 2012b). Little information exists to date to project how these SDGs will support climate-resilient development pathways. Formulating goals, however, will not suffice unless the global institutional framework for sustainable development is radically reformed (Biermann *et al*., 2012).

Paying attention to dynamic livelihoods and multidimensional poverty and the multifaceted impacts of climate change and climate change responses is central to achieving climate-resilient development pathways (see Chapter 20). Evidence from sections 13.2 and 13.3 suggests that increasing global inequality, new poverty in MICs and HICs, and more people shifting from transient to chronic poverty overlaid with business-as-usual development and climate policies, will bring the poor and the marginalized precariously close to the two most undesirable future scenarios as conceptualized in the shared socio-economic pathways (SSPs) (see Figure 20-2): social fragmentation (fragmented world) and inequality (unequal world). At the community level, inadequate governance structures and elite capture often propel less affluent households into deeper poverty. There is *high agreement* among scholars of global governance that fragmentation also exists at the level of the global climate regime (Biermann, 2010; Roberts, 2011; Mol, 2012), rooted in deep and entrenched inequalities (Parks and Roberts, 2010). The extent to which fragmentation promotes positive or negative outcomes of climate and development goals is contested, ranging from polycentric governance modes (Ostrom, 2010) to conflictive fragmentation (Biermann *et al*., 2009; Mittelman, 2013). Evidence from this chapter demonstrates that, in order to move toward the SSP1 (sustainability), a fundamental rethinking of poverty and development is needed that emphasizes equity among the poor and non-poor to collectively address GHG emissions and vulnerabilities while striving toward a joint, just, and desirable future.

13.5. Synthesis and Research Gaps

Previous IPCC reports have stated that climate change would cause disproportionally adverse effects for the world's poor. However, they presented a rather generalized view that all poor people were vulnerable, in contrast to earlier scientific studies highlighting vulnerability as contextual with variation over time and space. This chapter is entirely devoted to exploring poverty in relation to climate change. It uses a livelihoods lens to assess the interactions between climate change and the multiple dimensions of poverty, not just income poverty. This lens also reveals how inequalities perpetuate poverty to shape differential vulnerabilities and in turn the differentiated impacts of climate change on individuals and societies. This chapter illustrates that climate change adds an additional burden to the multiple facets of poor people's lives and livelihoods. Moreover, it emphasizes that climate change may create new groups of poor people, not only in low-income countries but also in middle- and high-income countries. Neither alleviating poverty nor decreasing vulnerabilities to climate change can be achieved unless entrenched inequalities are reduced. This chapter concludes that climate change policy responses often do not benefit the world's poor, and highlights lessons for climate-resilient development pathways.

Eight major research gaps are identified with respect to the observed and projected impacts of climate change and climate change responses:

- Poverty dynamics are not sufficiently accounted for in current climate change research. Most research as well as poverty measurements remain focused on only one or two dimensions of poverty. Insufficient work assesses the distribution of poverty at the level of households, spatial and temporal shifts, critical thresholds that plunge some transient poor into chronic poverty, and poverty traps, in the context of climatic and non-climatic stressors. Many of these dynamics remain hidden, incompletely captured in poverty statistics and disaster and development discourses. Key assumptions in economic models (e.g., constant within-country distribution of per-capita income over time, linear relationship between economic growth and poverty headcounts) are ill-suited to capture local and sub-national poverty dynamics, confounding projections of future poverty levels.
- Though an abundance of studies exists that explore climate change impacts on livelihoods, the large majority does not focus on trajectories but only offers snapshots. In contrast to static representations, an

explicit exploration of livelihood dynamics reveals how people respond to a series of climatic stressors and shocks over time.

