Chapter 12. Human Security

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Executive Summary

Human security will be progressively threatened as the climate changes (*high agreement, robust evidence)*. Human insecurity almost never has single causes, but instead emerges from the interaction of multiple factors [12.1.2; 12.2]. Climate change is an important factor in threats to human security through a) undermining livelihoods [12.2], b) compromising culture and identity [12.3], c) increasing migration that people would rather have avoided [12.4], and d) challenging the ability of states to provide the conditions necessary for human security [12.6].

Climate change will compromise the cultural values that are important for community and individual well-being *(high agreement, medium evidence*). The effect of climate change on culture will vary across societies and over time, depending on cultural resilience and the mechanisms for maintaining and transferring knowledge. Changing weather and climatic conditions threaten cultural practices embedded in livelihoods and expressed in narratives, world views, identity, community cohesion and sense of place. Loss of land and displacement, for example on small islands and coastal communities, has well documented negative cultural and well-being impacts [12.3.1, 12.3.3, 12.4.2].

Indigenous, local and traditional forms of knowledge are a major resource for adapting to climate change (*high agreement, robust evidence*). Natural resource dependent communities, including indigenous peoples, have a long history of adapting to highly variable and changing social and ecological conditions. But the salience of indigenous, local and traditional knowledge will be challenged by climate change impacts. Such forms of knowledge are often neglected in policy and research, and their mutual recognition and integration with scientific knowledge will increase the effectiveness of adaptation [12.3.3, 12.3.4].

Climate change will have significant impacts on forms of migration that compromise human security (*high agreement, medium evidence*). Some migration flows are sensitive to changes in resource availability and ecosystem services. Major extreme weather events have in the past led to significant population displacement, and changes in the incidence of extreme events will amplify the challenges and risks of such displacement. Many vulnerable groups do not have the resources to be able to migrate to avoid the impacts of floods, storms and droughts. Models, scenarios and observations suggest that coastal inundation and loss of permafrost can lead to migration and resettlement [12.4.2]. Migrants themselves may be vulnerable to climate change impacts in destination areas, particularly in urban centres in developing countries [12.4.1.2].

Mobility is a widely used strategy to maintain livelihoods in response to social and environmental changes (*high agreement, medium evidence*). Migration and mobility are adaptation strategies in all regions of the world that experience climate variability. Specific populations that lack the ability to move also face higher exposure to weather-related extremes, particularly in rural and urban areas in low and middle-income countries. Expanding

opportunities for mobility can reduce vulnerability to climate change and enhance human security [12.4.1, 12.4.2]. There is insufficient evidence to judge the effectiveness of resettlement as an adaptation to climate change.

Some of the factors that increase the risk of violent conflict within states are sensitive to climate change (*medium agreement, medium evidence*). The evidence on the effect of climate change and variability on violence is contested [12.5.1]. Although there is little agreement about direct causality, low *per capita* incomes, economic contraction, and inconsistent state institutions are associated with the incidence of violence [12.5.1]. These factors can be sensitive to climate change and variability. Poorly designed adaptation and mitigation strategies can increase the risk of violent conflict [12.5.2].

People living in places affected by violent conflict are particularly vulnerable to climate change (*high agreement, medium evidence*). Evidence shows that large-scale violent conflict harms infrastructure, institutions, natural capital, social capital and livelihood opportunities. Since these assets facilitate adaptation to climate change, there are strong grounds to infer that conflict strongly influences vulnerability to climate change impacts [12.5.3].

Climate change will lead to new challenges to states and will increasingly shape both conditions of security and national security policies (*medium agreement, medium evidence*). Physical aspects of climate change, such as sea level rise, extreme events and hydrologic disruptions, pose major challenges to vital transport, water, and energy infrastructure [12.6]. Some states are experiencing major challenges to their territorial integrity, including, small-island states and other states highly vulnerable to sea level rise [12.6.2]. Some transboundary impacts of climate change, such as changes in sea ice, shared water resources, and the migration of fish stocks, have the potential to increase rivalry among states. The presence of robust institutions can manage many of these rivalries such that human security is not severely eroded [12.5.1, 12.6.2].

12.1. Definition and Scope of Human Security

There are many definitions of human security, which vary according to discipline. This Chapter defines human security, in the context of climate change, as a condition that exists when the vital core of human lives is protected, and when people have the freedom and capacity to live with dignity. In this assessment, the vital core of human lives includes the universal and culturally specific, material and non-material elements necessary for people to act on behalf of their interests. Many phenomena influence human security, notably the operation of markets, the state, and civil society. Poverty, discrimination of many kinds, and extreme natural and technological disasters undermine human security.

The concept of human security has been informed and debated by many disciplines and multiple lines of evidence, by studies that use diverse methods (Paris 2001; Alkire, 2003; Owen 2004; Gasper 2005; Hoogensen and Stuvøy 2006; Mahoney and Pinedo 2007; Brauch *et al.*, 2009; Inglehart and Norris 2012). The concept was developed in parallel by UN institutions, and by scholars and advocates in every region of the world (UNDP 1994; Commission on Human Security, 2003; Najam 2003;Kaldor 2007; Poku and Sandkjaer 2009; Rojas 2009; Chourou, 2009; Sabur 2009; Othman 2009; Wun Gaeo 2009; Black and Swatuk 2009).

This Chapter assesses the risks climate change poses to individuals and communities, including threats to livelihoods, culture, and political stability. Chapters in Working Group II (WGIIAR4) in the Fourth Assessment Report (AR4) identified the risk climate change poses to livelihoods, cultures, and indigenous peoples globally (Chapters 5, 7, 9 10, 16, and 17) and that migration and violent conflicts increase vulnerability to climate change (Chapter 19), as well as highlighting that migration plays a role in adaptation. But this Chapter is the first systematic assessment across the dimensions of human security.

Research since publication of the AR4 has addressed the linkages between climate change and human security through concerted international research programmes and initiatives (Matthew *et al.*, 2010; Afifi and Jäger, 2010; O'Brien *et al.,* 2010; Oswald-Spring, 2012; Scheffran *et al.*, 2012a; Gleditsch, 2012; Sygna *et al.*, 2013). Specific dimensions of human security, such as food security, public health and well-being, livelihoods, and regional perspectives are examined systematically in Chapters 11, 13 and 19, and in Chapters 22-29 of this report, and this Chapter cross-refers to those assessments.

The assessment in this Chapter is based on structured reviews of scientific literature. These were carried out firstly using searches of scientific databases of relevant studies published from 2000 until 2013, with searches targeted at the core dimensions of culture, indigenous peoples, traditional knowledge, migration, conflict, and transboundary resources. These searches were supplemented by open searches to capture book and other non-journal literature. The comprehensive review in this Chapter reflects the dominant findings from the scientific literature that the impacts of climate change on livelihoods, cultures, migration, and conflict are negative, but that some dimensions of human security are less sensitive to climate change and driven by economic and social forces.

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Box 12-1. Relationship between Human Rights and Human Security in the Context of Climate Change

This Chapter focuses on human security, but does not explicitly frame the issue as one of rights. The argument is made in political and legal scholarship that human rights to life, health, shelter and food are fundamentally breached by the impacts of climate change. Climate change puts both human security and human rights at risk (Slade, 2007; Humphreys, 2010; Caney, 2010). But framing the issue of rights specifies minimum standards that apply universally, and such rights are often not realized in national and international law and practice or neglect the harm or rights of non-human species (Humphreys, 2010; Bell, 2013). Human security by contrast is inclusive of political, sociocultural, and economic rights, rather than legal rights (CHS, 2003), which are instrumental to its achievement (Bell, 2013).

Research on climate change risks to human rights examines legal issues in policy, litigation, and compensation (Posner, 2007). Many legal commentators argue that claims to human rights may ultimately not offer greater explanation of the harm to individuals or realise political traction in climate policy (Carlane and Depledge, 2007; Adelman, 2010; Bodansky, 2010). Several cases have tested these rights, especially of women, children, indigenous peoples, and other minorities (Oswald-Spring, 2008; Knox, 2009; Bodansky, 2010).

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This Chapter assesses research on how climate change may exacerbate specific threats to human security, and how factors such as lack of mobility or the presence of conflict restrict the ability to adapt to climate change. Research on the specific interaction of human security and climate change focuses on how cultural, demographic, economic, and political forces interact with direct and indirect climate change impacts, affecting individuals and communities (Krause and Jütersonke, 2005; Hoogensen and Stuvøy, 2006; O'Brien, 2006; Betancourt *et al.*, 2010; Sygna *et al,* 2013). The analysis concerns drivers of vulnerability across multiple scales and sectors, including, gender relations, culture, political institutions and markets. Each of these areas has its distinct disciplinary focus, methods, and levels of evidence as discussed in Box 12-2.

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Box 12-2. The Nature of Evidence about Climate Change and Human Security

Understanding the effects of climate change on human security requires evidence about social and environmental processes across multiple scales and sectors. This process-based analysis is informed by a wide array of theories, methods, and evidence used in different academic disciplines, and so is not contiguous. For example, this Chapter assesses anthropological research where culture influences responses to climate change or may be shaped by climate change; alongside political and economic studies which use data sets to test for correlations between climatic factors and violent conflicts; and historical observations using documentary and archaeological methods. These diverse sources strengthen the robustness of the conclusions for this assessment when they converge on similar findings (Van de Noort, 2011; Nielsen and Reenberg, 2012).

This Chapter reviews empirical studies from the social and physical sciences using both quantitative and qualitative data. Some studies examine the interactions between environmental changes and social outcomes. Few explicitly address climate change and human security links, but provide evidence of climate change impacts on human security (Ford *et al*., 2010). Individual case studies often make causal claims in given contexts, but their results may not be generalized. Where results from multiple comparative case studies agree, generalization is sometimes possible. This Chapter also assesses quantitative studies about large social units with correlations among different factors. Correlations alone do not explain causality, although they are important in testing theories.

Given the many and complex links between climate change and human security, uncertainties in the research on the biophysical dimensions of climate change, and the nature of the social science, highly confident statements about the influence of climate change on human security are not possible (Scheffran et al., 2012a). Yet there is good evidence about many of the discrete links in the chains of causality between climate change and human insecurity. In this Chapter the standardized IPCC language of uncertainty is applied to those linkages where appropriate.

