Chapter 13. Livelihoods and Poverty

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Executive Summary

This chapter discusses how livelihoods, poverty and the lives of poor people, 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 responses to climate change affect livelihoods and poverty. The Fourth Assessment Report stated that socially and economically disadvantaged and marginalized people are disproportionally affected by climate change. However, no comprehensive review of climate change, poverty, and livelihoods has been undertaken to date by the IPCC. This chapter addresses this gap, presenting evidence of the dynamic interactions between these three principal factors. At the same time, the chapter recognizes that climate change is rarely the only factor that affects livelihood trajectories and poverty dynamics; climate change interacts with a multitude of non-climatic factors, which makes detection and attribution challenging.

Observed climate variability, climate change, and extreme events constitute an additional burden to rural and urban people living in poverty. These climate-related hazards act as a threat multiplier, often with negative outcomes for livelihoods (*high confidence, based on medium evidence, high agreement*).

- Climate-related hazards, including subtle shifts and trends to extreme events, affect poor people's lives directly through impacts on livelihoods, such as losses in crop yields, destroyed homes, food insecurity, and loss of sense of place, and indirectly through increased food prices (*robust evidence, high agreement*). [13.2.1, 13.3]
- Changing climate trends lead to shifts in rural livelihoods with mixed outcomes, such as from crop-based to hybrid livestock-based livelihoods or to wage labor in urban employment. Climate change is one stressor that shapes dynamic and differential livelihood trajectories (*robust evidence, high agreement*). [13.1.4, 13.2.1.2]
- Urban and rural transient poor who face multiple deprivations slide into chronic poverty as a result of extreme events, or a series of events, when unable to rebuild their eroded assets. Poverty traps also arise from food price increase, restricted mobility, and discrimination (*limited evidence, high agreement*). [13.2.1.3, 13.2.1.4]
- Many events that affect poor people are weather-related and remain unrecognized by standard climate observations in many low-income countries, due to short time series and geographically sparse, aggregated, or partial data, inhibiting detection and attribution. Such events include short periods of extreme temperature, minor changes in the distribution of rainfall, and strong wind events (*robust evidence, high agreement*). [13.2.1]

Observed evidence suggests that climate change and climate variability worsen existing poverty, exacerbate inequalities, and trigger both new vulnerabilities and some opportunities for individuals and communities. 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 disadvantaged people exposed to persistent inequalities at the intersection of various dimensions of discrimination based on gender, age, race, class, caste, indigeneity, and (dis)ability are particularly negatively affected by climate change and climate-related hazards. Context-specific conditions of marginalization shape multidimensional vulnerability and differential impacts. [13.1.2.3, 13.1.3., 13.2.1.5]
- Existing gender inequalities are increased or heightened by climate-related hazards. Gendered impacts result from customary and new roles in society, often entailing higher workloads, occupational hazards indoors and outdoors, psychological and emotional distress, and mortality in climate-related disasters. [13.2.1.5]
- There is little evidence that shows positive impacts of climate change on poor people, except isolated cases of social asset accumulation, agricultural diversification, disaster preparedness, and collective action. The more affluent often take advantage of shocks and crises, given their flexible assets and power status. [13.1.4, 13.2.1.4]

Climate change will create new poor between now and 2100, in low-, medium, and high-income countries (LICs, MICs, and HICs), and jeopardize sustainable development. The majority of severe impacts are projected for urban areas and some rural regions in sub-Saharan Africa and Southeast Asia (*medium confidence, based on medium evidence, medium agreement*).

- Future impacts of climate change, extending from the near-term to the long-term, mostly expecting 2C scenarios, will slow down economic growth and poverty reduction, further erode food security, and trigger new poverty traps, the latter particularly in urban areas and emerging hotspots of hunger. [13. 2.2.2, 13.2.2.4, 13.4]
- Climate change will exacerbate multidimensional poverty in LICs and lower MICs, including high mountain states, countries at risk from sea level rise, and countries with indigenous peoples. Climate change will also create new poverty pockets in upper MICs and HICs where inequality is on the rise. [13.2.2]
- Wage-labor dependent poor households that are net buyers of food will be particularly affected due to food price increases, in urban and rural areas, especially in regions with high food insecurity and high inequality (particularly in Africa), although the agricultural self-employed could benefit [13.2.2.3, 13.2.2.4]

Current policy responses for climate change mitigation or adaptation will result in mixed, and in some cases even detrimental, outcomes for poor and marginalized people, despite numerous potential synergies between climate policies and poverty reduction (*medium confidence, based on limited evidence, high agreement*).

- Mitigation policies with social co-benefits expected in their design, such as CDM and REDD+, have had limited or no effect in terms of poverty alleviation and sustainable development. [13.3.1.1, 13.3.1.2]
- Mitigation efforts focused on land acquisition for biofuel production show preliminary negative impacts on the lives of poor people, such as dispossession of farmland and forests, in many LICs and MICs, particularly for indigenous peoples and (women) smallholders. [13.3.1.4]
- 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 addressed and needs for equity among poor and non-poor people are met. [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 poor and non-poor people, as well as the multifaceted and cross-scalar intersections of

poverty and livelihoods with climate change. This chapter is devoted to exploring poverty in relation to climate change, a novelty in the IPCC. It uses a livelihood lens to assess the interactions between climate change and multiple dimensions of poverty. We use the term "the poor," not to homogenize, but to describe people living in poverty, people facing multiple deprivations, and the socially and economically disadvantaged, as part of a conceptualization broader than income-based measures of poverty, acknowledging gradients of prosperity and poverty. This livelihood lens also reveals how inequalities perpetuate poverty to shape differential vulnerabilities and in turn the differentiated impacts of climate change on individuals and societies. The chapter first 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 rural and urban poor people as well as projected impacts up to 2100. We use "weather events and climate" as an umbrella term for climate change, climate variability, and extreme events, and also highlight subtle shifts in precipitation and localized weather events. Third, this chapter 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 and in the SREX, predominantly with reference to livelihood strategies and opportunities, diversification, resource-dependent communities, and sustainability. Yet, a comprehensive livelihood lens for assessing impacts was lacking. This chapter addresses these gaps. It assesses how climate change intersects with other stressors to shape livelihood choices and trajectories, to affect the spatial and temporal dimensions of poverty dynamics, and to 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 act and make lives meaningful (Scoones, 1998; Bebbington, 1999). Livelihoods are dynamic and people adapt and change their livelihoods 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. Poor and rich people both pursue livelihoods to make a living. However, as shown in this chapter, 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 reshaping their livelihoods (UNDP, 2007; Leary *et al.*, 2008; Adger, 2010; Quinn *et al.*, 2011). Some livelihoods are directly climate-sensitive, such as rain-fed smallholder agriculture, seasonal employment in agriculture (e.g. tea, coffee, sugar), fishing, pastoralism, and tourism. Climate change also affects households dependent on informal livelihoods or wage labor in poor urban settlements, directly through unsafe settlement structures or indirectly through rises in food prices or migration.

13.1.1.1. Dynamic Livelihoods and Trajectories

A livelihood lens is a grounded and multidimensional perspective that recognizes the flexibility and constraints with which people construct their complex lives and adapt their livelihoods in dynamic ways. By paying attention to the wider institutional, cultural, and policy contexts as well as shocks, seasonality, and trends, this lens reveals processes that push people onto undesirable trajectories or toward enhanced well-being. Better infrastructure and technology as well as diversification of assets, activities, and social support capabilities can boost livelihoods, spreading risks and broadening opportunities (Batterbury, 2001; Ellis *et al.*, 2003; Clot and Carter, 2009; Reed *et al.*, 2013; Carr, 2013). The sustainable livelihoods framework (Chambers and Conway, 1992) is widely used for identifying how specific strategies may lead to cycles of livelihood improvements or critical thresholds beyond which certain livelihoods are no longer sustainable (Sabates-Wheeler *et al.*, 2008). It emerged as a reaction to the predominantly

structural views of poverty and "underdevelopment" in the 1970s and became adopted by many researchers and development agencies (Ellis and Biggs, 2001). With the neoliberal turn in the late 1980s, the livelihoods approach became associated with a more individualistic development agenda, stressing various forms of capital (Scoones, 2009). Consequently, it has been criticized for its analytical limitations, such as measuring capitals or assets, especially social capital, and for not sufficiently explaining wider structural processes (e.g., policies) and ecological impacts of livelihood decisions (Small, 2007; Scoones, 2009). An overemphasis on capitals also eclipses power dynamics and the position of households in class, race, and other dimensions of inequality (Van Dijk, 2011).

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, economic, and political stressors; together, 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 the spread of infectious diseases, rapid urbanization, and economic globalization, where climate change acts as a threat multiplier, further marginalizing vulnerable groups (O'Brien and Leichenko, 2000; Eriksen and Silva, 2009). Climatic and other stressors affect livelihoods at different scales: spatial (e.g., village, nation) or temporal (e.g., annual, multi-annual). Both direct and indirect impacts are often amplified or weakened at different levels. Global or regional processes generate a variety of stressors, typically mediated by cross-level institutions, that result in locally experienced shocks (Reid and Vogel, 2006; Thomas *et al*., 2007; Paavola, 2008; Pouliotte *et al*., 2009) (see Figure 13-1 in FAQ 13.1).

Multiple stressors, simultaneous and in sequence, shape livelihood dynamics in distinct ways due to inequalities and differential vulnerabilities between and within households. More affluent households may be able to capitalize on shocks and crises while poorer households with fewer options are forced to erode their assets. Limited ability to adapt and some coping strategies may result in adverse consequences. Such maladaptive actions (see Glossary, and Chapters 14, 16) undermine the long-term sustainability of livelihoods, resulting in downward trajectories, poverty traps, and exacerbated inequalities (Ziervogel *et al*., 2006; Tanner and Mitchell, 2008; Barnett and O'Neill, 2010).

[INSERT FIGURE 13-1 HERE (within FAQ 13.1)
Figure 13-1: 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 Reason (2000).]

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 different 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 recognized as multidimensional (UNDP, 1990). It is influenced by social, economic, institutional, political, and cultural drivers; its reversal requires efforts in multiple domains that promote opportunities and empowerment, and enhance security (World Bank, 2001). In addition to material deprivation, multidimensional conceptions of poverty consider a sense of belonging and socio-cultural heritage (O'Brien and Leichenko, 2003), identity, and agency, or "the culturally constrained capacity to act" (Ahearn, 2001 p.54). 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 broadened, expanding the basis for understanding poverty and its drivers. Poverty measurements now better capture multidimensional characteristics and spatial and temporal nuances. Attention to multidimensional deprivations, such as hunger, illiteracy, unclean drinking water,

lack of access to health, credit, or legal services, social exclusion, and empowerment, have shifted the analytical lens to the dynamics of poverty and its institutionalization within social and political norms (UNDP, 1994; Sen, 1999; World Bank, 2001). Regardless of these shifting conceptualizations over time, comparable and reliable measures remain challenging and income per capita remains the default method to account for the depth of global poverty.