- Few studies examine how the structural inequalities, power imbalances, and intersecting axes of privilege and marginalization shape differential vulnerabilities to climate change. Although there is a growing body of literature on climate change and gender as well as on indigeneity, other axes such as age, class, race, caste, and (dis)ability, have been underexplored. Understanding how simultaneous and intersecting inequalities determine climate change impacts reveals which particular drivers of vulnerability are at play in one context, while absent in another.
- Very limited research examines climate change impacts on poor people and livelihoods in middle- to high-income countries. Despite mounting evidence of observed impacts of climatic events on the poor in MICs and HICs, as documented for the European heat wave, Hurricane Katrina in the U.S., and the ten-year drought in Australia, the majority of research on the poverty-climate nexus remains focused on the poorest countries.
- There remains a lack of rigorous data collection and analysis with respect to 'small' disasters in poor people's lives. This gap leads to significant underestimation of lived experiences with climate change, in which particular loss and harm remain largely undetected. There is a need for more climatology research informed by the needs of vulnerable livelihoods, for instance on the effects of changing winds as a combined result of climate change and land cover change, and their effects on increasing evaporation and water availability.
- Not enough consideration is given to the "long tails" in terms of extreme stressors and shock events, such as the potential of four degrees and beyond, underestimating the range of possible impacts on the poor and marginalized.
- There is a lack of in-depth research on the direct and indirect effects of mitigation and adaptation climate-related policies such as CDM, REDD+, biofuels, and insurance, on livelihoods, poverty, and inequality. More in-depth research has the potential to improve the capacity of these policies to become pro-poor.
- Limited understanding exists of how poverty alleviation and more equality between the poor and the non-poor are best built into climate-resilient development pathways in order to strive toward a just and desirable future for all.

Frequently Asked Questions

FAQ 13.1: How important are climate change-driven impacts on poverty compared to other drivers of poverty?

Poverty is a complex social and political problem, intertwined in numerous ways with processes of socioeconomic, cultural, institutional, and political marginalization, inequality, and deprivation, in low-, medium-, and high-income countries. Climate change intersects with the multidimensional facets of poverty to drive not only income poverty but also undermine wellbeing, agency, and a sense of belonging. This complexity makes measuring impacts and attribution to climate change exceedingly challenging. Even modest changes in seasonality of rainfall, temperature, and wind patterns, as observed for instance among climate-sensitive livelihoods in high mountain environments, drylands, and the Arctic, and in informal settlements and urban slums, can push transient poor and marginalized people over a critical threshold into chronic poverty as they lack access to effective response options. Impacts of extreme events, such as floods, droughts, and heat waves, especially when occurring in a series, can significantly erode poor people's assets and further undermine their protection in terms of labor, housing, infrastructure, and social networks. Indirect impacts, such as increases in food prices due to climate-related disasters and/or policies, can also harm the poor, including the urban poor who are net buyers of food.

FAQ 13.2: How do multiple stressors interact with dynamic livelihoods and structural inequalities?

Multiple stressors, or factors such as shifts in seasons and market volatility, interact and reinforce each other to affect livelihood opportunities and decision making. A variety of stressors and opportunities emerge from macro-level forces such as climate change, globalization, and technological change, as well as from conditions such as politics and infrastructure at the regional, national, and local levels. Institutions, policies, and decision making mediate which stressors result in shocks for particular livelihoods and households. Moreover, structural inequalities amplify and compound the effects of these stressors, especially for livelihoods and households with limited asset flexibility and/or those who experience inequalities and marginalization along the axes of gender, age, class, race,

indigeneity, and (dis)ability. The dynamic interplay between weather events and climate, institutions, and livelihoods is socially differentiated, allowing virtuous cycles and positive trajectories for some and vicious cycles and downward trajectories for others, at particular points in time. For instance, a women-headed household from the lowest caste in Nepal may struggle to satisfy additional labor demands to produce drought-resistant subsistence crops and fulfill sharecropping contracts to the high caste landlord while more affluent men-headed households from this high caste may benefit from shifting seasonal precipitation patterns and new local market opportunities.

[INSERT FIGURE 13-5 HERE

Figure 13-5: Multiple stressors related to climate change, globalizations, and technological change interact with national and regional institutions to create shocks to place-based livelihoods. Inspired by transition theory (Geels, 2011).]

FAQ 13.3: Are there unintended negative consequences of climate change policies for people who are poor?