Many climate change risks to human security warrant further investigation. There is a need for more comprehensive evidence, collected across multiple locations, and over long durations, to build and test theories about relationships between climate change and livelihoods, culture, migration, and conflict. Meeting this need requires analysis of the sensitivity of diverse livelihood systems to climate change; and the effects of cultural, economic, and political changes on the vulnerability and adaptability of livelihoods. Questions surrounding the cultural dimensions of climate require much more research using multiple methods to enable more general conclusions to be drawn, in particular about the effects of culture on climate change mitigation and adaptation. The sensitivity of human mobility to climate also requires new investigation, including, importantly, systematic long-term monitoring of population changes. The effects of migration on the vulnerability and adaptation of migrants, sending, and destination communities also warrants more research, to permit scope for targeted policy interventions to reduce vulnerability. Finally, with respect to advancing knowledge of climate change and violence, extensive as well as case-based research is necessary to build theories of causality, including examination of cases where climate changes and variability were managed peacefully, in addition to cases where conflict emerged. Explanations of processes that reduce violence despite climate variability and change are necessary for responses that help sustain and improve peace in a future where the climate is changing.

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Human security and insecurity are universal issues. In every country there are individuals and groups who are insecure (Mahoney and Pinedo, 2007; Pietsch and McAllister, 2010). Much research suggests that while the impacts of climate change on human security will be experienced most in developing countries, human security is at risk for vulnerable populations everywhere (Naess *et al*., 2006; Leichenko and O'Brien, 2008; Berrang-Ford *et al*., 2011).

The Chapter also evaluates research on the interaction between the state and human security, suggesting that increased human insecurity may coincide with a decline in the capacity of states to conduct effective adaptation efforts, thus creating circumstances in which there is greater potential for violent conflict, especially in the absence of means to resolve conflicts effectively. The analysis extends to assess how states protect the human security of their citizens. In other words, this Chapter examines the security of the state because it directly impinges on human security by affecting the ability of states to protect their citizens.

The framing of climate change as a security issue has been controversial. Some authors suggest that discourses on climate change and national security tend to downplay human security dimensions, and skew mitigation and adaptation responses towards state interests rather than those of the most vulnerable human populations (Floyd 2008; Barnett 2007, 2009; Brauch, 2009; Dalby 2009; Trombetta 2009; Verhoeven 2009; Oels, 2013). Nevertheless, some countries associate climate change risks with conventional security risks and many countries are concerned about the risks climate change poses to relations between states (see Sections 5 and 6). This Chapter therefore adopts a comprehensive approach to human security, which is widely supported in the literature (Barnett, 2001; Brauch *et al*., 2008, 2009, and 2011; Matthew *et al*., 2010; O'Brien *et al*. 2010; Oswald-Spring, 2012).

12.2. Economic and Livelihood Dimensions of Human Security at Risk from Climate Change

12.2.1. Climate Change Impacts on Material Aspects of Livelihood Security

The direct and material aspects of livelihood security include access to food, housing, clean water employment and the avoidance of direct risks to health. Chapters 7, 11, and 13 assess the evidence of the mechanisms that link climate change with these phenomena. They find that climate change poses significant risks in all these areas and all conclude that material aspects of life and livelihood, such as food, water and shelter are closely coupled to weather and climate but also to multiple factors in the economy and society (Battisti and Naylor, 2009; Bohle, 2009; Hertel et a*l*., 2010; Schlenker and Lobell, 2010; Deligiannis, 2012; Chapter 13.1.4). Hence, while attributing changes climate directly to human security is difficult, some major risks are well documented. This Chapter builds on that knowledge base to assess the interaction of those risks with cultural dimensions of change, and the risks of migration and conflict. It is well established that direct risks of climate change to life and livelihoods are highly differentiated by socio-demographic factors, such as by age, wealth and gender. Box CC-GC, for example, highlights how specific populations of men and women are vulnerable to weather extremes.

Table 12-1 summarizes studies that exemplify how climate variability and change affect the material aspect of human security through deprivation of immediate basic needs and erosion of livelihood assets and human capabilities. There are well-established links from climate variability and change to the stability of agriculture and food security; water stress and scarcity; as well as destruction of property (Carter *et al*., 2007; Leary *et al*., 2008; Peras *et al*., 2008; Paavola, 2008; Tang *et al*., 2009). Projections using various socio-economic and climate change scenarios indicates an increase in economic and health risks, including loss of lives in all regions (Hall *et al*., 2003; Kainuma et al., 2004; Tang *et al*., 2009) as well as a range of psychological stresses accompanying extreme climate events and decreased access to ecosystem resources (e.g. Doherty and Clayton, 2011). The cross chapter box on Heat Stress (Box CC-HS), for example, documents the evidence on the impacts of heat stress on both labour productivity and on health outcomes. Modeled and observational analysis of human exposure to climate-related natural disasters finds significant risk of large human losses, particularly in countries with significant populations in poverty (Peduzzi et al., 2009; Busby et al., 2013). Table 12.1, and the analysis in cognate chapters (Chapters 7.3; 11.3, 13.2.2) shows that risks are significant and well understood though there is uncertainty about how dimensions of basic needs livelihoods and the integrity of place and economic assets will unfold under scenarios of climate change. Those cognate Chapters confirm that elements of nutrition, economic stability, and threats to shelter and human health interact with each other and all represent significant challenges for adaptation. Following from this body of evidence, a number of studies conclude that adverse impacts of climate change on health and on human capital will lead to the erosion of human capability (UNDP, 2007; Costello *et al*., 2009).

[INSERT TABLE 12-1 HERE
Table 12-1: Illustrative examples of impacts of climate variability and change on immediate basic needs and longer term capabilities and assets from observational studies and from projections.]

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Box 12-3. Food Prices, Food Insecurity, and Links to Climate

Food prices and food-price shocks have significant impacts on human security. They do so through reduced access to and production of food that affects both consumers and food producers (e.g. Chapter 7.4.3, Chapter 13.2.1 and 13.2.2; Barrett, 2010). It is well established that food security is determined by a range of interacting factors including poverty, water availability, food policy agreements and regulations and the demand for productive land for alternative uses (Barrett, 2010; 2013). It is also established that many of these factors are themselves sensitive to climate variability and climate change. Specific observed food prices have, however, multiple causes and complex dynamics between markets, non-food demand for agricultural land, and the impact of adverse weather and droughts on the major agricultural producing regions (Piesse and Thirtle, 2009).

Spikes in food prices have particularly acute impacts on food insecurity at the domestic level, even in the absence of climate stresses. There was, for example, high regional variation in self-reported food insecurity following the global 2008 price spike: the reported food insecurity was especially serious insecurity across Africa and Latin American countries (Heady, 2013). The 2010-11 food price spike has been estimated to have pushed 44 million people below the basic needs poverty line across 28 countries (Ivanic et al., 2012). Food availability can also be affected by domestic production of food, particularly for those countries where there are restrictions on food imports (Berazneva and Lee, 2013; Barrett, 2013). There are therefore multiple pathways by which consumers including agricultural wage labourers in low-income countries are affected (Mendelsohn et al., 2007; Ahmed et al., 2009; Hertel and Rosch, 2010; Cohen and Garrett, 2010; Ruel at al., 2010). Declines in agricultural productivity linked to climate variability and losses in maize production, for example, have been shown in Zambia to reduce real urban incomes and to influence urban poverty for a portion of the population (Thurlow *et al*., 2012).

Food prices and food availability also affect socio-political stability and in the case of the 2008-09 and 2010-11 food price spikes have been associated with food riots (Johnstone and Lazo, 2011; Berazneva and Lee, 2013; Barrett, 2013). High food prices affect food access and food availability, but such insecurity is highly conditional on the responses of markets and governments and hence is variable. Berazneva and Lee (2013) show that 14 countries in Africa experienced food riots in 2008 and that they are characterized by higher levels of poverty, restricted food access and availability, more urbanized, and have more oppressive regimes and stronger civil societies than those countries which did not experience riots. The linkages between food riots are therefore dependent on responses of multiple private and state actors and it is generally concluded that it is difficult to attribute causality (Barrett, 2013).

Food prices, food access and food availability are critical elements of human security. There is robust evidence that food security affects basic-needs elements of human security and, in some circumstances, is associated with political stability and climate stresses. But there are complex pathways between climate, food production and human security and hence this area requires further concentrated research as an area of concern.

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12.2.2. Adaptation Actions and Livelihood Dimensions of Human Security

Adaptation strategies seek to reduce vulnerability and thereby advance human security. But they also run the risk of exacerbating elements of insecurity (e.g. Deligiannis, 2012; see also Section 12.2.2). Evaluations of development interventions, for example, provide robust evidence on how livelihoods can be secured and enhanced through adaptation in the context of external shocks and shorter-term climates stresses (e.g. Ellis, 2000; Dercon, 2004). But an emerging literature documents how some adaptation interventions can create new risks, are inefficient, or fail to recognize wider goals of system resilience (e.g. Eriksen et al., 2011; Adger et al., 2011; see also Chapter 13.3.2 and Chapter 20.3.2).

Adaptation interventions and strategies have been documented that reduce risks to human security, but vary in their effectiveness. Strategies that have been documented as promoting well-being include 1) diversification of income-generating activities in agricultural and fishing systems (Tolossa, 2008; Coulthard, 2008; Paavola, 2008; Galvin, 2009; Badjeck *et al*., 2010; West and Hovelsrud, 2010); 2) migration as a risk management strategy, for example, among pastoralists and farmers in rain-fed areas (Galvin, 2009) and amongst fishing communities (Perry and Sumaila, 2007; Badjeck et al., 2009); 3) the development of insurance systems, particularly amongst vulnerable groups (Badjeck *et al*., 2010; Linneroth-Bayer and Vari, 2008); and 4) the education of women (Boyle et al., 2006, Rammohan and Johar, 2009).

Some adaptation strategies may, however, undermine human security, particularly where strategies are implemented without taking cognizance of complex livelihood arrangements. In some cases, adaptations may entrench vulnerabilities and also have the potential to enforce inequalities (Barnett and O'Neill, 2010).
For example in parts of the Middle East and North Africa, the Andes and the Caribbean, amongst other areas, skewed water policy allocation in some cases that favour the affluent may heighten overall livelihood vulnerabilities to climate stress (Chapter 13.2.1.1).