In climate change literature, poverty and poverty reduction have been predominantly defined through an economic lens, reflecting various growth and development discourses (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). Yet, such framing allows for addressing the social and political contexts that generate and perpetuate poverty and structural 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 of development, although some responses may slow down achievements of international development such as those outlined in the 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), mainly promoted through market tools. A relational approach to poverty highlights the integral role of poor people in all social relations (Pogge, 2009; O'Brien *et al*., 2010; UNRISD, 2010; Gasper *et al*., 2013; St.Clair and Lawson, 2013). It emphasizes equity, human security, and dignity (O'Connor, 2002; Mosse, 2010). Akin to the capabilities approach (Sen, 1985; Sen, 1999; Nussbaum, 2001; Alkire, 2005; Nussbaum, 2011), the relational approach stresses the needs, skills, and aims 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 the ability of nations 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). 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 close to 1.7 billion people face multidimensional poverty, a significantly higher number than the 1.2 billion (World Bank, 2012a) indicated by the International Poverty Line (IPL) set at $1.25/day. Figure 13-2 depicts country-level examples of how the two poverty measures differ.

Caution is required for poverty projections. Estimates of poverty made using national accounts means (see Chapter 19) yield drastically different estimates to those produced by survey means, both for current estimates and future projections (Edward and Sumner, 2013a). Diverse conceptions of poverty further complicate projections, as multidimensional conceptions rely on concepts difficult to measure and compare. Data availability constrains current estimates let alone projections and their core assumptions (Alkire and Santos, 2010; Karver *et al*., 2012).

[INSERT FIGURE 13-2 HERE
Figure 13-2: A) Multidimensional poverty and income-based poverty using the International Poverty Line $1.25/day (in Purchasing Power Parity terms), with linear regression relationship (dotted line) based on 96 countries (UNDP, 2011b). The position of the countries relative to the dotted line illustrates the extent to which these two poverty measures are similar or divergent (e.g., Niger). B) The map insets show the intensity of poverty in two countries, based on the Poverty Gap Index at district level (per capita measure of the shortfall in welfare of the poor from the poverty line, expressed as a ratio of the poverty line). The darker the purple shading, the larger the shortfall.]

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

Geographic patterns of poverty are uneven and shifting. Despite its limitations, most comparisons to date rely on the IPL. In 1990, most of the world's $1.25 and $2 poor lived in low-income countries (LICs). By 2008, the majority of the $1.25 and $2 poor (>70%) resided in lower and upper middle-income countries (LMICs and UMICs), in part because some populous LICs such as India, Nigeria, and Pakistan grew in per capita income to MIC status (Sumner, 2010; Sumner, 2012a). Estimates suggest about one billion people currently living under $1.25/day in MICs and a second billion between $1.25 and $2, with an additional 320m and 170m in LICs, respectively (Sumner, 2012b).

About 70% of the $1.25 poor live in rural areas in the global South (IFAD, 2011), despite worldwide urbanization. Yet, this poverty line understates urban poverty as it does not fully account for the higher costs of food and non-food items in many urban contexts (Mitlin and Satterthwaite, 2013). Of the approximately 2.4 billion living under $2/day, half live in India and China. At the same time, relative poverty is rising in HICs. Many European countries face rapid increases in poverty, unemployment, and the number of working poor due to recent austerity measures. For example, 20% of Spanish citizens were ranked poor in 2009 (Ortiz and Cummins, 2013). See also Chapter 23.

The shift in distribution of global poverty toward MICs and the increase in relative poverty in HICs challenge the orthodox view that most of the world's poorest people live in the poorest countries, and suggests that substantial pockets of poverty persist in countries with higher levels of average per capita income. Understanding this shift in the geography of poverty and available social safety nets is vital for assessing climate change impacts on poverty. To date, both climate finance and research on climate impacts and vulnerabilities are largely directed towards LICs. Less attention has been paid to poor people in MICs and HICs. In the upper and lower MICs, the incidence of $2 poverty, despite declines, remains as high as 60% and 20%, respectively (Sumner, 2012b).

Projections for 2030 suggest $2 poverty as high as 963 million people in sub-Saharan Africa and 851 million in India (Sumner *et al*., 2012; Edward and Sumner, 2013a). However, uncertainty is high in terms of future growth and inequality trends; by 2030, $1.25 and $2 global poverty could be reduced to 300m and 600m respectively or remain at or above current levels, including in stable MICs (Edward and Sumner, 2013a). These future scenarios become more uncertain if climate change impacts on people who are socially and economically disadvantaged are taken into account or diversion of resources from poverty reduction and social protection to mitigation strategies is considered.

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 well-being (Leach *et al*., 1999; Little *et al*., 2008; Sallu *et al*., 2010). Yet, the most disadvantaged often find themselves in poverty traps, or 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 Chapters 10 and 12).

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). The AR4 identified poor and indigenous peoples in North America (Field *et al*., 2007) and in Africa (Boko *et al*., 2007) as highly vulnerable. Vulnerability, or the propensity or predisposition to be adversely

affected (Field *et al*., 2012a) by climatic risks and other stressors (see also Glossary), 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 peoples, women, children, the elderly, and disabled people who experience multiple deprivations that inhibit them 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) and may present significant barriers to adaptation.

Global income inequality has been relatively consistent since the late 1980s. In 2007, the top quintile of the world's population received 83% of the total income whereas the bottom quintile took in 1% (Ortiz and Cummins, 2011). Since 2005, between-country inequality has been falling more quickly and, consequently, has triggered a notable decline in total global inequality in the last few years (Edward and Sumner, 2013b). However, within-country inequality is rising in Asia, especially China, albeit from relatively low levels, and is falling in Latin America, albeit from very high levels, while trends in sub-Saharan Africa are difficult to discern regionally (Ravallion and Chen, 2012). Income inequality is rising in many fast growing LICs and MICs (Dollar *et al*., 2013; Edward and Sumner, 2013b). It is also growing in many HICs due to a combination of factors such as changing tax systems, privatization of social services, labor market regulations, and technological change (OECD, 2011). The 2008 financial crisis, combined with climate change, has further threatened economic growth in HICs, such as the U.K., and resources available for social policies and welfare systems (Gough, 2010). Recognizing how inequality and marginalization perpetuate poverty is a prerequisite for climate-resilient development pathways (see 13.4; and Chapters 1, 20, 27).

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

This chapter opens its analytical lens from a conventional focus on the poor in LICs as the prime victims of climate change to a broader understanding of livelihood and poverty dynamics and inequalities, revealing the highly unequal impacts of climate change. It highlights the complex relationship between climate change and poverty. The SREX recognizes that 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 crucial precondition for confronting climate change (Field *et al*., 2012a). If ignored, uneven social relations that disproportionally burden poor people with climate change's negative impacts provoke 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). They 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). People who are 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 13.2 and 13.3, climate change is an additional burden to people in poverty (*very high confidence*), and it will force poor people from transient into chronic poverty and create new poor (*medium confidence*).

The complex interactions among weather events and climate, dynamic livelihoods, multidimensional poverty and deprivation, and persistent inequalities, including gender inequalities, create an ever-shifting context of risk. The SREX concluded that 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 risks. Hence, explicit attention to how livelihood dynamics interact with climatic and non-climatic stressors is useful for identifying processes that push poor and vulnerable people onto undesirable trajectories, trap them in destitution, or facilitate pathways toward enhanced well-being. Figure 13-3 illustrates these dynamics as well as critical thresholds in livelihood trajectories.

[INSERT FIGURE 13-3 HERE
Figure 13-3: Illustrative depiction of livelihood dynamics under simultaneous climatic, environmental, and socio-economic stressors and shocks leading to differential livelihood trajectories over time, based on four case studies. The red boxes indicate specific critical moments when stressors converge, threatening livelihoods and well-being. Key variables and impacts numbered in the illustrations correspond to the developments described in the captions.]

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. Building on deductive reasoning and theorized linkages about these dynamic relationships, this section draws on a wide range of empirical case studies and simulations to illustrate linkages across multiple scales, contexts, and social and environmental processes and assess impacts of climate change. Although cases of observed impacts often rely on qualitative data and at times lack methodological clarity in terms of detection and attribution, they provide a vital evidence base for conveying these complex relationships. This section first describes observed impacts to date (13.2.1) and then projected risks and impacts (13.2.2).

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

Weather events and climate affect 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 strong winds can harm livelihoods (Douglas *et al.*, 2008; Ostfeld, 2009; Midgley and Thuiller, 2011; Bele *et al.*, 2013; Bryan *et al.*, 2013). Many such events remain unrecognized given that standard climate observations typically report precipitation or temperature by month, season, or year, thus obscuring changes that shape 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). Felt experiences of events such as drought, as shown among the Sumbanese in Eastern Indonesia through phenomenological research on perceptions of climatic phenomena, such as shade and dew (Orr *et al.*, 2012), further add to the complexity.

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 (see also Chapters 22-29). Impacts on access to assets, albeit important, are poorly documented in the literature, as are impacts on power relations and active struggles in designing effective and relational livelihood arrangements.

Weather events and climate affect *natural assets* on which certain livelihoods depend directly, 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 and winds decreased in Lake Tanganyika (Verburg and Hecky, 2009; Adrian *et al.*, 2009; Tierney *et al.*, 2010). Since the late 1970s, a drop in primary production and fish catches, a key protein source, has been observed, and climate change may exceed the effects of overfishing and other human impacts in this area (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 that, in 2025, could be 30-70% less per person (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; Li *et al.*, 2013), at times compounded by increased pathogens, insect attacks, and parasitic weeds (Stringer *et al.*, 2007; Byg and Salick, 2009), and less availability of and access to non-timber forest products (Hertel and Rosch, 2010; Nkem *et al.*, 2012) and medicinal plants and biodiversity (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), exacerbating livelihood risks due to loss of economic and social assets (see Chapters 5 and 29) (Perch and Roy, 2010). Densely populated coastal cities with high poverty 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) are already affected by floods and at risk of submersion. Resettlements are planned for the Limpopo River and the Mekong River Delta (de Sherbinin *et al*., 2011) and small island states may become uninhabitable (Burkett, 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 flood water and disrupted water and sanitation services. Flooding has adversely affected large cities in Africa (Douglas *et al*., 2008) and Latin America (Hardoy and Pandiella, 2009; Hardoy *et al*., 2011), in predominantly dense informal settlements due to inadequate drainage, and health infrastructure (UNDP, 2011c). Yet, upper middle- and high-income households living in flood-prone areas or high-risk slopes frequently can afford insurance and lobby for protective policies, in contrast to poor residents (Hardoy and Pandiella, 2009). Loss of physical assets in poor areas after disasters is often followed by 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 terraces, orchards, roads, and stream embankments in the Himalayas (Hewitt and Mehta, 2012; Azhar-Hewitt and Hewitt, 2012).

Erosion of *financial assets* as a result of climatic stressors include losses 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 such as higher expenses for funerals (Gabrielsson *et al*., 2012). In South and Central America, >630 weather and extreme events occurred 2000-2010, resulting in 16,000 fatalities, 46.6 million people affected, and economic losses of US$ 208 million (CRED, 2012). Income losses due to weather events mean less money for agricultural inputs (seeds, equipment), school tuition, uniforms, and books, and health expenses throughout the year (Thomas *et al*., 2007). Flooding in informal settlements in Lagos undermines job opportunities (Adelekan, 2010).