Policies related to climate change mitigation and adaptation may have unintended and potentially detrimental effects for poor people and their livelihoods. Climate-related policies have compound consequences. For example, the recent rapid increase in large-scale land acquisitions emerged, at least partially, as a result of climate change mitigation policies to promote biofuels, as well as a growing concern about food security in high- and middle-income countries. Conversion of presumably marginal or idle land in countries in Africa, Latin America, and Southeast Asia has contributed to food price increases and also has displaces smallholders' croplands. Poor urban residents are particularly vulnerable to food price increases as they use a large income share to purchase food while some agricultural self-employed groups may actually benefit from increased food prices. Besides stress on food security, other adverse consequences of biofuels have been reported for poor and marginalized people, including declining biodiversity, competition for water, and unfavorable shifts in access to and control over resources, often to the detriment of women farmers and other disadvantaged groups. However, in some cases, men and women who find employment in the biofuel industry acknowledge opportunities to participate in the cash economy.

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Table 13-1: Gendered impacts of Australia's ten-year drought.

Impacts	*For men*	*For women*
Increased workload	Heartbreaking and physically demanding tasks include feeding livestock, carting water, destroying frail animals	Increased work includes assisting with farm tasks and working off the farm for additional income
Community effects	Locked into farms, loss of political power	Increased interactions and caregiving work, taking care of others' health at the expense of their own
Psychological toll	Feel demonized (farmers responsible for crisis), increased stress, social isolation, depression, and high suicide levels	Working lives appear indefinite, and increased stress