12.3. Cultural Dimensions of Human Security

12.3.1. How Culture Interacts with Climate Impacts and Adaptation

Culture is a contested and highly fluid term that is defined in this Chapter as material and non-material symbols that express collective meaning. In all societies culture is expressed in knowledge, worldviews, beliefs, norms, values and social relationships (Crate, 2008; 2011; Heyd, 2008; Roncoli et al., 2009; Strauss, 2009; O'Brien and Wolf, 2010; Tingley et al*.*, 2010; Rudiak-Gould, 2012; Sudmeier-Rieux *et al*., 2012). In this definition culture shapes the relationship of society to environments and is a significant determinant of responses to environmental and other risks and challenges (Siurua and Swift, 2002; Pearce *et al*., 2009; Nielsen and Reenberg, 2010; Petheram et al., 2010; Buikstra et al., 2010; Paul and Routray, 2011).

There has been significant new research from psychology, anthropology, sociology and human geography in the period since AR4 on the lived experience of weather extremes and observed climate change, driven in part by observed warming trends in regions. This body of knowledge from across social science disciplines argues that climate change is embedded in and acts upon culture in myriad ways. For example, all consumption patterns are culturally embedded and therefore culture influences greenhouse gas emissions. The phenomenon of climate change itself is perceived differently depending on the culture in which it is viewed, with scientific expression representing only one possibility (Norgaard, 2011). Similarly, there are widely different cultural expressions of weather, risk and the need for adaptation to such hazards (Hulme, 2008; Adger *et al*., 2013). Therefore, since climate change has consequences for people this emerging body of knowledge shows with *high confidence* that climate change has significant cultural implications (Crate, 2011; Strauss, 2012).

Anthropological analysis of culture focuses on identity, community and economic activities. There is a growing body of research on how climate and other environmental change affects livelihood activities such as pastoralism, herding, farming, fishing and hunting and gathering in places where there is significant observed change. Research has documented how rural livelihoods and, therefore, cultural practices have been affected by changes in climate and associated impacts on natural capital. Many anthropological studies suggest that further significant changes in the natural resource base upon which many cultures depend would directly affect the cultural core, worldviews, cosmologies and mythological symbols of indigenous cultures (Crate, 2008; Gregory and Trousdale, 2009; Jacka, 2009). While changing socio-economic and environmental conditions may constrain existing community coping mechanisms (Rattenbury *et al*., 2009; West and Hovelsrud, 2010; Quinn *et al.,* 2011), other studies focus on how cultures adapt to significant societal and environmental changes. Many successful examples of the persistence of cultures despite significant upheaval exist throughout history (Nuttall, 2009; Cameron, 2012; Strauss, 2012).

Culture also interacts with adaptation though the way that cultural, local and individual perceptions affect narratives of risk, resilience and adaptive capacity. A body of research across disciplines argues that incorporation of cultural understanding of environment, risk and social practices increases the explanatory power of models of risk (Ifejika Speranza et al., 2008; Jacka, 2009; Adger et *al*., 2011). The way in which resource-dependent communities articulate and perceive climate change is often based on how English language terms are translated and understood in the local language (Rudiak-Gould, 2012). Furthermore, information is interpreted through personal lifestories life stories and culture (Kuruppu and Liverman, 2011). Local perceptions of what kind of knowledge is trustworthy may in fact lead to questioning of scientific findings (Ingram *et al*., 2002; Burns *et al*., 2010; Roncoli *et al*., 2011). Table 12-2 illustrates different dimensions in which climate change is interpreted and against which human security is affected.

Culturally embedded perceptions of climate change may either facilitate or hinder adaptation with implications for human security (Zamani *et al*., 2006; Burningham *et al*., 2008; West and Hovelsrud, 2010; Rudiak-Gould, 2012; Gómez-Baggethun *et al*., 2012; Nursey-Bray *et al*., 2012). Scientific information on weather variability and change is framed through cultural practices that can both enable (Dannevig *et* al., 2012) and constrain (Roncoli, 2006) adaptation. There are a number of anthropological studies that document how some cognitive frames do not perceive a changing climate and hence the concept of climate change itself does not have cultural resonance, whether or not the parameters of climate have been observed (Rudiak-Gould, 2012; Kuruppu and Liverman, 2011; Sánchez-Cortés and Chavero, 2011; Lipset, 2011; Hovelsrud *et al*., 2013). Most of these studies conclude that climate policies do not have legitimacy and salience when they do not consider how individual behaviour and collective norms are embedded in culture (Stadel, 2008; Jacka, 2009).

[INSERT TABLE 12-2 HERE
Table 12-2: Cultural dimensions of climate science, policy, impacts, and extreme events in the context of climate change.]

There is a significant body of research that analyses community and collective action for adaptation and generally finds positive outcomes. Many studies conclude that community-led action is effective for reducing risks and building capacity for adaptation (Davidson *et al*., 2003; Catto and Parewick, 2008; Harries and Penning-Rowsell, 2011; Gero *et al*., 2011; Fazey *et al*., 2010; Furgal and Seguin, 2006; Sudmeier-Riuex *et al.,* 2012; Anik and Khan, 2012; Adler, *et al*., 2012). Specifically, this literature finds that community participation in risk and vulnerability assessments produces more sustainable solutions (Ardalan *et al*., 2010; Gero *et al*., 2011) and that co-management of resources and learning increase adaptive capacity (Fazey *et al*., 2010; Armitage *et al.,* 2011; Dumaru, 2010; Ford *et al*., 2007). Much of this literature recognises, however, the structural barriers to community-led action and limited participation that can hinder effective community adaptation to climate change (Singleton, 2000; Davidson *et al*., 2003; King, 2008; Ensor and Berger, 2009; Nielsen and Reenberg, 2010; Onta and Resurrection, 2011). Further studies highlight barriers to widespread community responses that result from colonial history (Marino, 2012) and from political and economic globalization (Keskitalo, 2009; O'Brien *et al*., 2004).

12.3.2. Indigenous Peoples

There are around 400 million indigenous people worldwide (see Glossary for an inclusive definition), living under a wide range of social, economic and political conditions and locations (Nakashima *et al*., 2012). Indigenous peoples represent the world's largest reserve of cultural diversity and the majority of languages (Sutherland, 2003). Climate change poses challenges for many indigenous peoples, including to post-colonial power relations, cultural practices, their knowledge systems and adaptive strategies. For example, the extensive literature on the Arctic shows that changing ice conditions pose risks in terms of access to food and increasingly dangerous travel conditions (Ford *et al*., 2008; Ford *et al*., 2009; Hovelsrud *et al*., 2011; Chapter 28.4.1). Accordingly, there is a strong research tradition on the impacts of climate change in regions with substantial indigenous populations that focuses on indigenous peoples and their attachment to place. Most studies focus on local, traditional, and rural settings (Cameron, 2012) and hence have been argued to create a knowledge gap regarding new urban indigenous populations. Indigenous peoples are often portrayed in the literature as victims of climate change (Salick and Ross, 2009) and as vulnerable to its consequences (ACIA, 2005). However, traditional knowledge is increasingly being combined with scientific understanding to facilitate a better understanding of the dynamic conditions of indigenous peoples (Huntington 2011; Section 12.3.4).

There is a *high agreement* that, historically, indigenous peoples have had a high capacity to adapt to variable environmental conditions. This literature also suggests indigenous peoples also have less capacity to cope with rapidly changing socio-economic conditions and globalization (Tyler *et al.,* 2007; Crate and Nuttall, 2009). Documented challenges for indigenous cultures to adapt to colonization and globalization may reflect resilience and the determination of indigenous peoples to maintain cultures and identities. Furthermore, historical legacies affect the way that indigenous populations adapt to modern challenges: anthropological research has documented clear linkages between historical colonization and the way the way indigenous peoples respond to current climatic changes (Salick and Ross 2009; Cameron 2012; Howitt et al 2012; Marino, 2012).

Most of the literature in this area emphasizes the significant challenge of maintaining cultures, livelihoods and traditional food sources under the impacts climate change (Crate and Nuttall, 2009; Rybråten and Hovelsrud, 2010; Lynn *et al*., 2013). Examples from the literature show that traditional practices are already under pressure from multiple sources, reducing the ability of such practices to effectively respond to climate variability (Green *et al*., 2010). Empirical evidence suggests that the efficacy of traditional practices can be eroded when governments relocate communities (Hitchcock, 2009; McNeeley, 2012; Maldonado *et al*., 2013); if policy and disaster relief creates dependencies (Wenzel, 2009; Fernández-Giménez *et al.,* 2012); in circumstances of inadequate entitlements, rights and inequality (Shah and Sajitha, 2009; Green *et al*., 2010; Lynn *et al*., 2013); and when there are constraints to the transmission of language and knowledge between generations (Forbes, 2007). Some studies show that current indigenous adaptation strategies may not be sufficient to manage the projected climate changes (Wittrock *et al*., 2011).

Assessments of the cultural implications of climate change for human security illustrate similarities across indigenous peoples. Indigenous peoples have a right to maintain their livelihoods and their connections to homeland and place (Howitt *et al.,* 2012) and it is suggested that the consequences of climate change are challenging this right (Box 12-1; Crate and Nuttall, 2009). Some raise the question whether the western judicial system can uphold indigenous rights in the face of climate change (Williams, 2012) and that there is a need for justice that facilitates adaptation (Whyte, 2013). Additionally, there are uneven societal consequences related to climate change impacts (for example, use of sea ice - Ford *et al*., 2008)), which adds complexity to adaptation in indigenous societies. Heterogeneity within indigenous groups and differentiated exposure to risk has been found in other contexts, for example, in pastoralist groups of the Sahel (Barrett *et al*., 2001).

Much research on indigenous peoples concludes that lack of involvement in formal, government decision-making over resources decreases resilience: the literature recommends further focus on indigenous perceptions of risk and traditional knowledge of change, hazards and coping strategies and collective responses (Ellemor, 2005; Brown, 2009; Finucane, 2009; Turner and Clifton 2009; Sánchez-Cortés and Chavero, 2011; Maldonado *et al*., 2013). While providing economic opportunities, tourism development and industrial activities are particular areas of risk for indigenous peoples when they are not involved in decision-making (Petheram *et al*., 2010). Lack of formal participation in international negotiations may pose risks for indigenous peoples because their perspectives are not heard (Schroeder, 2010). However, there are examples of successful indigenous lobbying and advocacy, as in the case of managing persistent organic pollutants and heavy metals in the Arctic (Selin and Selin, 2008).