Equally important, albeit frequently overlooked, is the damage to *human assets* as a result of weather events and climate, such as food insecurity, undernourishment, and chronic hunger due to failed crops (*medium evidence*) (Patz *et al*., 2005; Funk *et al*., 2008; Zambian Government, 2011; 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, poor people further erode nutritional levels and human health while 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). 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) (see also Chapter 11 and CC-HS).

Finally, weather events and climate also erode *social and cultural assets*. In some contexts, 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 peoples (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 and well-being on a seasonal basis is not uncommon. To a large extent, the shifts from coping and hardship to recovery

are driven by annual and inter-annual climate variability, but may become exacerbated by climate change. Figure 13-4 illustrates seasonal livelihood sensitivity for the Lake Victoria Basin in East Africa (Gabrielsson *et al*., 2012).

[INSERT FIGURE 13-4 HERE
Figure 13-4: Seasonal sensitivity of livelihoods to climatic and non-climatic stressors for one calendar year, 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, socio-economic, 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 13-3). Uncertainty about West Africa's rainy season threatens small-scale farming and water management (Yengoh *et al*., 2010a; Yengoh *et al*., 2010b; Armah *et al*., 2011; Karambiri *et al*., 2011; Lacombe *et al*., 2012). 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. 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 southern Africa and India, people migrated to the coasts, switching from climate-sensitive farming to marine livelihoods (Coulthard, 2008; Bunce *et al*., 2010a; Bunce *et al*., 2010b). 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).

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. Women-headed households, children, people in informal settlements (see Chapter 8), and indigenous communities are particularly at risk, due to compounding stressors such as lack of governmental support, urban infrastructure, and insecure land tenure (see 13.2.1.5 and Chapter 12).

Poor people in urban areas in LICs and MICs 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 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). Poor households in urban and rural areas are particularly at risk when they are almost exclusively net buyers of food (Cranfield *et al*., 2007; Cudjoe *et al*., 2010; Ruel *et al*., 2010). Misselhorn (2005) showed in a meta-study of 49 cases of food insecurity in southern Africa 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). In rural areas, restricted forest access may exacerbate poverty among already income-poor and elderly households who rely on forest resources to respond to climatic shocks (Fisher *et al*., 2010). Yet, many such shifts remain underexplored, incompletely captured in poverty data and adaptation monitoring. The bulk of evidence in the literature is oriented toward extreme events, rapid-onset disasters, and subsequent impacts on livelihoods and poor people's lives. Subtle changes are rarely tracked, making quantification of long-term trends and detection of impacts difficult.

13.2.1.4. Poverty Traps and Critical Thresholds

Poverty traps arise when climate change, variability, and extreme events keep poor people poor and make some poor even poorer. Yet, attribution remains a challenge. Among disadvantaged people in urban areas, poverty traps are 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 (Hardoy and Pandiella, 2009). In rural areas, poverty traps are reported when climate change impacts on poor people persist over decades, such as through environmental degradation and recurring stress on ecosystems in the Sahel (Kates, 2000; Hertel and Rosch, 2010; Sissoko *et al*., 2011; UNCCD, 2011), or 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), persistent discrimination through legal structures and formal institutions, especially for women and other marginalized groups (Campbell *et al*., 2009; McDowell and Hess, 2012), and at the nexus of climate, health and conflict (see Chapter 10).

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, poor people often rely on social networks, including reciprocal gifts and exchanges, to protect themselves from shocks and crises such as droughts and illness (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 example from accidents during flood events, diminish poor people's main asset, labor (Douglas *et al*., 2008), and may plunge them into chronic poverty.

Few studies illustrate positive livelihood impacts as a result of climate change or climate-induced shocks, and they often tend to refer to more affluent and powerful constituencies. Very scarce evidence exists of poor people escaping poverty traps (see Figure 13-2). In Cameroon, though, farming communities benefit from occasional rainfall during the dry season and more food stuffs while the drying of swamps allows maize off season (Bele *et al*., 2013). In Lake Victoria Basin, collective action has increased as a result of HIV/AIDS and climate change, boosting social assets (Gabrielsson and Ramasar, 2012). Lessons from Hurricane Mitch (1998) in Honduras point toward more equitable land distribution and better flood preparedness that benefit the poor after disasters (McSweeney and Coomes, 2011).

13.2.1.5. Multidimensional Inequality and Vulnerability

Climate variability and change as well as climate-related disasters contribute to and exacerbate inequality, in urban and 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, age, race, class, caste, indigeneity, and (dis)ability, embedded in uneven power structures, also known as intersectionality (Nightingale, 2011; Kaijser and Kronsell, 2013) (see Figure 13-5). This section illustrates how climate impacts intersect with inequality, primarily along the lines of gender, age, and indigeneity. Other chapters are referenced.

[INSERT FIGURE 13-5 HERE
Figure 13-5: Multidimensional vulnerability driven by intersections dimensions of inequality.]

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

Existing ***gender inequality*** (see Box CC-GC) is increased or heightened 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; Galaz *et al*., 2008; Osbahr *et al*., 2008; Demetriades and Esplen, 2008; Buechler, 2009; Nightingale, 2009; Terry, 2009; Dankelman, 2010; MacGregor, 2010; Alston, 2011; Arora-Jonsson, 2011; Resurreccion, 2011; Zotti *et al*., 2012; Heckenberg and Johnston, 2012; Shah *et al*., 2013; Alston and Whittenbury, 2013; Rahman, 2013). While earlier studies have tended to highlight women's quasi-universal vulnerability in the context of climate change (e.g. Denton, 2002), this focus can ignore the complex, dynamic, and intersecting power relations and other structural and place-based causes of inequality (Nightingale, 2009; UNFPA, 2009; Arora-Jonsson, 2011). Moreover, the construction of economically poor women as victims 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 differentially affected by climate variability and change. 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 infra-structure (Table 13-1). In India, more women than men, especially women of lower castes, work as wage laborers to compensate for crop losses (Lambrou and Nelson, 2013) while in Tanzania, wealthier women hire poorer women to collect animal fodder during droughts (Muthoni and Wangui, 2013). Climate variability amplifies food shortages in which women consume less food (Lambrou and Nelson, 2013) and suffer from reproductive tract infections and water-borne diseases after floods (Neelormi *et al*., 2008; Campbell *et al*., 2009). Women farmers in the Philippines relying on high-interest loans were sent to jail after defaulting on debts following crop failure (Peralta, 2008). In Uganda, men were able to amass land after floods while droughts reduced women's non-land assets (Quisumbing *et al*., 2011). In Ghana, some husbands prevent their wives from cultivating individual plots as a response to gradually shifting rainfall seasonality, thereby undermining both women's agency and household well-being (Carr, 2008).

Feminization of responsibilities: 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 tended to work longer hours during extreme events and women adopted extra responsibilities during disaster preparation and recovery (e.g., storing food and water and taking care of the children, the sick, and the elderly) and when their husbands migrated. In Cambodia, Khmer men and women accepted culturally-taboo income-generating activities under duress, when rice cropping patterns shifted due to higher temperatures and more irregular rainfall (Resurreccion, 2011). Despite increased workloads for both sexes, women's extra work adds to already many labor and caring duties (Nelson and Stathers, 2009; MacGregor, 2010; Petrie, 2010; Arora-Jonsson, 2011; Kakota *et al*., 2011; Resurreccion, 2011; Muthoni and Wangui, 2013; Shah *et al*., 2013). In Nepal, shifts in the monsoon season, longer dry periods, and decreased snowfall push Dalit girls and women ('untouchable' caste) to grow drought-resistant buckwheat and offer more day labor to the high caste Lama landlords while Dalit men seek previously taboo patronage protection to engage in cross-border trade (Onta and Resurreccion, 2011). Rising male out-migration, e.g., in Niger and South Africa, leave women with all agricultural tasks yet limited extra labor (Goh, 2012). Additional workloads exhaust women emotionally and physically, shown in South Africa (Babugura, 2010).

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). Anecdotal evidence suggests that women tea pickers in Malawi, Kenya, India, and Sri Lanka suffer and die from heat stress as payment by quantity discourages rest breaks (Renton, 2009) (see also Chapter 11 and CC-HS). 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). Yet, male outmigration could provide opportunities for women to move beyond traditionally constrained roles, explore new livelihood options, and access public decision-making space (CIDA, 2002; Fordham *et al*., 2011).

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; Babugura, 2010; Boetto and McKinnon, 2013; Hargreaves, 2013). Increased gender-based violence within households is reported as an indirect social consequence of climate-related disasters, as well as slow-onset climate events, due to greater stress and tension, loss and grief, and disrupted safety nets, reported for Australia (Anderson, 2009; Alston, 2011;

Parkinson *et al*., 2011; Whittenbury, 2013; Hazeleger, 2013), New Zealand (Houghton, 2009), the U.S. (Jenkins and Phillips, 2008; Anastario *et al*., 2009), Vietnam (Campbell *et al*., 2009) and Bangladesh (Pouliotte *et al*., 2009).

Mortality: Social conditioning affects mortality for women and men. Rahman (2013) and Nellemann et al. (2011) confirm patterns of gender disparity with respect to swimming that contribute to high number of female deaths due to climate-related disasters. Restricted mobility keeps women in Bangladesh and Nicaragua waiting in risk-prone houses during floods (Saito, 2009; Bradshaw, 2010). Some disaster relief structures that lack facilities appropriate for women may contribute to increased harm and mortality (World Bank, 2010). When they are socio-economically disadvantaged and the disasters exacerbate existing patterns of discrimination, more women die in hurricanes and floods (Neumayer and Plümper, 2007; Ray-Bennett, 2009). Yet, men experience a higher mortality rate when fulfilling culturally-imposed roles as heroic life-savers (Röhr, 2006; Campbell *et al*., 2009; Resurreccion, 2011).

[INSERT TABLE 13-1 HERE
Table 13-1: Examples of gendered climate experiences.]

_____ 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 (13.3 per 1,000 girls) 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 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). See Chapter 11 for more details.

Health impacts of weather events and climate differentially affect *the elderly* and *socially isolated* (Frumkin *et al*., 2008) (see also Chapter 11). 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 droughts (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 underestimate the risk and severity of heat waves through their social networks and fail to act (Wolf *et al*., 2010). In the U.S., Europe, and South Korea, the elderly, children, and persons of lower socio-economic status have a heightened risk of heat-related mortality (Baccini *et al*., 2008; Balbus and Malina, 2009; Son *et al*., 2012). Preliminary evidence suggests differential harm of 2012 Superstorm Sandy in New York, observed among elderly people and medically underserved populations (Pagán Motta, 2013; Teperman, 2013; Uppal *et al*., 2013).