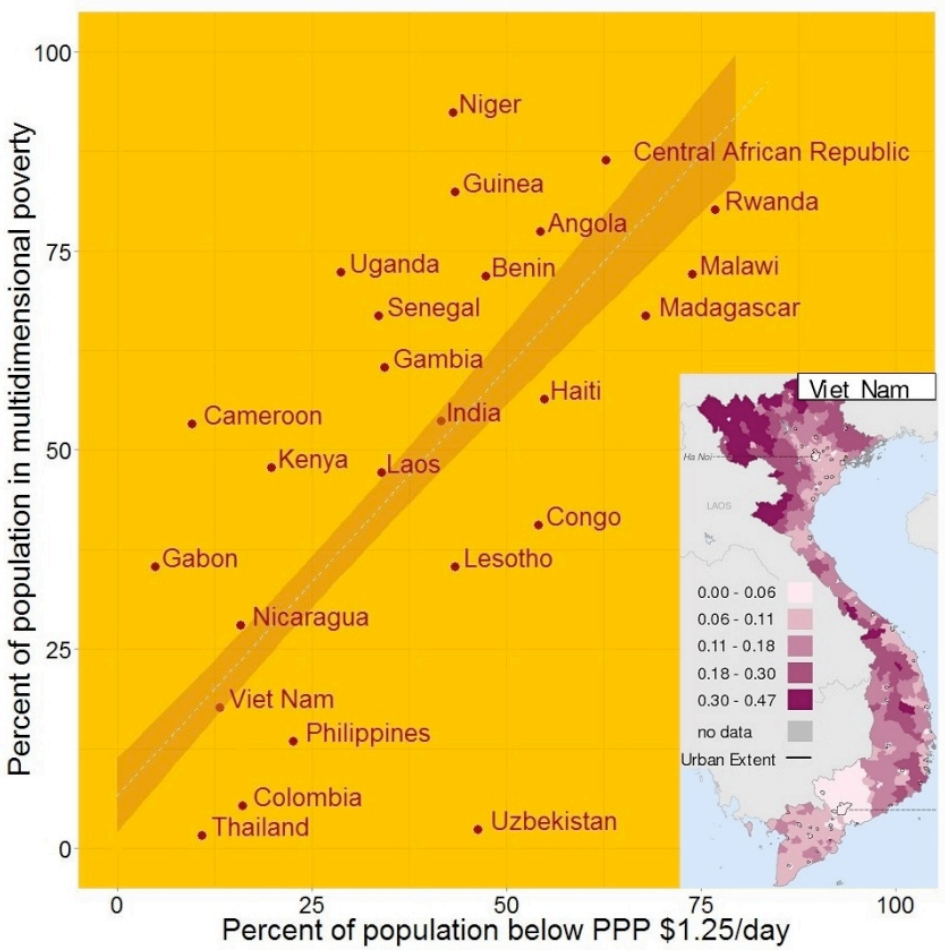
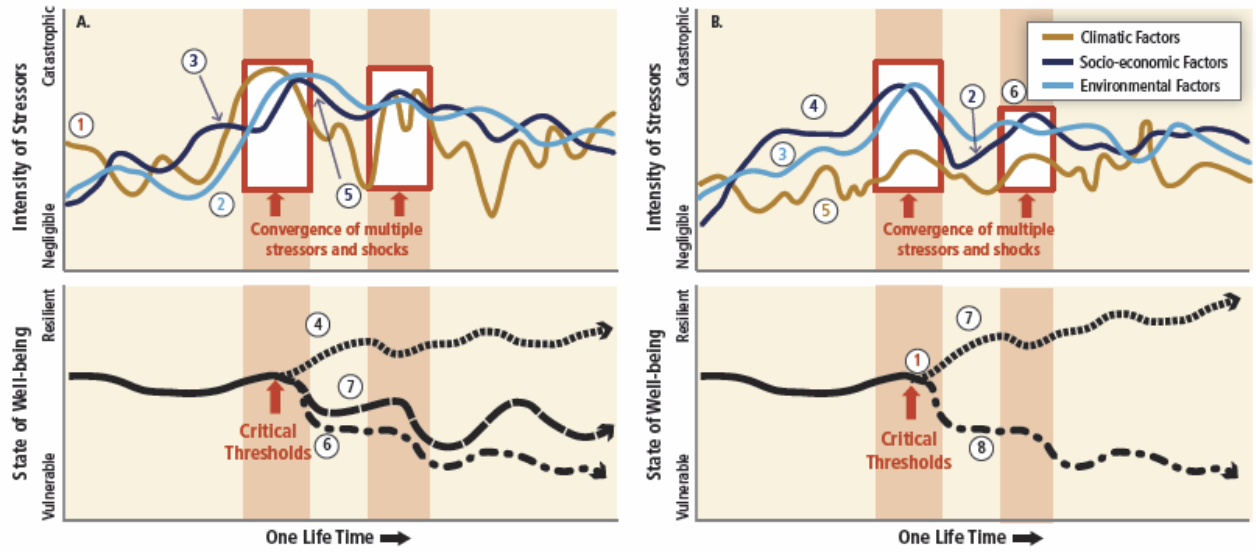
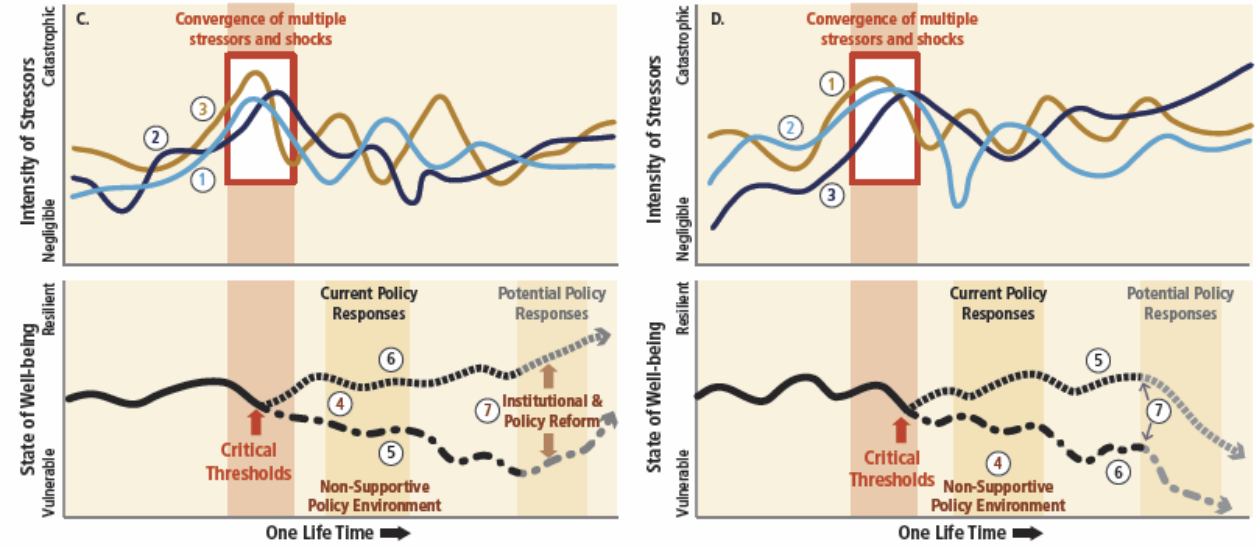