12.3.3. Local and Traditional Forms of Knowledge

There is *high agreement* among researchers that involvement of local people and their local, traditional, or indigenous forms of knowledge in decision-making is critical for ensuring human security (Ellemor, 2005; Kesavan and Swaminathan, 2006; Burningham *et al*., 2008; Mercer et al., 2009; Pearce et al., 2009; Anik and Khan, 2012). Such forms of knowledge include categories such as traditional ecological knowledge, indigenous science and ethnoscience (Nakashima and Roué, 2002). Collectively they are defined as ‘a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations’ (Berkes 2012: 7). In addition to reasserting culture, identity and traditional values, such forms of knowledge are experiential, dynamic and highly context dependent, developed through interactions with other forms of knowledge (Ford *et al*., 2006; Orlove *et al.,* 2010; Sánchez-Cortés and Chavero, 2011; Eira *et al*., 2013).

The conclusion of much anthropological studies in this area is that there is *robust evidence* that mutual integration and co-production of local and traditional and scientific knowledge increase adaptive capacity and reduce vulnerability (Kofinas, 2002; Oberthür *et al*., 2004; Tyler *et al*., 2007; Anderson *et al*., 2007; Vogel *et al*., 2007; West *et al*., 2008; Armitage *et al*., 2011; Frazier *et al*., 2010; Marfai *et al*., 2008; Flint *et al*., 2011; Ravera *et al.,* 2011; Nakashima *et al*., 2012; Eira *et al*., 2013). Local and traditional knowledge about historical changes, events and adaptation strategies are valuable for evaluating contemporary responses to environmental and social change and policy (Angassa and Oba, 2008; Desta and Coppock, 2004; Eira *et al.,* 2013; Ford *et al*., 2008; Lefale, 2010; Osbahr *et al*., 2010; Orlove *et* al., 2000; Fernández-Giménez, *et al.,* 2012). Traditional knowledge contributes to mitigating the impact of natural disasters (Rautela, 2005), maintaining domestic biodiversity (Emperaire and Peroni, 2007) and developing sustainable adaptation and mitigation strategies (Nyong *et al*., 2007; Adler *et al*., 2012). A study of Borana indigenous pastoralists, for example, documented how loss of technical and organizational practices contributed to progressive land degradation, erosion of social structures and poverty (Homann *et al*., 2008). Local and traditional knowledge is also applied in folk forecasting of weather and has been shown to be mutually reinforcing with scientific forecasts of weather at different timescale (Orlove *et al*., 2000; Nyong *et al*., 2007; Tyler *et al*., 2007; Gearheard *et al*., 2010; Hovelsrud and Smit, 2010;).

Despite recognition in studies of the value of local and traditional knowledge, such knowledge is most often not included in adaptation planning (Tàbara *et al*., 2003; King *et al*., 2007; Ifejika Speranza *et al*., 2008; Huntington, 2011). There are many challenges in managing, utilizing, acknowledging and incorporating local and traditional knowledge (Huntington, 2011). Such knowledge is often generated and collected through participatory approaches, an approach that may not be sufficient because of the cultural and social dynamics of power and interpretation (Roncoli *et al*., 2011). Local and traditional knowledge itself may have its limits. Some studies suggest that local or traditional knowledge may not be sufficient to provide the proper response to unexpected or infrequent risks or events (Nunn, 2000; Burningham *et al*., 2008; Kuhlicke, 2010).

There is also concern, documented in many anthropological studies, that indigenous and traditional knowledge is itself under threat. If local or traditional knowledge is perceived to be less reliable because of changing environmental conditions (Ingram *et al*., 2002; Ford *et al.,* 2006) or because of extreme or new events that are beyond the current local knowledge and cultural repertoire (Valdivia *et al*., 2010; Hovelsrud *et al.,* 2010a), then community vulnerability and the vulnerability of local or traditional knowledge itself, may increase (Kalanda-Joshua *et al.,* 2011). New conditions may require new knowledge to facilitate and maintain flexibility and improving livelihoods (see also Homann *et al*., 2008). Kesavan and Swaminathan (2006) documented how societal and environmental conditions have changed to the point at which local knowledge is supplemented with new technologies and new knowledge in coastal communities in India. A study in the Himalayas found that erosion of traditional knowledge occurs through government regulations of traditional building materials and practices (Rautela, 2005). The social cohesion embedded in such practices is weakened because of a move towards concrete construction which changes the reliance on and usefulness of traditional knowledge about wood as a building material (Rautela, 2005).

12.4. Migration and Mobility Dimensions of Human Security

12.4.1. Impacts of Climate Change on Displacement, Migration, and Mobility

12.4.1.1. Nature of Evidence on Climate Change and Migration

This Section details how some existing migration systems may be significantly disrupted by impacts of climate change in a number of important dimensions. This finding comes from a very significant new body of observational and theoretical research in the past five years, as the migration and mobility dimensions of the impacts of climate change and the central role of mobility in adaptation has become apparent (Afifi and Jäger, 2010; Piguet *et al*., 2011; Foresight, 2011; Serrano-Oswald *et al*., 2013). As with other elements of human security, the dynamics of interaction of mobility with climate change are multi-faceted and direct causation is difficult to establish.

The major findings of this emerging science demonstrate the multiple drivers of migration; show the role of displacement of populations from extreme weather events; and highlight the governance challenges of displaced peoples and the challenges of migration for urban sustainability (Foresight, 2011; Seto, 2011; Black *et al*., 2011a, 2011c; White, 2011a; Parnell and Walawege, 2011; Geddes *et al*., 2012). Studies have derived these findings through multiple methods and lines of evidence including statistical inference to explain observed migration patterns using climate or related impacts as independent variables; sample surveys of migrant motivations and behavior; modeling techniques; and historical analogies (McLeman and Hunter, 2010; Piguet, 2010; Warner, 2011; Warner and Afifi, 2013; Oswald-Spring, 2013).

Migration in this Chapter is defined in terms of temporal and spatial characteristics: it is a permanent or semi-permanent move by a person of at least one year that involves crossing an administrative, but not necessarily a national, border (Brown and Bean, 2005). Permanent migration as well as temporary and seasonal migration, are prevalent in every part of the world, driven by economic and other imperatives. The most significant contemporary overall trend in migration continues to be major movements of people from rural to urban settlements. The proportion of the global population that is urban has risen from 10 percent in 1900 to over 50 percent in 2009 and is projected to reach 59 percent by 2030 (Grimm *et al*., 2008). Around 80 percent of all migration is presently within countries (UNDP 2009). Existing global migration trends mapped onto ecological zones by de Sherbinin *et al.*

(2012) show that the past four decades have seen out-migration from mountain regions and from drylands. Net migration to coastal zones is estimated as having been over 70 million people in the 1990-2000 census period.

12.4.1.2. Potential Pathways from Climate Change to Migration

Extreme weather events provide the most direct pathway from climate change and migration. It is widely established that extreme weather events displace populations in the short term because of their loss of place of residence or economic disruption. Only a proportion of displacement leads to more permanent migration (Foresight, 2011; Hallegatte, 2012). Much of the literature, such as reviewed in the IPCC SREX report, concludes that an increasing incidence and changing intensity of extreme weather events due to climate change, will lead directly to the risk of increased levels of displacement.

The evidence on displacement as a result of weather-related events suggests that most displaced people attempt to return to their original residence and rebuild as soon as practical. The Pakistan floods of 2010 for example caused primarily localised displacement for large numbers of people across a wide area (Gaurav *et al.*, 2011), rather than longer-distance migration. Structural economic causes of social vulnerability may determine whether temporary displacement turns into permanent migration. In New Orleans, after Hurricane Katrina, for example, economically disadvantaged populations were displaced in the immediate aftermath and most (?) have not returned (Myers *et al.*, 2008; Mutter, 2010). Fussell *et al.* (2010) found that 14 months after the event, African American residents returned more slowly, because they had suffered greater housing damage. Studies conclude that displacement affected human security through affecting housing, economic and health outcomes and that these have perpetuated the initial impact into a chronic syndrome of insecurity (Adams et al., 2009; Hori and Shafer, 2010). Furthermore, there are well-documented gender differences in displacement from extreme events, especially when women lose their social networks or their social capital, and women are often affected by adverse mental health outcomes in situations of displacement (Tunstall *et al.*, 2006; Oswald-Spring, 2008; Hunter and David, 2011).

Therefore, extreme weather events are not necessarily associated with displacement and can also be associated with immobility or in-migration. Changing economic structures can shape the ability of affected populations to cope with extreme weather without being displaced. While the poorest households in Honduras were hardest hit by Hurricane Mitch in 1990 (Glantz and Jamison, 2000; McLeman and Hunter 2010; McSweeney and Coomes, 2011), they were found to be less vulnerable to storms a decade later due to changes in land tenure and better early warning systems (Villagrán, 2011, 2011a). Paul (2005) found that there was little displacement in Bangladesh following floods and that residents perceived an influx of migrants due to the reconstruction.

It is well established in demography that while migration is a common strategy to deal with livelihood risk, movement is costly and disruptive and hence may only be used as an adaptation of last resort (McLeman, 2009). Hurlimann and Dolnicar (2011) showed for eight Australian settlements experiencing long term drought that relocation and migration was perceived to be the least desirable adaptation. Marshall *et al.* (2012) similarly showed that place attachment dominated decision-making and reluctance to undertake relocation of farming communities. Haug (2002) showed that pastoralists displaced due to drought in Sudan in the 1990s attempted to return to their previous settlements after the drought, notwithstanding conflict and other factors. McLeman and Hunter (2010) reviewed historical cases of displacement migration and concluded that non-migration or rapid return significantly outweighs permanent migration following hurricane impacts in the Caribbean, Dust Bowl migration in the 1930s USA, or dry season migration in the West African Sahel.

A further strand of evidence shows social differentiation in access to the resources necessary to migrate influences migration outcomes (Renaud *et al.*, 2011; Black *et al.*, 2013). Vulnerability is inversely correlated with mobility, leading to those being most exposed and vulnerable to the impacts of climate change having the least capability to migrate (Figure 12-1). Therefore, climate change risks can be significant when they reduce and constrain opportunities to move (Black *et al.*, 2013). Alternatively, the most vulnerable households are able to use migration to cope with environmental stress, but their migration is an emergency response that creates conditions of debt and increased vulnerability, rather than reducing them (Warner and Afifi, 2013). Table 12-3 summarises studies on the migration outcomes of weather extremes and long-term environmental change. It shows that some events lead to increased displacement of populations; while others lead to reduce mobility. Table 12-3 also demonstrates that, in many circumstances, members of a population will display differentiated migration outcomes on the basis of ethnicity, wealth or gender (Elliot and Pais, 2006; Gray and Mueller, 2012; Upton, 2012).