Inequality and disproportionate effects of climate-related impacts also occur along the axes of *indigeneity a*nd *race*. Disproportionate climate impacts are documented for Afro-Latinos and displaced indigenous groups in urban Latin America (Hardoy and Pandiella, 2009), and indigenous peoples in the Russian North (Crate, 2013) and the Andes (Andersen and Verner, 2009; Valdivia *et al*., 2010; McDowell and Hess, 2012; Sietz *et al*., 2012). See Chapter 12 for impacts on indigenous cultures. In the U.S., low-income people of color are more affected by climate-related disasters (Sherman and Shapiro, 2005; Morello-Frosch *et al*., 2009; Lynn *et al*., 2011) as demonstrated in the case of low-income African-American residents of New Orleans after Hurricane Katrina (Elliott and Pais, 2006).

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

Future climate change, as projected through modeling, will continue to affect poor people in rural and urban areas in LICs, MICs, and HICs, alter their livelihoods, and make efforts to reduce poverty more difficult (*high confidence*). Studies reveal a broad range of impacts for the near- (2030-2040) and long-term (2080-2100) future, depending on the climatic, agro-economic, and demographic models employed, their key variables, and spatial scale, which vary from a country's agro-ecological zones to the global. Few projections take into account policy options or adaptation.

Projections emphasize the complexity and heterogeneity of future climate impacts, including winners and losers in close geographic proximity. Anticipated impacts on the poor are expected to interact with multiple stressors, most notably social vulnerability (Iglesias *et al*., 2011), low adaptive capacity and subsistence constraints under chronic poverty (Liu *et al*., 2008), weak institutional support (Menon, 2009; Xu *et al*., 2009; Skoufias *et al*., 2011a; Skoufias *et al*., 2011b), population increases (Müller *et al*., 2011), natural resource dependence (Adano *et al*., 2012), 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).

Table 13-2 illustrates estimated risks and adaptation potentials for livelihoods and poverty dimensions until 2100.

[INSERT TABLE 13-2 HERE
Table 13-2: Key risks from climate change for poor people and their livelihoods and the potential for risk reduction through adaptation. Key risks are identified based on assessment of the literature and expert judgment by chapter authors, with evaluation of evidence and agreement in the supporting chapter sections. Each key risk is characterized as very low, low, medium, high, or very high. Risk levels are presented in three timeframes: present, near-term (2030-2040), and long-term (2080-2100). Near-term indicates that projected levels of global mean temperature do not diverge substantially across emissions scenarios. Long-term differentiates between a global mean temperature increase of 2°C and 4°C above preindustrial levels. For each timeframe, risk levels are estimated for a continuation of current adaptation and for a hypothetical highly adaptive state. Bars that only show the latter indicate a limit to adaptation (see Chapter 16). Relevant climate variables are indicated by symbols. This table should not be used as a basis for ranking severity of risks.]

13.2.2.1. Projected Risks and Impacts by Geographic Region

Climate change will exacerbate risks and in turn further entrench poverty (*very high confidence*). The well known and highly referenced Wheeler data set (2011) analyzes climate risk and coping ability by country. Future increases in the frequency of extreme events are overlaid with considerable poverty, although not all poor people will be at risk. Of the 20 countries and regions most at risk, seven are LICs (Bangladesh, Ethiopia, Kenya, Madagascar, Mozambique, Somalia, and Zimbabwe), eight are LMICs (Bolivia, Djibouti, Honduras, India, Philippines, Sri Lanka, Vietnam, and Zambia), four are UMICs (China, Colombia, Cuba, and Thailand), and one is a HIC (Hong Kong). For China, Djibouti, India, Kenya, and Somalia, climate contributes between 46.4% and 87.5% to a 2008-2015 rise in national risk, compared to income and urbanization. Highest sensitivity to sea level rise by 2050, based on low-elevation coastal zones, population density, and areas of storm surge zones, is expected for India, Indonesia, China, the Philippines, and Bangladesh. India and Indonesia are projected to experience a 80% and 60% increase, respectively, in their populations at risk from sea level rise, housing a combined total of >58 million people most at risk by 2050; six million people more at risk from sea level rise in China will bring its total to 22 million, and Bangladesh's at-risk population is predicted to grow to 27 million – more than double since 2008 (Wheeler, 2011).

Specific regions at high risk are those exposed to sea-level rise and extreme events and with concentrated multi-dimensional poverty, including pockets of poor people in LICs and MICs: mega-deltas in Bangladesh, Thailand, Myanmar, and Vietnam (Eastham *et al*., 2008; Wassmann *et al*., 2009), drylands (Anderson *et al*., 2009; Piao *et al*., 2010; Sietz *et al*., 2011), mountain areas (Beniston, 2003; Valdivia *et al*., 2010; Gerlitz *et al*., 2012; McDowell and Hess, 2012; Gentle and Maraseni, 2012), watersheds in the Himalayas (Xu *et al*., 2009), ecologically-fragile areas in China (Taylor and Xiaoyun, 2012), coastal areas with severe ecosystem deterioration in eastern and southern Africa (Bunce *et al*., 2010a; Bunce *et al*., 2010b) and river deltas subject to resource extraction (Syvitski *et al*., 2009).

13.2.2.2. Anticipated Impacts on Economic Growth and Agricultural Productivity

Most projected future impact studies focus on the long-term effects of climatic changes and shocks on agricultural productivity, mainly in Africa, Asia, and Latin America. They typically examine impacts on economic growth (see also Chapter 10), changes in food prices and food security, and extrapolated changes in poverty head counts.

For future poverty head counts caused by climate change, the literature shows disagreement. For the very near future, a study by Thurlow et al. (2009) estimates 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. Skoufias et al. (2011b), using 2055 predictions based on the Nordhaus (2010) RICE model, state that under business-as-usual and optimal abatement, global poverty (measured at $2/day) could be reduced by 800 million people, due to annual 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 people living in poverty (Skoufias *et al.*, 2011b). In contrast, Tubiello et al. (2008) project that, by 2080, the number of undernourished people may 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.

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. One study for the U.S., using the SRES A2 scenario, projects that four climate change impacts – hurricane damage, energy costs, water costs, and real estate – are expected to cost 1.8% of the country's GDP by 2100, leading to higher household costs for basic necessities like energy and water (Ackerman *et al.*, 2008). Groups that spend the highest proportion of their income on these necessities will be disproportionately affected.

A growing body of literature estimates future changes in agricultural production and food prices due to climate change, variability, and extreme events (Slater *et al.*, 2007; Thomas *et al.*, 2007; Assuncao and Cheres, 2008; Burke *et al.*, 2011) (see Chapters 7, 9, and CC-HS). Mixed trends are projected for major staples for all continents until the mid-21st century. For the near-term future, the production of coarse grains in Africa may be reduced by 17-22% due to climate change; well-fertilized modern seed varieties are projected to be more susceptible to heat stress than traditional ones (Schlenker and Lobell, 2010). By 2080, a major 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 near- and long-term climate change impacts on livelihood assets highlight the erosion of financial assets 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. In Mali's agricultural-pastoralist transition zone, due to temperature increase and drying projected for 2025 and coupled with a 50% increase in population, shifts from rain-fed millet and sorghum to semi-arid, predominantly livestock subsistence are expected to expose an extra six million people to malnutrition, including 250,000 children suffering from stunting (Jankowska *et al.*, 2012). Simulated probabilities of failed seasons, using current daily rainfall data and 2050 projections for the length of growing period, show transitions from cropping to livestock in other marginal cropping areas in Africa (Thomas

et al., 2007; Jones and Thornton, 2009). The HadCM3 and A1F1 models show that, by 2050, expanding vector populations, especially tsetse, and a >20% decline in growing period, in livestock-dependent and mixed crop-livestock livelihoods in semi-arid to arid Africa and Asia, combined with increasing water scarcity and stover loss due to maize substitution (Thornton *et al.*, 2007) 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 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. In the near-term future, 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 LICs and MICs, the poverty headcount is expected to drop in some occupational strata and increase in others; only in most African countries are yield impacts expected to be too severe to allow benefits (Hertel and Rosch, 2010). Long-term, a one-time maximum extreme dry event, simulated for 1971-2000 and 2071-2100 using the IPCC-SRES A2 scenario for 16 LICs and MICs, shows a 95-110% raise in poverty for urban wage groups in Malawi, Zambia, and Mexico, while self-employed farming households consolidate assets and face the smallest increase in vulnerability (Ahmed *et al.*, 2009). By 2100, climate change would leave low-income, minority, and politically marginalized groups in California's agriculture with fewer economic opportunities, based on SRES B1 and A1Fi scenarios, particularly in dairy and grape production (Cordova *et al.*, 2006; Shonkoff *et al.*, 2011).

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 will 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 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, almost half of the 650,000 new poor under the worst historic 10-year period projected till 2016 are expected to be in urban areas while rural poverty remains high (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 near-term future (up to 2031). Shifts in and out of poverty may occur by 2050 for small-scale coffee farmers in Central America, as suitable coffee growing areas move to higher altitudes, especially when constrained by unequal access to agro-technical and climatic information (Laderach *et al.*, 2011).

Poor countries will face greater poverty as a result of climate change and extreme events (*medium 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) project long-term coupled climate change- and conflict-induced poverty traps for the DRC and several other sub-Saharan countries.

Some climate change projections (see CC-HS and WG1 Chapters 11, 12, and 14) indicate the possibility of large impacts that may exceed thresholds of detrimental shocks to livelihoods and poverty, unless strong adaptation and/or mitigation responses are implemented in a timely manner (Kovats and Hajat, 2008; Sherwood and Huber, 2010). Since women do most of the agricultural work, they will suffer disproportionally from heat stress; for instance, in parts of Africa, women carry out 90% of hoeing and weeding and 60% of harvesting work (Blackden and Wodon, 2006). Toward the end of the century, the risk of heat stress may become acute in parts of Africa, particularly the Sahel, and the Indian sub-continent, potentially preventing people from practicing agriculture (Patricola and Cook, 2010; Dunne *et al.*, 2013). 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 higher 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. Such policy responses were designed to have positive effects on sustainable development or at least be neutral in terms of unintended side effects. Yet, much of the peer-reviewed literature scrutinizing these responses suggests otherwise. This section reviews empirical evidence of impacts of particular mitigation (13.3.1) and adaptation (13.3.2) responses in the context of livelihood and poverty trajectories and inequalities. Some of this evidence is preliminary as several policies are still in their infancy while other cases fail to assess multidimensional poverty or dynamic livelihood decision making in the context of climate change responses.

13.3.1. Impacts of Mitigation Responses

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. Impacts of current mitigation policies on livelihoods and poverty are controversial with polarized views on the potential of such policies for sustainable development in general and poverty alleviation in particular (Collier *et al*., 2008; Böhm, 2009; Hertel and Rosch, 2010; Michaelowa, 2011). 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.

13.3.1.1. The Clean Development Mechanism (CDM)

The CDM (see Chapter 13 in WGIII) aims to promote sustainable development and thus CDM projects require approval by the host country's designated national authority. 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 and Vietnam, are expected to generate livelihood benefits and employment, and reduce poverty among beneficiaries (UNFCCC, 2011; UNFCCC, 2013). The secretariat's own assessment of the CDM's development benefits along 15 indicators suggested much room for improvement (UNFCCC, 2011). Most of the statistical information in official reports on CDM is based either on project documents or on surveys of project personnel rather than in-depth studies.