Figure 13-1: Multidimensional poverty and income poverty, with linear regression relationship (dotted line) and shaded 95% confidence interval based on 96 countries (HDR, 2011). The map inset shows the Poverty Gap Index score in Viet Nam, aggregated at district level, expressed as ratio of poverty line of yearly expenditure per capita).



A. Botswana's drylands (Sallu et al., 2010). Over the past 30 years, rural households have faced 1) droughts, late onset and increased unpredictability of rainfall, and frost, 2) drying of Lake Xau, and land degradation. Households responded differently to these stressors, given their financial and physical assets, diversification of and within livelihood activities, family relations, and institutional and governmental support. Despite 3) weakening of social networks and declining livestock due to lack of water, distinct livelihood trajectories emerged. 4) "Accumulators" were often able to benefit from crises, for instance through access to salaried employment or 5) new hunting quotas, while 6) "dependent" households showed a degenerative trajectory, losing more and more livelihood assets, becoming reliant on governmental support after another period of convergent stressors. 7) "Diversifiers" had trajectories fluctuating between vulnerable and resilient states.

B. Coastal Bangladesh (Pouliotte et al., 2010) 1) Households in Surbarnabad have faced a critical threshold and shifted from rice and vegetable cultivation to saltwater shrimp farming, 2) which has grown due to a strong export market and international donor and national government support. This shift is a result of a combination of environmental and socio-economic factors, out of which climatic stressors appear to only play a minor role: 3) saltwater intrusion due to 4) the construction and poor management of the Bangladeshi Coastal Embankment Project, the construction of a dam in India, local water diversions, 5) and sea level rise and storm surges. The conversion to shrimp farming 6) has caused rising disease levels and 7) concentrated wealth and power for the more affluent families while 8) further diminishing the livelihood options for the poor who lack the resources to grow crops in salinated water and lose grazing areas and dung from formerly accessible rice fields.



C. Mountain environments (McDowell & Hess, 2012). Indigenous Aymara farmers in highland Bolivia face land scarcity, pervasive poverty, climate change, and lack of infrastructure due in part to racism and institutional marginalization. 1) The retreat of the Mururata glacier causes water shortages, compounded by 2) the increased water requirements of cash crops on smaller and smaller "minifundios" and market uncertainties. 3) High temperatures amplify evaporation, and flash floods coupled with delayed rainfall cause irrigation canals to collapse. 4) The current policy environment makes it difficult to access loans and obtain land titles, 5) pushing many farmers onto down-ward livelihood trajectories while 6) those who can afford it invest in fruit and vegetable trees at higher altitudes. 7) Sustained access to land, technical assistance, and irrigation infrastructure would be vital policy responses to enhance wellbeing.

D. Urban flooding in Lagos (Adelekan, 2010). Flooding threatens the livelihoods of people in Lagos, Nigeria, where >70 percent live in slums. 1) Increased severity in rainstorms, sea level rise, and storm surges, coupled with 2) the destruction of mangroves and wetlands, disturb people's jobs as traders, wharf workers, and artisans, while destroying physical and human assets. 3) Poor urban management, lacking infrastructure for water supply, and inadequate stormwater drainage have not kept up with urban growth. 4) Inadequate policy responses, including uncontrolled land reclamation, make these communities highly vulnerable to flooding. 5) Only some residents can afford sand and broken sandcrete blocks. 6) Livelihood conditions in these slums are expected to further erode for most households. 7) Given policy priorities for the construction of high-income residential areas, current residents fear eviction.