[INSERT FIGURE 12-1 HERE
Figure 12-1: Relationship between vulnerability to environmental change and mobility showing that populations most exposed and vulnerable to the impacts of climate change may have least ability to migrate. Source: Adapted from Black *et al.,* 2013.]

There is some evidence that climate changes, through impacts on productivity, can lead to reductions in migration flows. Studies in Table 12-3 highlight that some longer distance migration is reduced by drought in pastoral systems (Findley, 1994; van der Geest, 2011; Sánchez *et al*., 2012). Drought was also found to reduce migration in other systems. Henry *et al*. (2004) confirmed in a multi-year study of Burkina Faso that the movement to other rural areas increased in dry years, but long distance or international migration was limited to years of high agricultural productivity. Pioneer migration to urban centres, long distance migration and international migration require significant human and financial capital and hence is restricted to wealthier populations or to time periods where the household has sufficient resources. However, in some contexts drought can lead to increased migration – often short term and short distance migration. Kniveton *et al*. (2011, 2012) modeled migration movements from the 1980s in Burkina Faso and project that future scenarios of decreased rainfall would increase rates of out-migration from rural areas.

[INSERT TABLE 12-3 HERE
Table 12-3: Empirical evidence on observed or projected mobility outcomes (migration, immobility, or displacement) associated with weather-related extremes or impacts of longer-term climate change.]

Whether or not negative environmental change influences the decision to migrate; migrant populations may be exposed to more hazardous climatic conditions in their new destinations (Black *et al*., 2011a). There is some evidence that new migrants are more at risk in destination areas such as cities. Low-income migrants, as well as being socially excluded, cluster in high-density areas that are often highly exposed to flooding and landslides, with these risks increasing with climate change (Chatterjee, 2010; Fox and Beall, 2012; McMichael *et al*., 2012). Migrants in Buenos Aires, Lagos, Mumbai and Dakar (Chatterjee, 2010; World Bank, 2010; Mehrotra *et al*., 2011) more often live in hazardous locations than long-term residents. In Dakar, 40 percent of new migrants in the decade till 2008 resided in areas with high flood risk. Wang *et al*. (2012) found that migrants had less knowledge about typhoon risks in Shanghai. Tompkins *et al*. (2009) showed that new migrants in the Cayman Islands are most vulnerable to tropical cyclones as they are least likely to prepare for cyclones, live in locations with high exposure to cyclone impacts, and interact mostly with expatriates without previous cyclone experience. There is no established evidence that rapid urbanization itself is a source of conflict: Buhaug and Urdal (2013) test hypotheses on social disorder and population growth in 55 cities in Africa and find that rapid growth of city populations does not drive urban unrest.

12.4.1.3. Migration Trends and Long-Term Climate Change

Long-term environmental change, sea-level rise, coastal erosion, and loss of agricultural productivity (Table 12-3) will have a significant impact on migration flows (Lilleor and Van den Broeck, 2011). The evidence in this area comes from simulation studies of future migration flows and permanent displacement. Barbieri *et al*. (2010) estimated emigration rates in Brazil from affected rural areas and found that de-population occurs with relatively modest rates of warming. In their scenarios the biggest increase in migration comes from productive agricultural areas that support a large labour force. Mendelsohn *et al*. (2007) concluded that in dryland Brazil urban migration is *very likely* due to agricultural income loss.

Longer term environmental change caused by climate change also amplifies existing trends such as rural to urban migration, though results diverge on the importance of climate change and resource scarcity in driving such trends. Modelling studies with future projections on Mexico-US migration rates (Feng *et al*., 2009), and on Brazilian internal migration (Barbieri *et al*., 2011) show that projections of drying increase emigration in established migration routes and de-population of rural areas (Oswald-Spring *et al*., 2013). Barrios *et al*. (2006) showed that observed rainfall declines in areas of sub-Saharan Africa explain part of the differences in urbanization rates across countries, with periods of rainfall decline increasing urbanization in sub-Saharan Africa, but the urbanization is also explained by simultaneous economic liberalization and policy change.

Sea level changes have been projected to lead to permanent displacements as coastal areas become uninhabitable. Curtis and Schneider (2011), for example, project 12 million people to be displaced by sea-level rise by 2030 in four major coastal areas in the US. Nicholls *et al*. (2011) estimate permanent displacements based on potential sea-level changes till 2100 (see Chapter 5.5.7). A 0.5m sea-level change implies a *likely* land loss of 0.877 million km^2 by 2100, displacing 72 million people, with no adaptation investment; with a 2.0 m sea- level change, 1.789 million km^2 would be lost, displacing 187 million people, or 2.4 percent of global population, mostly in Asia. If governments undertook adaptation investments in all coasts (e.g. building protective dikes), then the study suggests very low levels of people displaced under the 0.5 m scenario and a population of less than half a million displacement under the 2.0 m sea level rise scenario. Hallegatte *et al*. (2011) and Seto (2011) show that such protection measures are *very likely* as the cost of not investing in protecting urban land and infrastructure is much greater, especially for major urban centres.

Even in areas under threat from long-term climate change and sea-level rise, observations show that populations at risk do not always choose to migrate. For example, a series of studies have sought to explain population stability in low-lying island nations. Mortreux and Barnett (2009) found that migration from Tuvalu was not driven by perceptions of climate change and that, despite forecasts that the island could become uninhabitable, residents have remained for reasons of culture and identity. Shen and Gemenne (2011) concur that both Tuvalu residents and migrants from Tuvalu did not cite climate change as a reason for the migration that occurs. Similarly, in the Peruvian Andes, Adams and Adger (2013) found that cultural ecosystem services and place attachment shape decisions not to migrate and hence populations persist despite difficult environmental conditions. However, these studies also find that environmental risks directly affect perceptions of well-being, cultural integrity and economic opportunities. They conclude that the impacts of climate change may be a more significant driver of migration in the future.

12.4.2. Migration as an Adaptation to Climate Change Impacts

Migration is a widely used adaptation strategy that reduces risks in highly vulnerable places, as demonstrated by a wide range of studies. Research drawing on experience of migration policy concludes that a greater emphasis on mobility within adaptation policies would be effective when undertaken in a sensitive manner (Bardsley and Hugo, 2010; Barnett and Webber, 2010; Warner, 2010; Gemenne, 2011). This emerging literature shows that migration can be promoted to successfully reduce risk, not least through remittance flows between sending and destination areas (Fox and Beall, 2012; Martin, 2012; Deshingker, 2012). The prospect of migration as an effective adaptation is recognized through its inclusion in the Cancun Accord of the UN Framework Convention on Climate Change (Warner, 2012).

With observed climate changes and projected changes in resource productivity and risks, various governments are engaged in planning to move settlements as part of adaptation strategies (de Sherbinin *et al*., 2011; Biermann, 2012). Scientific literature on these policies most often portrays resettlement as a failure of adaptation and a policy of last resort (Barnett and Webber, 2010; Fernando *et al*., 2010; Hugo, 2011). Most practice to date, learning from other resettlement programmes, demonstrates negative social outcomes for those resettled, often analysed as breaches in individual human rights (Bronen, 2011; Johnson, 2012; Arnall, 2013). There are some documented examples of settlements that are already planning for their own relocation, such as five indigenous communities in Alaska that have experienced increased erosion, loss of sea ice cover, and flooding over the past decades (Bronen, 2010). These settlements have undertaken planning for relocation and have received government funding for these processes. Bronen (2010) and Bronen and Chapin (2013) conclude that while the relocations are feasible, there are significant perceptions of cultural loss and related studies report psychological stress and community dislocation (Cunsolo-Wilcox *et al*., 2012, 2013). The studies argue that legitimacy and success depend on incorporating cultural and psychological factors in the planning processes (Bronen and Chapin, 2013). There is significant resistance to relocation, even where such options are well planned and have robust justifications, as demonstrated by Marino (2012) for relocation in Alaska.

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Box 12-4. Evidence on the Existence of Environmental Migrants and International Policy for their Protection

There is widespread agreement in the scientific and legal literature that the use of the term climate refugee is scientifically and legally problematic (Taccoli, 2009; Piguet, 2010; Black *et al.,* 2011a; Gemenne, 2011; Jakobeit and Methmann 2012; Bettini, 2013; Piguet, 2013). McAdam calls the concept 'erroneous as a matter of law and conceptually inaccurate' (McAdam, 2011, p. 102). The reasons are threefold. First, most migration and climate studies point to the environment as triggers and not causes for migration decisions. Second, some studies focus on the negative geo-political implications of changing the Geneva Convention on refugees to include environmental migrants as well as the lack of global instruments to handle internal displaced peoples or international migrants (Martin, 2009; Cournil, 2011). Third, many small island countries are reluctant themselves to have their international migrants designated as being victims of climate change (McNamara and Gibson, 2009; Farbotko, 2010; Barnett and O'Neill, 2011; Farbotko and Lazrus, 2012).

The arguments put forward for a specific legal instrument to deal with migrants who have been displaced as a direct result of climate change impacts include issues of rights, given such migration is imposed and involuntary (Bates, 2002; Bell, 2004); and the particular status of small island nations where displacement could affect sovereignty (Williams, 2008; Owens, 2008; Biermann and Boas, 2009). For international displacement and migration, there is a growing literature on practical adaptation and action: the existence of governance mechanisms to improve handling of currently displaced people, and the optimal design of such mechanisms in the future (e.g. Bryavan and Rajan, 2006; Williams, 2008; Biermann and Boas, 2009, Docherty and Giannini, 2009; Martin, 2009; McAdam, 2011). This literature focuses on strategies for adaptation, mitigation and resilience building, and concludes that significant adaptation may be required to protect and to empower internally or international migrants triggered by climate change.

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12.5. Climate change and Armed Conflict

12.5.1. Climate Change as a Cause of Conflict

In the past decade there has been a marked increase in research investigating the relationship between climate change and violent and armed conflict. This section assesses of the full spectrum of research using diverse methods and data that seeks to understand the relationship between climate change and armed conflict. Chapter 19 provides a more detailed assessment of those studies that seek to quantify the influence of climate factors on violence of all kinds, including personal violence. Chapter 19 defines the influence of climate facts on violence to be an emergent risk and a new focus of research. In this Chapter, armed conflicts are defined as those conflicts that involve more than 25 battle-related deaths in a year. This can include: interstate conflicts, intrastate conflicts that involve governments, non-state conflicts in which governments are not directly involved, and one-sided conflicts involving organised violence against civilians (Themnér and Wallensteen, 2012).