The assessment of the CDM in the peer-reviewed literature is more cautious and pessimistic than UNFCCC, and three reviews (Olsen, 2007; Sutter and Parreño, 2007; Michaelowa and Michaelowa, 2011) contend that the current CDM design is neither pro-poor nor contributes to sustainable development. One reason for the low performance on sustainable development criteria is that the CDM does not have any requirements for monitoring and verification of development impacts as required for emissions reductions (Boyd *et al*., 2009). Critiques entail 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), procedural limitations (Lund, 2010), and carbon offset goals favored over poverty reduction goals (Wittman and Caron, 2009). While some authors claim that the CDM undermines local and non-governmental input (Shin, 2010; Corbera and Jover, 2012), others stress its transparency, including the voices of local stakeholders (Michaelowa *et al*., 2012). Also, the CDM may compete with the informal sector (Newell and Bumpus, 2012) and accentuate uneven development by eroding local livelihood security (Boyd and Goodman, 2011). In a meta-analysis of 114 CDM projects, Crowe (2013) conclude that <10% of CDM projects had successfully delivered pro-poor benefits and only one of them had positive ratings on all seven criteria for pro-poor benefits. Among the most promising examples are CDM projects 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+)

Experience with REDD+ and other forest carbon projects is inadequate to permit generalizations about effects on livelihoods and poverty (Cotula *et al*., 2009; Hayes and Persha, 2010; Springate-Baginski *et al*., 2010) (see Chapter 9). A study of 20 avoided deforestation projects prior to REDD+ in Latin America, Africa, and Asia shows that only five conducted some outcome or impact assessment, revealing a lack of rigor in evaluation (Caplow *et al*., 2011).

Despite optimism in policy analyses about the potential of REDD+ for poverty alleviation (Angelsen *et al*., 2009; Kanowski *et al*., 2011; Rahlao *et al*., 2012; Somorin *et al*., 2013), there is growing evidence and *high agreemen*t in the peer-reviewed literature that REDD+ may not lead to poverty alleviation and that there may even be negative consequences. Concerns include threats to the poor (Phelps *et al*., 2010; Ghazoul *et al*., 2010; Larson, 2011; Van Dam, 2011; McDermott *et al*., 2011; Börner *et al*., 2011; Neupane and Shrestha, 2012; Mahanty *et al*., 2012) and indigenous peoples (Shankland and Hasenclever, 2011). Latent negative impacts include exclusion of local people from forest use, and loss of local ownership in documenting the state of forests due to external monitoring and verification mechanisms (Gupta *et al*., 2012; Pokorny *et al*., 2013). 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). 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). Positive future benefits for poor people from REDD+ will require attention to tenure and property rights, gender interests, and community engagement (Danielsen *et al*., 2011; Mustalahti *et al*., 2012).

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 communities and indigenous peoples. If 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; Savaresi, 2013).

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 (Estrada and Corbera, 2012), 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 transnational large-scale land acquisitions (LSLA), is a near-term climate change mitigation response that raises two major livelihood and poverty concerns: food price increases and dispossession of

land (see Chapters 4 and 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 (*medium evidence, high agreement*). Biofuel production is considered the primary driver, but there may be links to climate change through high food prices (Daniel, 2011), food insecurity (Robertson and Pinstrup-Andersen, 2010; Rosset, 2011; Sulser *et al*., 2011), and carbon markets potentially raising land prices, e.g. REDD+ (Cotula *et al*., 2009; Zoomers, 2010; Anseeuw *et al*., 2012). LSLA global targets are biofuels (40%), food (25%) and forestry (3%), with much regional variation (Anseeuw *et al*., 2012). The 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 (Von Braun and Ahmed, 2008; Mitchell, 2008; Aksoy and Isik-Dikmelik, 2008; Elobeid and Hart, 2008; Baffes and Haniotis, 2010; Ajanovic, 2011; Condon *et al*., 2013). Some studies link the 2007/08 price spike to speculation in agricultural futures markets (Runge and Senauer, 2007; Ghosh, 2010) driven partly by potential future profits from biofuels while their role was relatively less important in the 2010/11 price spike (Trostle *et al*., 2011).

LSLA have also triggered a land rush in LICs, which affects livelihood choices and outcomes, with some distinct gender dimensions (Chu, 2011; De Schutter, 2011; Julia and White, 2012; Peters, 2013). New competition for land dispossesses smallholders, displaces food production, degrades the environment, and pushes poor people 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) and indigenous peoples (Montefrio, 2012; Obidzinski *et al*., 2012; Montefrio and Sonnenfeld, 2013; Manik *et al*., 2013). 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 somewhat among regions, with the greatest risk for negative outcomes for smallholders in Africa (Daley and Englert, 2010; Borras *et al*., 2011).

Mainstream economic modeling offers 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

Local responses to climate variability, shocks, and change have always been part of livelihoods (Morton, 2007). Formal policy responses to climate change, however, have developed more recently as the urgency of adaptation, in addition to mitigation, became a clear international policy mandate (Pielke Jr *et al*., 2007). 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 near-term effects of autonomous and planned adaptation and formal insurance schemes on the livelihoods of poor populations. Since adaptation policies and projects are relatively recent, understanding of their long-term effects is very limited.

13.3.2.1. Impacts of Adaptation Responses 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 responses (Halstead and O'Shea, 2004), and 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 due to 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) or require more labor-intensive practices that undermine people's health and may push them over a poverty threshold (Eriksen and Silva, 2009). Moreover, autonomous adaptation strategies can increase vulnerability for others or be subject to local elite capture (McLaughlin and Dietz, 2008; Eriksen and Silva, 2009; Bhattamishra and Barrett, 2010). Men's migration in Northern Mali, for example, increases the workload of the rest of the family, especially women, and reduces children's school attendance (Brockhaus *et al*., 2013). There is no evidence regarding the impacts of autonomous responses on people living in poverty in MICs and HICs.

Few rigorous studies about pilot adaptation projects exist outside of organizations' own assessments (Mapfumo *et al*., 2010; Nkem *et al*., 2011) or evaluations of how planned adaptation was 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 due to scarce baseline poverty data. Other projects, such as in India's Karnataka Watershed, are said to have increased agricultural productivity, income, and employment, benefiting the poorest and landless and improving equity (IEG, 2012). National Action Plans of Adaptation tend to overemphasize technological and infrastructural measures while often overlooking poor people's needs, gender issues, and livelihood and adaptation strategies (Agrawal and Perrin, 2009; Perch, 2011).

13.3.2.2. Insurance Mechanisms for Adaptation

Insurance mechanisms (see Glossary and Chapter 10) 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 a household's process to rebuild assets after climate shocks over years (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; De Jode, 2010). Unable to access insurance, they often invest in low-risk, low-return livelihood activities, which makes asset accumulation 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 (see also Chapter 10) have emerged, showing 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 on investment, production, and income under drought and flood risk, including possible longer-term impacts on future income- earning activities and health, although affordability may limit the potential for the poorest (Yamauchi *et al*., 2009; Hochrainer-Stigler *et al*., 2012; Karlan *et al*., 2012; Tadesse and Brans, 2012). There is emerging evidence that weather index insurance can be specifically designed to reach the people usually uninsurable for example by premium-for-work arrangements. In such arrangements farmers provide labor and in return get an insurance certificate against rain failure in a crucial growth period for their staple crops (Brans *et al*., 2011). Slow uptake of insurance among poor people may be related to farmers not fully understanding the schemes' merits and function or not trusting that payouts will come (Giné and Yang, 2009; Patt *et al*., 2010).

13.4. Implications of Climate Change for Poverty Alleviation Efforts

This section assesses how climate change may affect efforts to alleviate poverty. Evidence from observed impacts and projections highlight both challenges and opportunities. The section builds on the findings from 13.1 to 13.3 and stresses the need to take into account the complexity of livelihood dynamics, multidimensional poverty, and intersecting inequalities to successfully navigate climate-resilient development pathways (see Glossary).

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 well-being, 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 undermine 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 declining adaptive capacity, which will hamper development (*high confidence*). Posey (2009) flags lower adaptive capacities in communities with concentrations of racial minorities and low-income households than in more affluent areas, due to marginalization and multidimensional inequality. Iglesias *et al*. (2011) project continental disparities in agricultural productivity under progressively severe climate change scenarios with highest risks for Africa and Southeast Asia. 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 Chapters 14-16, 20). 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 (Brans *et al*., 2011; 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 poor people 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. 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 poor people, 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, 2009; Niño-Zarazúa, 2011; Barrientos, 2011). There is *medium agreement* among scholars

and practitioners that SP helps people in chronic poverty reduce risk and protect assets during crises (Devereux *et al*., 2010; Barrientos, 2011; Dercon, 2011; Devereux *et al*., 2011). At the regional and municipal level, SP often fails to address local government capacity to ensure risk reduction by providing water, sanitation, drainage, health care, and emergency services. Also, SP does not intentionally strengthen local collective capacity to proactively address climate change risks and take action (Satterthwaite and Mitlin, 2013).

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). ASP should be understood as a framework rather than a package of specific measures. ASP has almost exclusively focused on LICs and some MICs with very little attention to 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 as part of dynamic livelihood trajectories (Heltberg *et al*., 2009; Arnall *et al*., 2010; Bee *et al*., 2013). The Productive Safety Net Program in Ethiopia, for instance, 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* (UNDP, 2012) 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 long-term livelihood security and well-being in addition to short-term disaster relief (Gilligan *et al*., 2009; Conway and Schipper, 2011; Béné *et al*., 2012; UNDP, 2012). Local governments in urban contexts have limited capacities to address livelihood security, but more scope to increase resilience through risk-reducing infrastructure (Satterthwaite and Mitlin, 2013).

Disaster risk reduction (DRR): The development and application of DRR (see Glossary) has been among the most important routes for highlighting risks of extreme weather among local governments and civil society, and came to the fore as the concentration of disaster deaths from extreme weather in LICs and MICs became evident (UNISDR, 2009; UNISDR, 2011). However, the accumulated effect of several small-scale events is often more damaging than large-scale ones (Aryal, 2012). DRR is now 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 disadvantaged people, 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. Lessons learned from Hurricane Katrina and the Tōhoku earthquake and tsunami showcase the multiplier effect of a disaster on top of underlying structural inequalities. Their persistence years later, as witnessed with Katrina (Schwartz, 2007; Zottarelli, 2008; Fussell *et al*., 2010) further stresses the need for expanded analyses beyond disaster 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 boost renewable energy use, which could increase energy access for billions of people currently without 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 also Chapter 11), employment, and cost savings relative to fossil fuels (Edenhofer *et al*., 2011; Jerneck and Olsson, 2012).