Figure 13-2: Livelihood dynamics under simultaneous climatic, environmental, and socioeconomic stressors and shocks leading to differential risk spaces and livelihood trajectories over a lifetime.

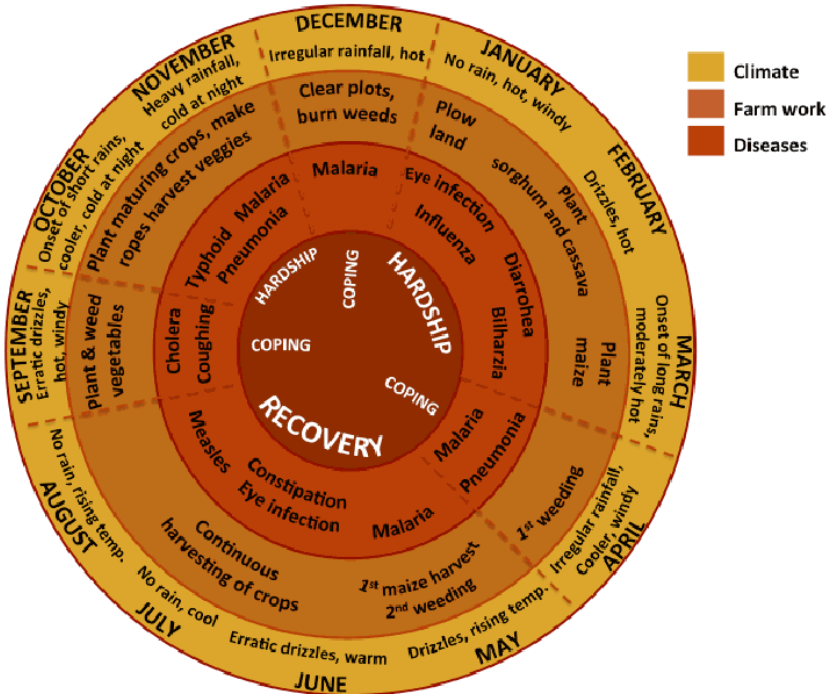


Figure 13-3: 'Wheel of hardship' – a generalized seasonal calendar depicting livelihood conditions and stress based on experiences of smallholder farmers in the Lake Victoria Basin in Kenya and Tanzania (Gabrielsson *et al.*, 2012).