There is a specific research field that explores the relationship between large-scale disruptions in climate and the collapse of past empires. Relationships are explored using statistical analysis and data derived from archaeological and other historical records. For example, the timing of the collapse of the Khmer empire in the Mekong basin in the early 15th century corresponds to an unusually severe prolonged drought (Buckley *et al.,* 2010). DeMenocal (2001) summarizes evidence that suggests that major changes in weather patterns coincided with the collapse of several previously powerful civilizations, including the Anasazi, the Akkadian, Classic Maya, Mochica, and Tiwanaku empires. Other historical reference points of the interaction of climate with society emerge from analysis of the little

Ice Age. Some studies show that the Little Ice Age in the mid 17th century was associated with more cases of political upheaval and warfare than in any other period (Parker 2008, Zhang *et al.,* 2011), including in Europe (Tol and Wagner 2010), China (Brook 2010), and the Ottoman empire (White 2011b). These studies all show that climate change can exacerbate major political changes given certain social conditions, including a predominance of subsistence producers, conflict over territory, and autocratic systems of government with limited power in peripheral regions. The precise causal pathways that link these changes in climate to changes in civilizations are not well understood due to data limitations. Therefore, it should be noted that these findings from historical antecedents are not directly transferrable to the contemporary globalized world. The literature urges caution in concluding that mean future changes in climate will lead to large-scale political collapse (Butzer 2012).

Most of the research on the connections between climate change and armed conflict focuses on the connections between climate variability and intrastate conflicts in the modern era. For the most, part this research examines rainfall or temperature variability as proxies for the kinds of longer-term chances that might occur due to climate change. Several studies examine the relationship between short-term warming and armed conflict (Burke *et al*., 2009; Buhaug 2010; Koubi *et al*., 2012; Theisen *et al*., 2012; O'Loughlin *et al*., 2012). Some of these find a weak relationship, some find no relationship, and collectively the research does not conclude that there is a strong positive relationship between warming and armed conflict (Theisen *et al.,* 2013).

The large majority of studies focuses on Africa and use satellite-enhanced rainfall data collected since 1980. A global study by Hsiang *et al*. (2011) considers changes in climate over multiple years, and finds that since 1950 and in countries that are affected by ENSO the risk of war within countries rises during an ENSO period. This study is supported by some studies that find associations between deviations in rainfall and civil war (Miguel *et al*., 2004; Hendrix and Glaser 2007; Hendrix and Salehyan 2012; Raleigh and Kniveton 2012), but contradicted by others that find no significant association between droughts and floods and civil war (Buhaug 2010; Buhaug and Theisen 2012; Koubi *et al*. 2012; Theisen *et al*. 2012; Slettebak 2012). There is high agreement that in the specific circumstances where other risk factors are extremely low (such as where *per capita* incomes are high, and states are effective and consistent), the impact of changes in climate on armed conflict is negligible (Bernauer *et al.,* 2012; Koubi *et al*., 2012; Scheffran *et al.,* 2012a; Theisen *et al.,* 2013).

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Box 12-5. Climate and the Multiple Causes of Conflict in Darfur

Climate variability or climate change are popularly reported to be significant causes of the mass killing in the Darfur region that began in 2003 (see Mazo, 2009). Five detailed studies dispute the identification of the Darfur conflict as being primarily caused by climate change (Kevane and Gray, 2008; Brown, 2010; Hagen and Kaiser, 2011; Sunga, 2011; Verhoeven, 2011). They find that the violence in Darfur has multiple causes, notably:

- The legacy of past violence, which established groups that had a history of violent action and a supply of weapons;
- Manipulation of ethnic divisions by elites in Khartoum;
- Weakening of traditional conflict resolution mechanisms through government policies and as a consequence of famines;
- Systematic exclusion of local groups from political processes, including of the Fur, Masalit and Zaghawa ethnic groups;
- Limited economic development and inadequate provision of public services and social protection, stemming from governance and policy failures, political instability, and misuse of official development assistance.

All studies of this conflict agree that it is not possible to isolate any of these specific causes as being most influential (Kevane and Gray, 2008; Hagen and Kaiser, 2011; Sunga, 2011; Verhoeven, 2011). Most authors identify government practices as being far more influential drivers than climate variability, noting also that similar changes in climate did not stimulate conflicts of the same magnitude in neighboring regions, and that in the past people in Darfur were able to cope with climate variability in ways that avoided large scale violence.

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A growing body of research examines the connections between climate variability and non-state conflicts. There is some agreement that either increased rainfall and decreased rainfall in resource-dependent economies enhances the risk of localized violent conflict, particularly in pastoral societies in Africa (Benjaminsen and Ba, 2009; Benjaminsen *et al*., 2009; Adano et al*.,* 2012; Butler and Gates, 2012; Fjelde and von Uexkull, 2012; Hendrix and Salehyan, 2012; Raleigh and Kniveton, 2012; Theisen, 2012). In all such cases, the presence of institutions that are able to peacefully manage conflict are highlighted as the critical factors in mediating such risks (Gausset, 2005; Hidalgo *et al.,* 2010; Adano *et al.,* 2012; Benjaminsen *et al*., 2012, Butler and Gates, 2012, O'Loughlin *et al.,* 2012, Theisen, 2012).

In response to the challenges of finding direct associations between changes in climate and violence, some research has examined the effects of changes in climate on factors that are known to increase the risk of civil war (Bergholt and Lujala, 2012, Koubi *et al.,* 2012). Civil war has been studied extensively using quantitative and qualitative techniques, and there is high agreement about factors that increase the risk of civil war, namely: a recent history of civil violence, low levels of *per capita* income, low rates of economic growth, economic shocks, inconsistent political institutions, and the existence of conflict in neighboring countries (Miguel *et al*.,2004, Weede, 2004; Hegre and Sambanis, 2006; Dixon, 2009; Blattman and Miguel, 2010; Brückner and Ciccone, 2010). Nevertheless, almost all studies note the need for convincing theories that explain these associations.

Many of the factors that increase the risk of civil war and other armed conflicts are sensitive to climate change. For example, Chapter 10 shows that climate change will slow rates of economic growth and impede efforts to grow *per capita* incomes in some low income countries, particularly in Africa where the risk of conflict is highest (Mendelsohn *et al*., 2000, Mendelsohn *et al.,* 2006, Stern, 2007, Eboli *et al*., 2010). Extreme events, which may become more intense due to climate change, can also produce economic shocks (Bergholt and Lujala, 2012; Hallegatte, 2012; Adam, 2013), although the direct association between disasters and armed conflict is contested (Pelling and Dill, 2010; Bergholt and Lujala, 2012; Slettebak, 2012). Studies have inferred that climate change can undermine the consistency of institutions that provide public goods (Barnett and Adger, 2007; Scheffran *et al*., 2012b) and hence weaken states and increase conflict risks. However, there is some evidence that under certain circumstances, disasters can provide critical opportunities to build peace in conflict settings and to improve governance institutions (Kingsbury, 2007; Olson and Gawronski, 2010; Bruckner and Ciccone, 2011).

In summary, there is justifiable common concern that climate change or changes in climate variability increases the risk of armed conflict in certain circumstances (Bernauer *et al.,* 2012; Gleditsch, 2012; Scheffran *et al.,* 2012; Hsiang *et al*., 2013), even if the strength of the effect is uncertain. This concern is justified given robust knowledge of the factors that increase the risk of civil wars, and medium evidence that some of these factors are sensitive to climate change. There is also general agreement in the literature that there is a need for theories and data that explain the processes that lead from changes in climate to violence; for example on how formal and informal institutions that help avoid violent outcomes (Barnett and Adger, 2007; Scheffran and Battaglini, 2011; Buhaug and Theisen, 2012, Gleditsch, 2012; Murtinho and Hayes, 2012). Confident statements about the effects of future changes in climate on armed conflict are not possible given the absence of generally supported theories and evidence about causality (see Box 12-5).

12.5.2. Conflict and Insecurity Associated with Climate Policy Responses

Research is beginning to show that climate change mitigation and adaptation actions can increase the risk of armed conflict, as well as compound vulnerabilities in certain populations (Bumpus and Liverman, 2008; Adger and Barnett, 2009; Webersik, 2010; Fairhead *et al.,* 2012; Marino and Ribot, 2012; Steinbruner *et al*., 2012). This is based on robust evidence that violent political struggles occur over the distribution of benefits from natural resources (Peluso and Watts, 2001). Hence, in circumstances where property rights and conflict management institutions are ineffective or illegitimate, efforts to mitigate or adapt to climate change that change the distribution of access to resources have the potential to create and aggravate conflict.

Actions taken in response to climate change can aggravate existing significant inequalities or grievances over resources (Marino and Ribot, 2012), limit access to land and other resources required to maintain livelihoods, or otherwise undermine critical aspects of human security (Bumpus and Liverman, 2008, Fairhead *et al.,* 2012). Maladaptation or greenhouse gas mitigation efforts at odds with local priorities and property rights may increase the risk of conflict in populations, particularly where institutions governing access to property are weak, or favour one group over another (Barnett and O'Neill, 2010; Butler and Gates, 2012, McEvoy and Wilder, 2012). Research on the rapid expansion of biofuels production includes studies connecting land grabbing, land dispossession, and social conflict (Molony and Smith, 2010; Borras *et al.,* 2010; Dauverge and Neville, 2010; Vermeulen and Cotula, 2010). One study has identified possible links between increased biofuels production, food price spikes, and social instability such as riots (Johnstone and Mazo, 2011).

The provision of financial resources in payment for ecosystem services projects, such as are associated with Reduced Emissions from Deforestation and Forest Degradation (REDD), has the potential to stimulate conflict over resources and property rights (Melick, 2010). For example, efforts to ensure 'REDD readiness' in Tanzania (Beymer-Farris and Bassett, 2012; 2013; Burgess *et al*., 2013) and the Congo basin (Brown *et al.,* 2011) have been contested, and placed communities in conflict with conservationists and governments. Eriksen and Lind (2009) similarly find that climate change adaptation interventions in Kenya have aggravated surrounding conflicts.