_____ 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 near- and long-term climate-resilient development pathways (see Chapter 20). This perspective acknowledges the 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 poor people (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 poor and marginalized people precariously close to the two most undesirable future scenarios as conceptualized in the shared socio-economic pathways (SSPs) (see Chapter 1): 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 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 suggests that, in order to move toward the mid- and long-term SSP1 (sustainability), a fundamental rethinking of poverty and development will need to emphasize equity among poor and non-poor people 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 people. 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 devoted to exploring poverty in relation to climate change, a new theme in the IPCC. It uses a livelihood 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, and how they 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 poor people and their livelihoods, acting as a threat multiplier. 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 reviewed in this chapter often do not benefit poor people, 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 many 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 majority does not focus on continuous struggles and trajectories but only offers snapshots. An explicit analysis of livelihood dynamics would more clearly reveal how people respond to a series of climatic stressors and shocks over time.
- Few studies examine how structural inequalities, power imbalances, and intersecting axes of privilege and marginalization shape differential vulnerabilities to climate change. Although there is growing literature on climate change and gender as well as on indigeneity, other axes such as age, class, race, caste, and (dis)ability, remain underexplored. Understanding how simultaneous and intersecting inequalities determine climate change impacts shows 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 regarding small-scale disasters, i.e. those that go unnoticed because of their limited extent, but whose accumulated effect may exceed large-scale disasters. 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 poor people and vulnerable livelihoods, for instance on the effects of changing winds as a combined result of climate and land cover change, and their effects on increasing evaporation and water availability.
- Not enough consideration is given to extreme stressors and shocks, e.g., under potential global mean warming of +4°C and beyond, underestimating impacts on poor and marginalized people and limits to adaptation.
- 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 benefit poor people.
- 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 to strive toward a just and desirable future for all.

Frequently Asked Questions

FAQ 13.1: What are multiple stressors and how do they intersect with inequalities to influence livelihood trajectories? *[to be placed in Section 13.1.1.2]*

Multiple stressors are simultaneous or subsequent conditions or events that provoke/require changes in livelihoods. Stressors include climatic (e.g. shifts in seasons), socio-economic (e.g. market volatility), and environmental (e.g. destruction of forest) factors, that interact and reinforce each other across space and time to affect livelihood opportunities and decision making (see Figure 13-1). Stressors that originate at the macro level include climate change, globalization, and technological change. At the regional, national, and local levels, institutional context and policies shape possibilities and pitfalls for lessening the effects of these stressors. Which specific stressors ultimately result in shocks for particular livelihoods and households is often mediated by institutions that connect the local level to higher levels. Moreover, inequalities in low-, medium-, and high-income countries often amplify the effects of these stressors. This is particularly the case for livelihoods and households that have limited asset flexibility and/or those that experience disadvantages and marginalization due to gender, age, class, race, (dis)ability, or being part of a particular indigenous or ethnic group. Weather events and climate compound these stressors, allowing some to benefit and enhance their well-being while others experience severe shocks and may slide into chronic poverty. Who is affected, how, where, and for long depends on local contexts. For example, in the Humla district in Nepal, gender roles and caste relations influence livelihood trajectories in the face of multiple stressors including

shifts in the monsoon season (climatic), limited road linkages (socio-economic), and high elevation (environmental). Women from low castes have adapted their livelihoods by seeking more day-labor employment, whereas men from low castes ventured into trading on the Nepal-China border, previously an exclusively upper caste livelihood.

FAQ 13.2: How important are climate change-driven impacts on poverty compared to other drivers of poverty?
[to be placed in Section 13.1.4]
Climate change-driven impacts are one of many important causes of poverty. They often act as a threat multiplier, meaning that the impacts of climate change compound other drivers of poverty. Poverty is a complex social and political problem, intertwined with processes of socioeconomic, cultural, institutional, and political marginalization, inequality, and deprivation, in low-, middle-, and even high-income countries. Climate change intersects with many causes and aspects of poverty to worsen not only income poverty but also undermine well-being, agency, and a sense of belonging. This complexity makes detecting and measuring attribution to climate change exceedingly difficult. Even modest changes in seasonality of rainfall, temperature, and wind patterns can push transient poor and marginalized people into chronic poverty as they lack access to credit, climate forecasts, insurance, government support, and effective response options, such as diversifying their assets. Such shifts have been observed among climate-sensitive livelihoods in high mountain environments, drylands, and the Arctic, and in informal settlements and urban slums. 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 livelihoods in terms of labor productivity, housing, infrastructure, and social networks. Indirect impacts, such as increases in food prices due to climate-related disasters and/or policies, can also harm both rural and urban poor people who are net buyers of food.

FAQ 13.3: Are there unintended negative consequences of climate change policies for people who are poor?
[to be placed in Section 13.3.1]
Climate change mitigation and adaptation policies may have unintended and potentially detrimental effects on poor people and their livelihoods (the set of capabilities, assets, and activities required to make a living). Here is just one example. In part as a result of climate change mitigation policies to promote biofuels and growing concern about food insecurity in middle and high income countries, large-scale land acquisition in Africa, Southeast Asia, and Latin America has displaced small landholders and contributed to food price increases. Poor urban residents are particularly vulnerable to food price increases as they use a large share of their income to purchase food. At the same time, higher food prices may benefit some agricultural self-employed groups. Besides negative impacts on food security, biofuel schemes may also harm poor and marginalized people through declining biodiversity, reduced grazing land, competition for water, and unfavorable shifts in access to and control over resources. However, employment in the biofuel industry may create opportunities for some people to improve their livelihoods.

Cross-Chapter Box

Box CC-HS. Heat Stress and Heat Waves

[Lennart Olsson (Sweden), Dave Chadee (Trinidad and Tobago), Ove Hoegh-Guldberg (Australia), John Porter (Denmark), Hans-O. Pörtner (Germany), Kirk Smith (USA), Maria Isabel Travasso (Argentina), Petra Tschakert (USA)]

Heat waves are periods of abnormally and uncomfortably hot weather during which the risk of heat stress on people and ecosystems is high. The number and intensity of hot days have increased markedly in the last three decades (Coumou et al., 2013) (*high confidence*). According to WG I, it is *likely* that the occurrence of heat waves has more than doubled in some locations due to human influence and it is *virtually certain* that there will be more frequent hot extremes over most land areas in the latter half of the 21st century. Coumou et al. (2013) predicted that, under a medium warming scenario, the number of monthly heat records will be over 12 times more common by the 2040s compared to a non-warming world. In a longer time perspective, if the global mean temperature increases to +10C or more, the habitability of large parts of the tropics and mid-latitudes will be at risk (Sherwood and Huber, 2010). Heat waves affect natural and human systems directly, often with severe losses of lives and assets as a result, and they may act as triggers for tipping points (Hughes et al., 2013). Consequently, heat waves play an important role in several key risks noted in Chapter 19 and CC-KR.

Economy and Society [Ch 10, 11, 12, 13]

Environmental heat stress has already reduced the global labor capacity to 90% in peak months with a further predicted reduction to 80% in peak months by 2050. Under a high warming scenario (RCP8.5), labor capacity is expected to be less than 40% of present day conditions in peak months by 2200 (Dunne et al., 2013). Adaptation costs for securing cooling capacities and emergency shelters during heat waves will be substantial.

Heat waves are associated with social predicaments such as increasing violence (Anderson, 2012) as well as overall health and psychological distress and low life satisfaction (Tawatsupa et al., 2012). Impacts are highly differential with disproportional burdens on poor people, elderly people, and those who are marginalized (Wilhelmi et al., 2012). Urban areas are expected to suffer more due to the combined effect of climate and the urban heat island effect (Fischer et al., 2012). In LICs and MICs, adaptation to heat stress is severely restricted for most people in poverty and particularly those who are dependent on working outdoors in agriculture, fisheries, and construction. In small-scale agriculture, women and children are particularly at risk due to the gendered division of labor (Croppenstedt et al., 2013). The expected increase in wildfires as a result of heat waves (Pechony and Shindell, 2010) is a concern for human security, health, and ecosystems. Air pollution from wildfires already causes an estimated 339,000 premature deaths per year worldwide (Johnston et al., 2012).

Human Health [Ch 11]

Morbidity and mortality due to heat stress is now common all over the world (Barriopedro *et al*., 2011; Rahmstorf and Coumou, 2011; Nitschke et al., 2011; Diboulo et al., 2012; Hansen et al., 2012). People in physical work are at particular risk as such work produces substantial heat within the body, which cannot be released if the outside temperature and humidity is above certain limits (Kjellstrom et al., 2009). The risk of non-melanoma skin cancer from exposure to UV radiation during summer months increases with temperature (van der Leun, Jan C et al., 2008). Increase in ozone concentrations due to high temperatures affects health (Smith et al., 2010), leading to premature mortality, e.g. cardiopulmonary mortality (Smith et al., 2010). High temperatures are also associated with an increase in air-borne allergens acting as a trigger for respiratory illnesses such as asthma, allergic rhinitis, conjunctivitis, and dermatitis (Beggs, 2010).

Ecosystems [Ch 4, 5, 6, 30]

Tree mortality is increasing globally (Williams et al., 2012) and can be linked to climate impacts, especially heat and drought (Reichstein et al., 2013), even though attribution to climate change is difficult due to lack of time series and confounding factors. In the Mediterranean region, higher fire risk, longer fire season, and more frequent large, severe fires are expected as a result of increasing heat waves in combination with drought (Duguy et al., 2013), Box 4.2.

Marine ecosystem shifts attributed to climate change are often caused by temperature extremes rather than changes in the average (Pörtner and Knust, 2007). During heat exposure near biogeographical limits, even small (<0.5°C) shifts in temperature extremes can have large effects, often exacerbated by concomitant exposures to hypoxia and/or elevated CO_2 levels and associated acidification (Hoegh-Guldberg et al., 2007), Figure 6-5, (*medium confidence*) [Ch 6.3.1, 6.3.5; 30.4; 30.5; CC-MB]

Most coral reefs have experienced heat stress sufficient to cause frequent mass coral bleaching events in the last 30 years, sometimes followed by mass mortality (Baker et al., 2008). The interaction of acidification and warming exacerbates coral bleaching and mortality (*very high confidence*).Temperate seagrass and kelp ecosystems will decline with the increased frequency of heat waves and through the impact of invasive subtropical species (*high confidence*). [Ch 5, 6, 30.4-30.5, CC-CR, CC-MB]

Agriculture [Ch 7]

Excessive heat interacts with key physiological processes in crops. Negative yield impacts for all crops past +3C of local warming without adaptation, even with benefits of higher CO_2 and rainfall, are expected even in cool environments (Teixeira et al., 2011). For tropical systems where moisture availability or extreme heat limits the length of the growing season, there is a high potential for a decline in the length of the growing season and

suitability for crops (*medium evidence, medium agreement*) (Jones and Thornton, 2009). For example, half of the wheat-growing area of the Indo-Gangetic Plains could become significantly heat-stressed by the 2050s.

There is *high confidence* that high temperatures reduce animal feeding and growth rates (Thornton et al., 2009). Heat stress reduces reproductive rates of livestock (Hansen, 2009), weakens their overall performance (Henry et al., 2012), and may cause mass mortality of animals in feedlots during heat waves (Polley et al., 2013). In the U.S., current economic losses due to heat stress of livestock are estimated at several billion USD annually (St-Pierre et al., 2003).