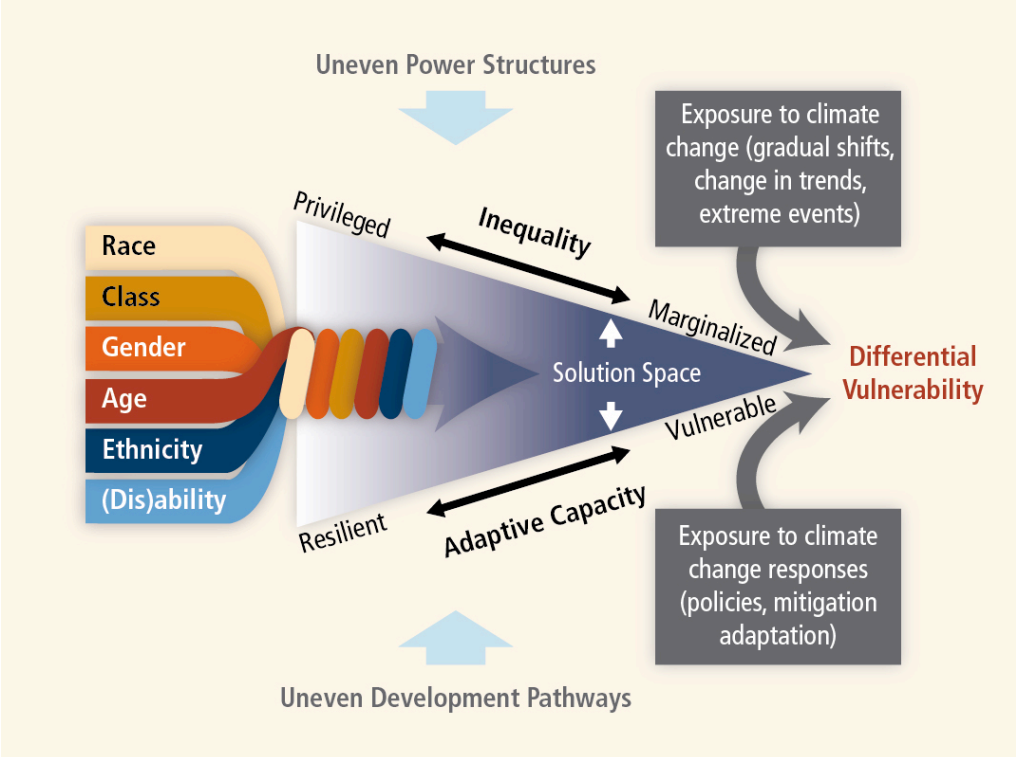


Figure 13-4: Intersecting dimensions of inequality.

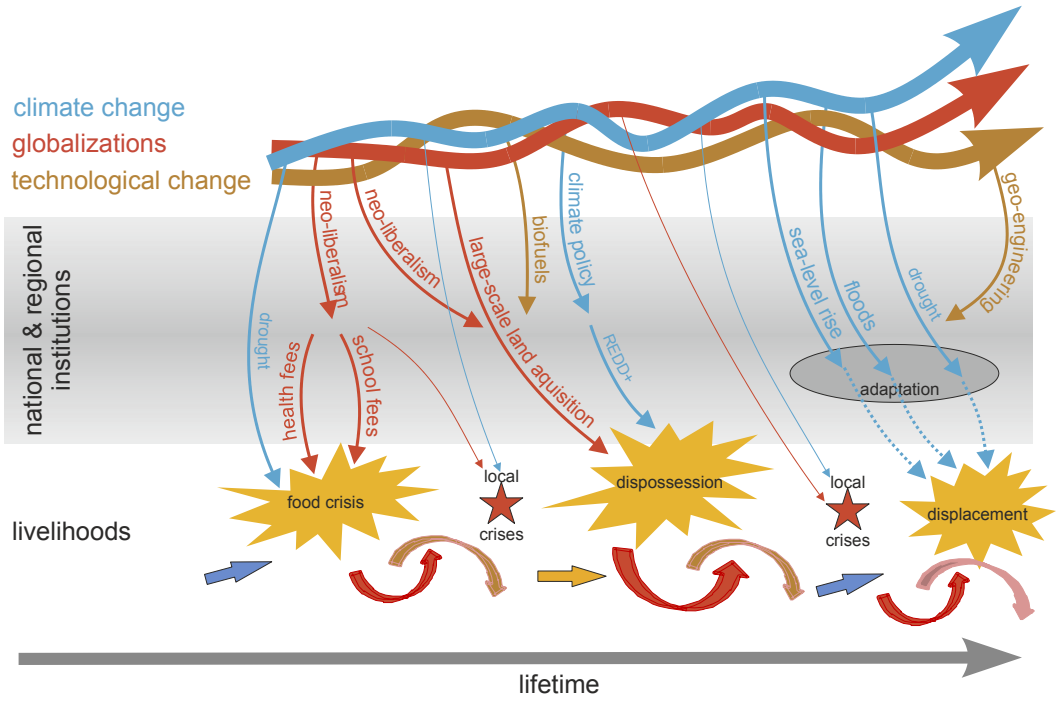


Figure 13-5: Multiple stressors related to climate change, globalizations, and technological change interact with national and regional institutions to create shocks to place-based livelihoods. Inspired by transition theory (Geels, 2011).