Climate change mitigation will increase demand for deployment of less carbon-intensive forms of energy, including hydropower some of which have historically resulted in social conflict and human insecurity (for example because of forced resettlement), and this is a basis for concern about increased violence and insecurity in the future (Conca, 2005; McDonald-Wilmsen *et al*., 2010; Sherbinin *et al.,* 2011). Other research points to an increased use of nuclear power increasing the threat of nuclear proliferation or incidents of nuclear terrorism (Socolow and Glaser, 2009, Steinbruner *et al*., 2012). Climate policy responses also have the potential to reduce conflict in various ways, as explained further in Section 12.5.4.

12.5.3. Violent Conflict and Vulnerability to Climate Change

Many of the capacities required to adapt to climate change are threatened by ongoing or recent armed conflict (Barnett, 2006, Brklacich *et al.,* 2010). There is a strong body of evidence from development studies and political science that violent conflict undermines human security and the capacity of individuals, communities and states to cope with changes (Stewart and Fitzgerald, 2001; Blattman and Miguel, 2010). These observations suggest, with *high confidence*, that where violent conflict emerges and persists the capacity to adapt to climate change is reduced for affected populations. This is illustrated in Figure 12-2 shows that post-conflict societies have low adaptive capacity, where human development acts as a proxy for its status (Barnett, 2006; Lind and Eriksen, 2006; Eriksen and Lind, 2009; Adger, 2010).

[INSERT FIGURE 12-2 HERE
Figure 12-2: Conflict and post-conflict societies exhibit low levels of governance and human development. Data based on UNDP Human Development Index and World Bank index on Governance effectiveness. Source: Adapted from Adger, 2010.]

Armed conflict disrupts markets and destroys infrastructure, limits education and the development of human capital, causes death and injury to workers, and decreases the ability of individuals, communities and the state to secure credit (Stewart *et al.,* 2001; Goodhand, 2003; Blattman and Miguel, 2010). Conflict thus creates poverty and constrains livelihoods: that in turn increases vulnerability to the impacts of climate change (Nigel, 2009; Deng, 2010a, Hilson and van Bockstael, 2011). Thus, violent conflict is a major cause of hunger and famines (de Waal, 1993, Messer and Cohen, 2011, Rowhani *et al.,* 2011). Armed conflict interrupts the ability of resource dependent individuals and communities to access natural resources (Pike, 2004; Detraz, 2009; Kolmannskog, 2010; Raleigh, 2011), and in so doing limits their capacity to adapt to climate change. The denial of strategic space as a tactic in armed conflict (through for example, deliberate destruction of crops and spreading of landmines in conflict affected regions) can reduce the capacity of individuals and communities to access natural capital and hence cope with climate variability (Berhe, 2007; Unruh, 2011).

A parallel body of research documents spiraling negative feedbacks where armed conflict reduces access to ecosystem goods and services, that can lead to inefficient use of natural resources and hence to further environmental degradation. Chronic political instability in Zimbabwe, is, for example, implicated in high levels of illegal bush meat hunting (Lindsey *et al.,* 2011). Conflict, and the displacement of large populations, can also alter the abundance and distribution of biodiversity and can result in significant deforestation (Chase and Griffin, 2011; Lindsell *et al.,* 2011; Stevens *et al.,* 2011).

The capacity for collective action is a critical determinant of the capacity to adapt to climate impacts, and this too can be undermined by violent conflict, depending on the nature of violence and the strategies households adapt in response (Deng, 2008, 2010b). When conflict exacerbates existing horizontal inequalities between ethnic or religious groups, foments distrust in local or government institutions, or isolates individuals and households, the social capital that is important for adapting to climate change is also degraded (Bogale and Korf, 2007). Conflict-related displacement also disrupts social networks and makes it difficult to achieve elements of secure livelihoods, such as marriage, access to land, or access to communal social safety nets (Kolmannskog, 2010; Raleigh, 2011). In situations of violent conflict, efforts to address climate change that provide financial or resource flows that can be captured by local elites or illegitimate institutions, may compound divisions and exacerbate grievances (Brown *et al.,* 2011; Verhoeven, 2011).

Armed conflict can decrease the capacity of governments to function effectively, which in turn impedes adaptation (Tignino, 2011; Feitelson *et al.,* 2012). For example, research has shown that chronic political conflict has reduced the ability of governance institutions at many scales to effectively manage water resources in the Gaza Strip (Shomar, 2011), parts of the Balkans (Skoulikidis, 2009), and the Middle East (Zeitoun *et al*., 2012). Instability has affected planning process around urban land use in Palestine (Raddad *et a*l., 2010) and in regions of Iraq (Hassan, 2010). Armed conflict may also undermine the ability of states to prevent and respond to natural disasters and humanitarian crisis (Keen, 2008). A lack of trust in government commitment or capacity to respond, the presence of police or military forces that lack legitimacy, or recent conflict between government and local forces, hampers the ability of these institutions to provide effective relief (Wisner, 2001).

12.5.4. Peace-Building Activities in Promoting Adaptation

In situations where conflict is resources based, it is widely established that resource management has significant potential to contribute to conflict management by channeling competing interests over resources into non-violent resolutions (Conca and Dabelko, 2002; Conca and Wallace, 2009; Lujala and Rustad, 2011; Jensen and Lonergan, 2013). This research on environmental peacebuilding and peacemaking considers that natural resource management, and by extension climate change adaptation, can help build peace to avoid conflicts, and broker peace in conflict situations (Tanzler *et al*., 2010).

Research on bilateral and multilateral interactions between two or more states from 1948 to 2008 shows strong evidence of significant formal cooperation among river basin riparian states, and no cases of water causing two states to engage in war (Wolf *et al.,* 2003; Wolf, 2007; De Stefano *et al.,* 2010). Transboundary water cooperation, particularly joint management, flood control, and technical cooperation, can form a basis for longer-term cooperation on a range of contentious issues. Efforts at basin-wide institutional development to lower conflict potential focuses on moving from the assertion of conflicting rights to water; to addressing the multiple values of water; and ultimately to sharing benefits across national boundaries (Sadoff and Grey, 2002).

There is an emerging body of evidence about the effectiveness of efforts to enhance cooperation and lower conflict around natural resources (Lujala and Rustad, 2011; Jensen and Lonergan, 2013). Some transboundary conservation areas, referred to as ‘peace parks’, are designed to reduce conflict and enhance cooperation across borders. The evidence of the effectiveness of peace parks is limited and ambiguous, with some studies documenting political, economic and conservation cooperation (Ali and Marton-LaFevre, 2007), but others document conflict generation between local communities, elites, and states (Duffy, 2002).

12.6. State Integrity and Geopolitical Rivalry

Climate change will affect the integrity of states through impacts on critical infrastructure, threats to territorial integrity, and geopolitical rivalry (Gilman *et al*., 2011). These infrastructure and geopolitical impacts directly affect state capacities to provide a range of ecological, economic, social, and political services that fundamentally contribute to human security (Barnett, 2003; Busby, 2008; Barnett *et al*., 2010; Webersik, 2010).

12.6.1. Critical Infrastructure and State Capacity

Climate change and extreme events are projected to damage a range of critical infrastructure, with water and sanitation, energy, and transportation infrastructure being particularly vulnerable (Chapter 8.2.4; Rozenzweig *et al*., 2011; UN Habitat, 2011). Climate change is expected to exacerbate water supply problems in some urban areas that in turn pose multiple risks to cities. For example the high temperature and low rainfall events that can cause a decline in the supply of water to cool power plants are those that simultaneously increase energy demand for cooling, threatening to disrupt power supply and information and communications technology. In areas where there may be flooding or increased snow and ice storms, critical infrastructure may be damaged (see Chapter 8.2.3). Areas that are vulnerable to flooding, landslides or forest fires will have greater risk of such infrastructure damage (Revi, 2005; Awuor *et al*., 2008; Adelekan, 2010; Keywood *et al*, 2013).

Climate change impacts on critical infrastructure will reduce the ability of some states to provide social and public services (see Chapter 8.2.4.6). For example, power outages stemming from water shortages or storms can in turn lead to reductions in service delivery from hospitals, police forces and emergency responders. Damage to roads, rails, airports, bridges and related transport infrastructure can similarly reduce the ability of governments to provide for citizen needs. The impact of thawing permafrost on infrastructure will affect the viability of settlements in high latitudes (Chapter 28.2.4.2; Chapter 28.3.4.3; Larsen *et al*., 2008; Marino, 2012; Dersken *et al*., 2012). In countries that are poor or that depend heavily on climate-sensitive activities such as agriculture, climate impacts are expected to lead to significant declines in income and in turn government revenues. Mideksa (2010) estimates that climate change impacts will reduce Ethiopia's GDP by nearly ten percent.

12.6.2. Geopolitical Issues

Analysis of the actions of states and security institutions show that many states view current and anticipated climate changes as contributing to geopolitical concerns (Dabelko, 2009; Smith, 2011). The ability of states to share resources and provide human security is challenged by climate change impacts. Climate change impacts can create contested claims to territory on land and at sea and, in extreme cases, can threaten the territorial integrity or viability of states (Barnett and Campbell, 2010; Houghton *et al*., 2010; Yamamoto and Esteban, 2010).

For small island states and countries with significant areas of soft low-lying coasts (Hanson *et al*., 2011), sea-level rise and extreme events threaten to erode and subsume significant land areas and associated infrastructure and settlements, in the absence of significant adaptation (Chapter 5.4.3.2; Nicholls *et al*., 2011). For countries made up entirely of low-lying atolls, sea-level rise, ocean acidification, and increases in episodes of extreme sea-surface temperatures, compromise human security for existing or larger numbers of people (Barnett and Campbell, 2010, Fisher, 2011). With projected high levels of sea-level rise beyond the end of this century, the physical integrity of low-lying islands is under threat (Chapter 29.3, Barnett and Adger, 2003; Houghton *et al*., 2010). The opening of resources, such as the social, economic, and political dimensions of loss of sea ice in the Arctic (Chapter 28.2.5), represents an example of climate change impacts being geopolitically significant to states, even in the absence of direct conflict (Box 12-6). Expected sea level rise and resulting coastline changes may affect the location of Exclusive Economic Zones and contribute to conflicts over natural resources or boundary locations (Houghton *et al*., 2010).