Box CC-HS References

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Table 13-1: Examples of gendered climate experiences*

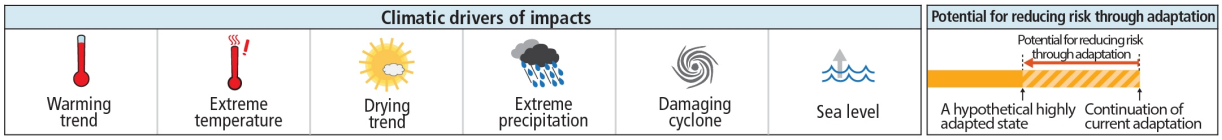
Experiences	Male farmers	Female farmers
Increased workload	Demanding tasks such as feeding livestock, carting water, destroying frail animals (A)	Assistance with farm tasks and working off the farm for additional income (A)
	Increased migration for wage labor, typically farther away from home (I)	Increased collection of firewood and uptake of wage labor (esp. lower castes) in neighboring villages (I)
Community interactions, isolation, and exploitation	Locked into farms, loss of political power (A)	Increased interactions and caregiving work, taking care of others' health at the expense of their own (A)
	Exploitation by labor contractors when migrating (I)	Disadvantage in accessing institutional support and climate information (I)
Physical and psychological toll	Feel demonized (farmers seen as responsible for crisis), increased stress, social isolation, depression, and high suicide levels (A)	Working lives appear indefinite, resulting in increased stress (A)
	Increased anxiety to provide food and access loans and escape trap of indebtedness, increase in domestic fights, sometimes suicide (I)	Increased pressure to provide food and save some more from sale for consumption, less food intake, increase in domestic fights (I)

*A = Australia (ten-year drought, 2003-2012), based on Alston, 2011;

I = India (climate variability and changing climatic trends), based on Lambrou and Nelson, 2013.

Table 13-2: Key risks from climate change for poor people and their livelihoods and the potential for risk reduction through adaptation. Key risks are identified based on assessment of the literature and expert judgment by chapter authors, with evaluation of evidence and agreement in the supporting chapter sections. Each key risk is characterized as very low, low, medium, high, or very high. Risk levels are presented in three timeframes: present, near-term (2030-2040), and long-term (2080-2100). Near-term indicates that projected levels of global mean temperature do not diverge substantially across emissions scenarios. Long-term differentiates between a global mean temperature increase of 2°C and 4°C above preindustrial levels. For each timeframe, risk levels are estimated for a continuation of current adaptation and for a hypothetical highly adaptive state. Bars that only show the latter indicate a limit to adaptation (see Chapter 16). Relevant climate variables are indicated by symbols. This table should not be used as a basis for ranking severity of risks.

Key risk	Adaptation issues and prospects	Climatic drivers	Supporting ch. sections	Timeframe	Potential for reducing risk through adaptation
Deteriorating livelihoods in drylands, due to high and persistent poverty. Risk of reaching tipping points for crop and livestock production in small-scale farming and/or pastoralist livelihoods (*high confidence*)	Adaptation options are limited due to persistent poverty, declining land productivity, food insecurity, and limited government support due to marginalization. Rural-urban migration is a potential adaptation strategy.		13.2.1.2, 13.2.2.1, 13.2.2.3	Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	Very low – Medium – Very high
Destruction and deterioration of assets physical (homes, land and infrastructure), human (health), social (social networks), cultural (sense of belonging and identity) and financial (savings) due to floods in flood-prone areas, such as low-lying deltas, coasts, and small islands (*high confidence*)	Adaptation options are limited for people who cannot afford relocation to safer areas. Government support and private options (e.g. insurance) are limited for people with insecure or unclear tenure.		13.2.1.1, 13.2.1.3, 13.2.1.5, Box 13-1	Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	Very low – Medium – Very high
Shifts from transient to chronic poverty due to persistent economic and political marginalization of poor people combined with deteriorating food security (*high confidence*)	Adaptation options are limited due to exclusion from markets and low government support. Policies for adaptation are unsuccessful because of failure to address persistent inequalities.		13.2.1.3, 13.2.2.4	Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	Very low – Medium – Very high
Declining work productivity, morbidity (e.g. dehydration, heat stroke, and heat exhaustion) and mortality from exposure to heat waves. Particularly at risk are agricultural and construction workers as well as children, homeless people, the elderly, and women who have to walk long hours to collect water (*high confidence*)	Adaptation options are limited for people who are dependent on agriculture and too poor to afford agricultural machinery. Adaptation options are limited in the construction sector where many poor people work under insecure arrangements. Adaptation might be impossible in certain areas in a +4C world.		13.2.1.1, 13.2.1.5, 13.2.2.4, Box 13-1	Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	Very low – Medium – Very high
Declining agricultural yields, primarily in already hot climates, with severe impacts on countries and communities highly dependent on agriculture. Declining yields may cause further deterioration of assets: financial (savings), human (health), social (social networks) and cultural (sense of belonging and identity) (*high confidence*)	Adaptation by changing livelihoods away from agriculture is limited due to poverty and marginalization. Adaptation strategies such as early or late planting, inter-cropping, and shifting crops bring mixed benefits and have limitations, often depending on household resources and access to seasonal forecasts and longer-term projections. In a +4C world, adaptation in agriculture is very limited.		13.2.2.2, 13.2.2.4	Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	Very low – Medium – Very high
Reduced access to water for rural and urban poor people due to water scarcity and increasing competition for water (*high confidence*)	Adaptation through reducing water use is not an option for the large number of people already lacking adequate access to safe water. Access to water is subject to various forms of discrimination, for instance due to gender and location. Poor and marginalized water users are unable to compete with water extraction by industries, large-scale agriculture, and other powerful users.		13.2.1.1, 13.2.1.3, 13.2.1.5, Box 13-1	Present Near-term (2030-2040) Long-term (2080-2100) 2°C 4°C	Very low – Medium – Very high



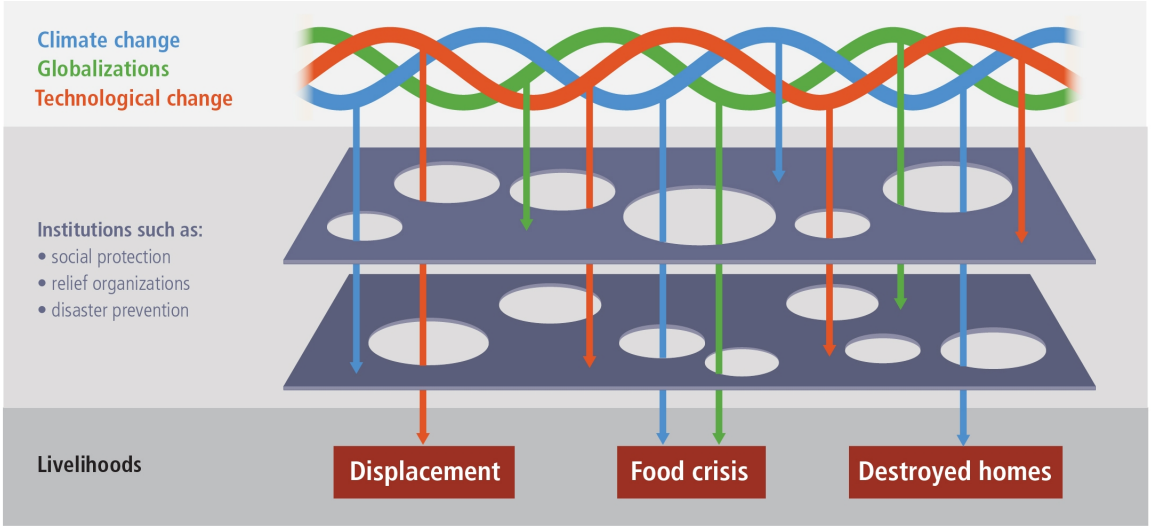


Figure 13-1: Multiple stressors related to climate change, globalizations, and technological change interact with national and regional institutions to create shocks to place-based livelihoods, inspired by Reason (2000).

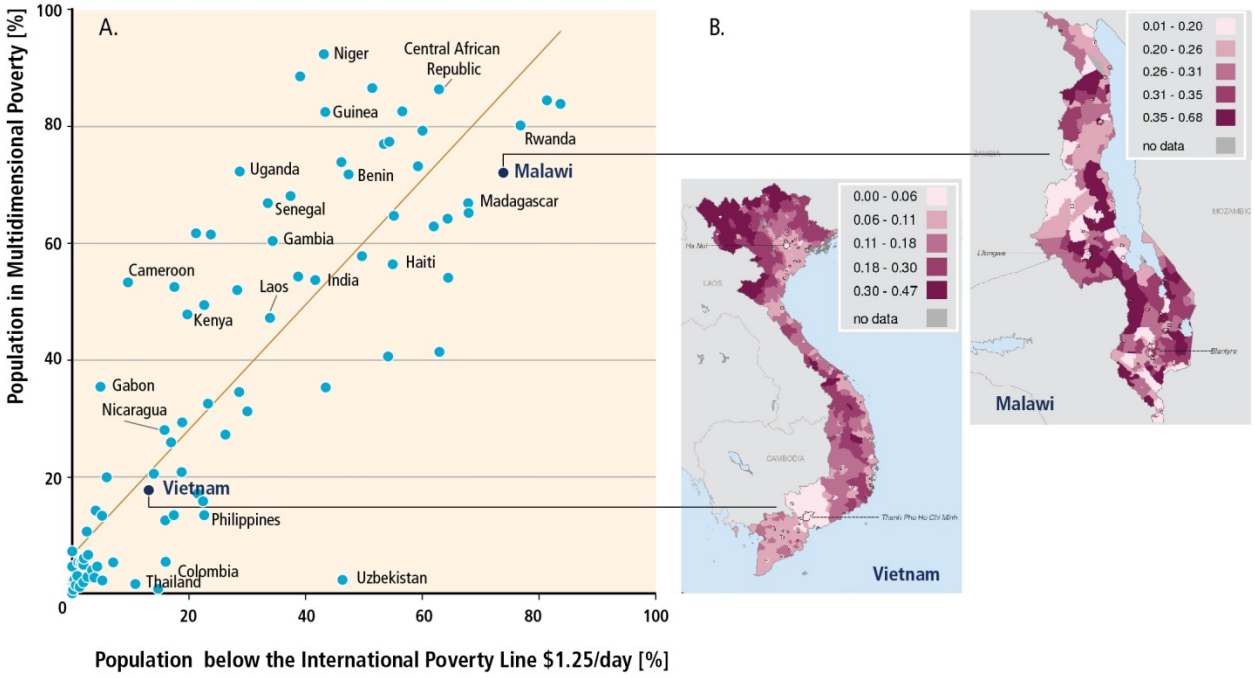
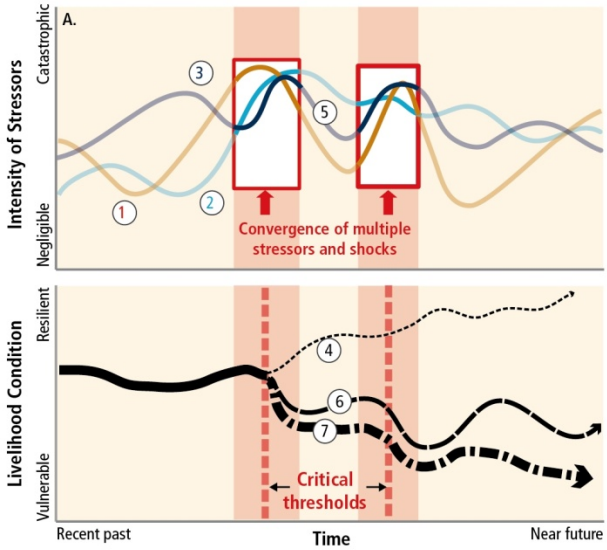
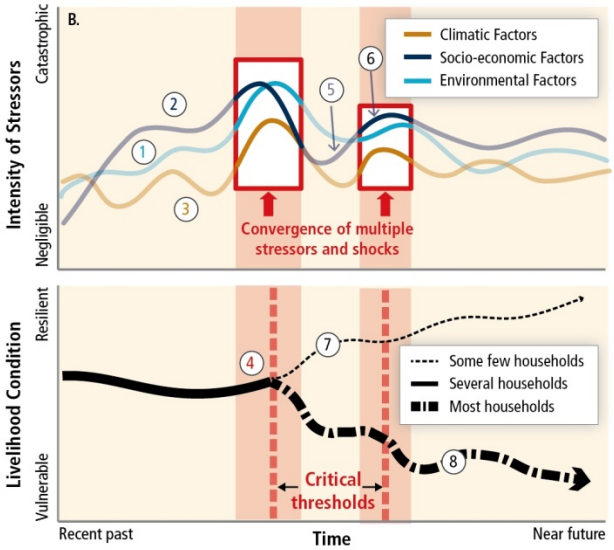


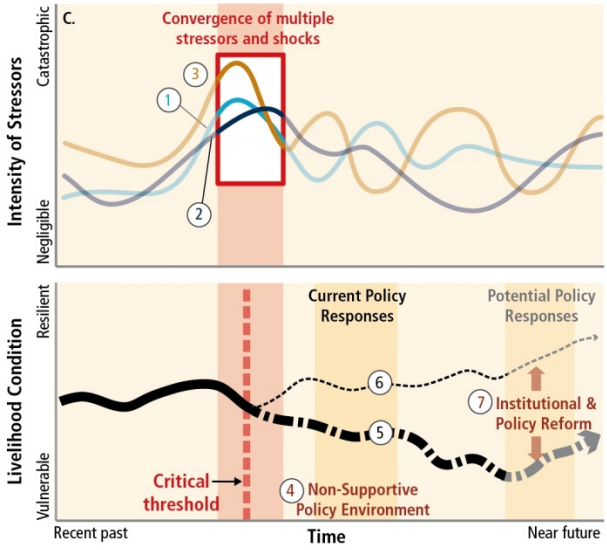
Figure 13-2: A) Multidimensional poverty and income-based poverty using the International Poverty Line $1.25/day (in Purchasing Power Parity terms), with linear regression relationship (dotted line) based on 96 countries (UNDP, 2011b). The position of the countries relative to the dotted line illustrates the extent to which these two poverty measures are similar or divergent (e.g., Niger). B) The map insets show the intensity of poverty in two countries, based on the Poverty Gap Index at district level (per capita measure of the shortfall in welfare of the poor from the poverty line, expressed as a ratio of the poverty line). The darker the purple shading, the larger the shortfall.



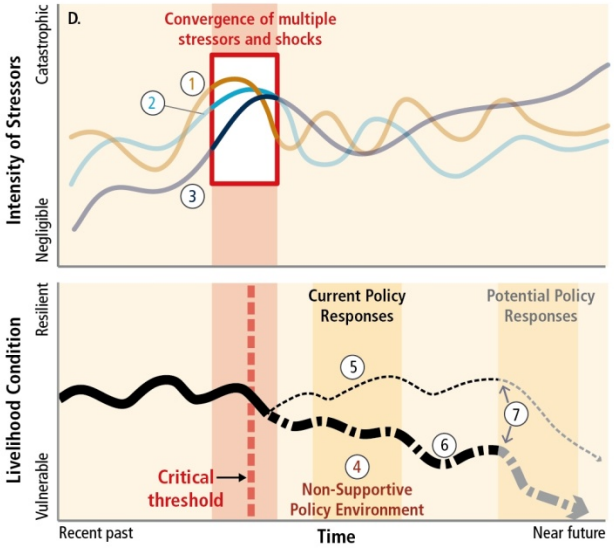
A. Botswana's drylands (Sallu et al., 2010). Over the past 30 years, rural households have faced droughts, late onset and increased unpredictability of rainfall, and frost (1), drying of Lake Xau, and land degradation (2). Households responded differently to these stressors, given their financial and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



B. Coastal Bangladesh (Pouliotte et al., 2010). In the Surnabads, a combination of environmental and socio-economic factors, out of which climatic stressors appear to only play a minor role, have changed livelihoods: saltwater intrusion (1) due to the construction and poor management of the Bangladeshi Coastal Embankment Project, the construction of a dam in India, local water diversions (2), and sea level rise and storm surges (3). The convergence of these stressors caused households to cross a critical threshold from rice and vegetable cultivation to saltwater shrimp farming (4). A strong export market and international donor and national government support facilitated this shift (5). However, increasing density of shrimp farming then triggered rising disease levels (6). Wealth and power started to become more concentrated among a few affluent families (7) while livelihood options for the poorer households further diminished due to lacking resources to grow crops in salinated water, the loss of grazing areas and dung from formerly accessible rice fields (8), and rising disease levels (6).



C. Mountain environments (McDowell and 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. The retreat of the Mururata glacier causes water shortages (1), compounded by the increased water requirements of cash crops on smaller and smaller "minifundios" and market uncertainties (2). High temperatures amplify evaporation, and flash floods coupled with delayed rainfall cause irrigation canals to collapse (3). The current policy environment makes it difficult to access loans and obtain land titles (4), pushing many farmers onto down-ward livelihood trajectories (5) while those who can afford it invest in fruit and vegetable trees at higher altitudes (6). Sustained access to land, technical assistance, and irrigation infrastructure would be effective policy responses to enhance well-being (7).



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

Figure 13-3: Illustrative depiction of livelihood dynamics under simultaneous climatic, environmental, and socio-economic stressors and shocks leading to differential livelihood trajectories over time, based on four case studies. The red boxes indicate specific critical moments when stressors converge, threatening livelihoods and well-being. Key variables and impacts numbered in the illustrations correspond to the developments described in the captions.

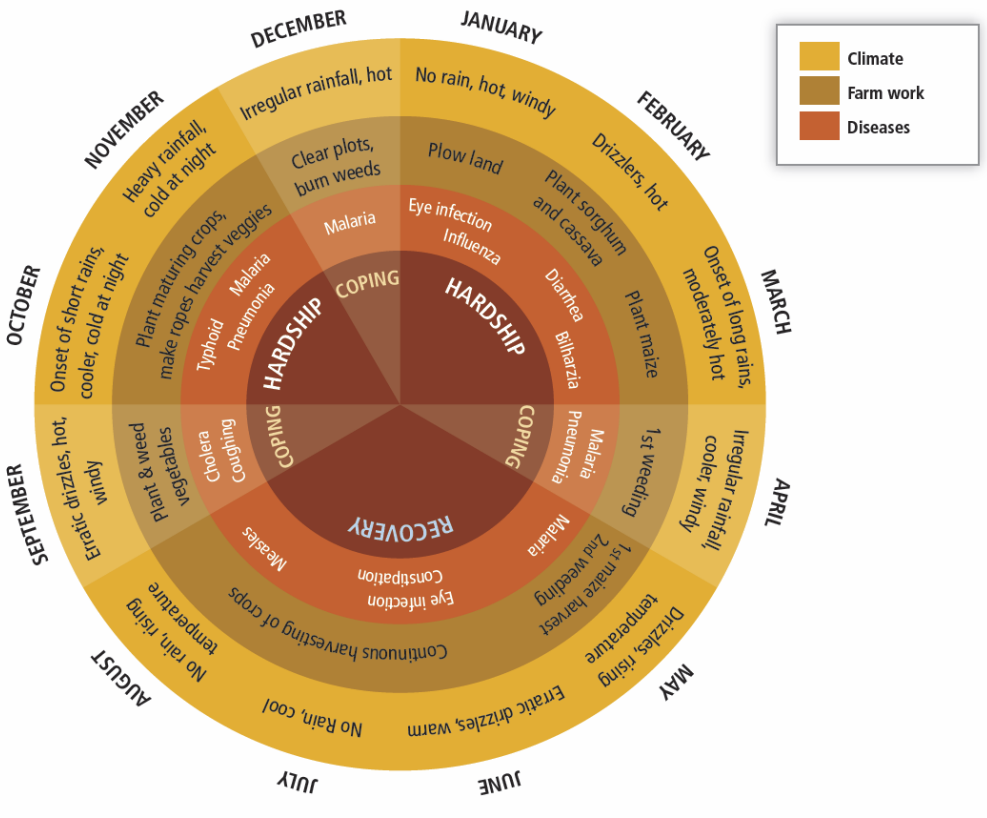


Figure 13-4: Seasonal sensitivity of livelihoods to climatic and non-climatic stressors for one calendar year, based on experiences of smallholder farmers in the Lake Victoria Basin in Kenya and Tanzania (Gabrielsson *et al.*, 2012).

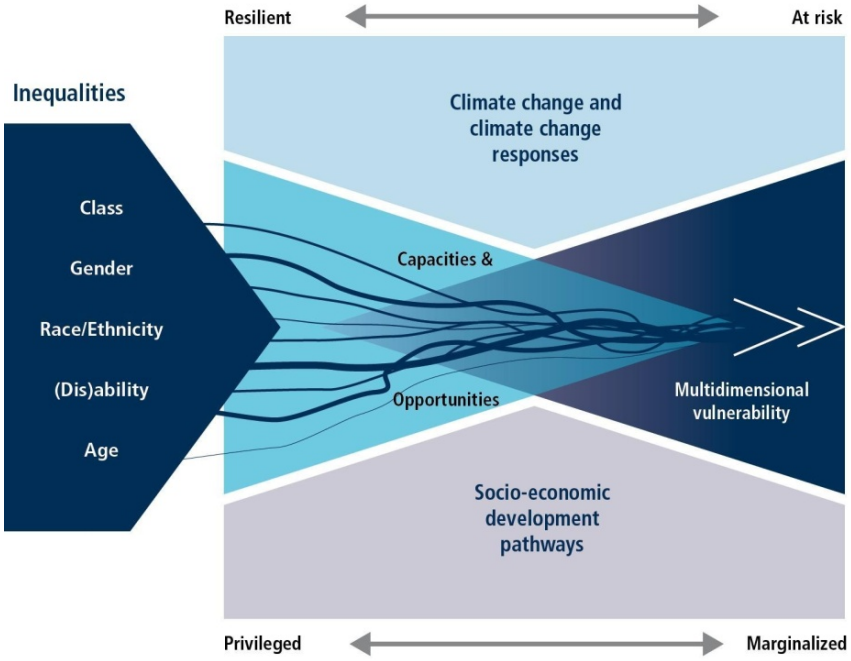


Figure 13-5: Multidimensional vulnerability driven by intersections dimensions of inequality.