Productive ocean fisheries are already directly affected by climate change, altering the range of important commercial fish stocks (MacNeil *et al*., 2010). Fishing, as an economic activity, is adapted to highly variable environmental and management conditions; however, the movement of fish stocks (See Chapter 6.3.2) (Berkes *et al*., 2006) has been suggested to increase transboundary rivalry (MacNeil *et al*., 2010). For example, northward shifts of mackerel, herring and capelin stocks are creating economic and geopolitical tension (Sumaila *et al*., 2011).

_____ START BOX 12-6 HERE _____

Box 12-6. Evidence on Security and Geopolitical Dimensions of Climate Change Impacts in the Arctic

Impacts of climate change on the Arctic region exemplify the multiple interactions of human security with geopolitical risks. System-wide changes in the Arctic region affect multiple countries and a global commons resource given Arctic roles in regulating the global climate and ocean systems (Carmack *et al*., 2012; Duarte *et al*., 2012). Anticipated changes will contribute to greater geopolitical considerations and human insecurity in the Arctic region. They include: food insecurity affecting specific cultures and knowledge systems (outlined in Section 3); energy security implications through opening of sub-sea oil and gas reserves; increased shipping; increased pollution; search and rescue challenges and increased military presence in the region.

The Arctic has been warming at about twice the global rate since 1980, resulting in unprecedented loss in sea ice. The Arctic Ocean is projected to experience major reductions in sea ice, and under some projections would be ice-free by the end of the century (Chapter 28.1; WG1 SPM E5 medium confidence). These changes have implications for land based infrastructure, shipping, resource extraction, coastal communities, and transport (Holland *et al*., 2006; Larsen *et al*., 2008; Stephenson *et al*., 2011; Chapter 28.3.4). There is medium evidence that changes will create or revive terrestrial and maritime boundary disputes among Arctic countries (Borgerson, 2008; Ebinger and Zambetakis, 2009; Lusthaus, 2010). There is little evidence the changing Arctic will become a site for violent conflict between states (Young, 2009; Berkman, 2010; Brosnan *et al*., 2011). At present, political institutions are providing forums for managing resource competition, new transportation practices, and boundary disputes but anticipated increased stresses will test these institutions in the future (Ebinger and Zambetakis, 2009).

_____ END BOX 12-6 HERE _____

The impacts of climate-induced water variability on transboundary water basins constitute a cluster of geopolitical concerns. The high levels of international interdependence on transboundary rivers such as the Nile, Limpopo, Amu Darya, Syr Darya, Mekong, Ganges, Brahmaputra, Tigris, Euphrates, and Indus connect the conditions of the rivers with national development trajectories. Climate change is expected to disrupt the dynamics of runoff (*high agreement, robust evidence*, see Chapter 3.4.5). Warming, for example, will bring forward the snow melt season in all but the coldest regions, altering seasonal water flows (See Chapter 3.4.5). Such projects have led to concerns over transboundary tensions, particularly where challenges stemming from rising consumption and growing populations are already present (Swain, 2012; National Research Council, 2012).

Research on transboundary conflict and cooperation prioritizes rate of change rather than absolute scarcity in connection with the risk of conflict over water, particularly between states (De Stefano *et al*., 2012). This focus stems from higher perceived risk of conflict when institutions at local, state, and regional levels have less time to adapt to scarcity or variability by dealing with disputes through diplomatic and other non-violent mechanisms (Wolf *et al*., 2003; Wolf, 2007; De Stefano *et al*., 2010; De Stefano *et al*., 2012). Sudden changes in flow that heighten risk and challenge institutional responses include declines in seasonal snow or glacial melt. Transboundary basin institutions and international legal mechanisms have demonstrated an ability to manage conflict effectively (Sadoff and Grey, 2002; Wolf, 2007; Dellapenna and Gupta 2009; Brochmann and Hensel, 2009; Goulden *et al*., 2010; Dinar *et al*., 2011; Tir and Stinnett, 2012; Bernauer and Siegfried, 2012; Feitelson *et al.,* 2012; Gartzke, 2012). Other research emphasizes that these transboundary water institutions receive limited financial and political investment, involve unequal or inequitable cooperation between powerful and less powerful countries, and are present in only a limited number of transboundary basins (Conca *et al*., 2006; Zeitoun and Warner, 2006; Zeitoun and Mirumachi, 2008).

Geoengineering that involves deliberate large-scale manipulation of the environment aimed at reducing negative climate change impacts (Chapter 20.3), remains an unproven strategy to address climate change. The high levels of uncertainty and high likelihood of differential geographic impacts of geoengineering are anticipated sources of tension or conflict between states (Robock, 2008; Preston, 2013; Dalby, 2013). These include regional effects of solar radiation management on reduced precipitation in specific areas in Asia or in the Sahel (Ricke *et al*., 2011; Haywood *et al*., 2013) with negative food production implications. The ability of states to deploy geoengineering unilaterally under limited international legal mechanisms creates the potential for conflict. Examples of security institutions attempting weather modification present the prospect of military involvement in deploying or interdicting geoengineering efforts (Fleming, 2010). The prospect for the securitization of geoengineering responses is contested: geoengineering technologies could be used for hostile purposes but the significance of this possibility is contested (Keith, 2000; Robock, 2008; Corner and Pidgeon, 2010; Brzoska, 2012).

12.7. Synthesis

This Chapter shows that climate change and climate variability pose risks to various dimensions of human security, which arise through diverse causal processes, and which will be manifest at different scales. There is *high agreement* in the literature for this conclusion that comes from multiple lines of evidence. There are, however, multiple and competing perspectives on the nature and causes of insecurity arising from climate change (Barnett, 2010). For example, farmers in the Sahel are concerned about the risks weather extremes pose to their livelihoods (Mertz *et al*., 2009), whereas people in Tuvalu report that the cultural impacts of migration are a primary concern rather than climate change directly (Mortreux and Barnett, 2009). Organisations whose mandates include aspects of human security prioritise some risks of climate change over others. For example the International Organization for Migration is concerned with the implications of climate change for migration, and the United States National Intelligence Council is focused on the risk that climate change will increase political instability and geopolitical rivalry. In this respect the framing of climate change as an issue of human security enables conversations across the boundaries of diverse policy communities (Gasper, 2010).

The risks that climate change poses to human security, arise through multiple and interacting processes. Those processes also operate across diverse spatial and temporal scales. High levels of complexity mean that no conceptual model or theory captures the full extent of the interactions between all of climate change, livelihoods, culture, migration, and violent conflict. However, as this Chapter has shown, there are feedbacks between the key elements of livelihoods, culture, migration, and violent conflict. Figure 12-3 depicts interactions between the primary elements discussed in this Chapter. Deterioration in livelihoods, influenced in certain cases by climate change and climate variability, is a human security issue in its own right. But such stress to livelihoods also gives rise to migration, which may be unavoidable and undesirable. Such movements, in turn, imply changes in important cultural expressions and practices, and, in the absence of institutions to manage the settlement and integration of migrants in destination areas, can increase the risk of violent conflict. This conflict can in turn undermine livelihoods, impel migration, and weaken valued cultural expressions and practices. The evidence in the Sections above shows that some interventions and policies enhance human security, while others inadvertently can exacerbate insecurity (depicted in red and blue arrows in Figure 12-3).

[INSERT FIGURE 12-3 HERE
Figure 12-3: Synthesis of evidence on the impacts of climate change on elements of human security and the interactions between livelihoods, conflict, culture, and migration. Interventions and policies indicated by difference between initial conditions (solid black) and outcome of intervention (white circles). Some interventions (blue arrows) show net increase human security while others (red arrows) lead to net decrease in human security.]

Each dimension of human security examined in this Chapter demonstrates the potential for adaptation to minimize risks to human security. Again there is high agreement on this finding, reflected in Table 12-4, with multiple lines of evidence from food security, to migration, to conflict resolution. This Chapter suggests that often institutions anticipate and react to these risks to human security (Barnett *et al*., 2010; Ribot, 2011; Artur and Hilhorst, 2012). These institutional responses can significantly dampen or amplify the way changes in climate change and extreme events give rise to human insecurity. Table 12-4 summarises a number of example risks to human security, with the final column demonstrating that these risks can be ameliorated through adaptation for many of those examples. In general, higher levels of climate change impacts become less amenable to adaptation.

[INSERT TABLE 12-4 HERE
Table 12-4: Examples of important risks from climate change for elements of human security and the potential for risk reduction through mitigation and adaptation. These risks are identified based on this Chapter assessment and expert judgments of the authors, with supporting evaluation of evidence and agreement in the relevant chapter sections. Each risk is characterized as very low, low, medium, high, or very high. Risk levels are presented for the near-term era of committed climate change (here, for 2030-2040), in which projected levels of global mean temperature increase do not diverge substantially across emissions scenarios. Risk levels are also presented for the longer-term era of climate options (here, for 2080-2100), for global mean temperature increase of 2°C and 4°C above preindustrial levels. For each timeframe, risk levels are estimated for the current state of adaptation and for a hypothetical highly adapted state. Relevant climate variables are indicated by symbols. As the assessment considers potential impacts on diverse and incompatible elements and systems, risk levels should not be used to evaluate relative risk between the rows.]

Adaptation and mitigation strategies and interventions can also affect human insecurity in positive and negative directions. There is evidence that adaptation and mitigation strategies that are imposed on communities are more likely to impact negatively on human security than those that are consistent with their capabilities and values (*medium agreement, limited evidence*) (Ensor and Berger, 2009; Barnett and O'Neill, 2011, Marino, 2012, Mercer *et al*., 2012). Adaptation strategies that seek to reduce exposure to climate change, through the development of large infrastructure or the resettlement of communities against their will, carry risks of disrupted livelihoods, displaced populations, deterioration of valued cultural expressions and practices, and in some cases violent conflict (Table 12-4). Similarly, mitigation policies that entail changes in property regimes that are not consistent with resource ownership and use can impact negatively on human security. There is strong evidence to demonstrate that mitigation activities that align with local interests and institutions can have significant co-benefits for human security, especially through human health (Klein et al., 2005; Ayers and Huq, 2009; Laukkonen *et al*., 2009; Haines *et al*., 2009; Moser 2012; West *et al*., 2013).

In summary, climate change is one of many risks to the vital core of material well-being and culturally specific elements of human security that vary depending on location and circumstance. For regions where human insecurity is prevalent, these additional factors include poverty, discrimination, and inadequate provision of public services and public health, and opportunities for education. Investments in institutional responses to facilitate adaptation can dampen many of the potential adverse effects of climate change on human security (see Figure 12-3). Conversely, inappropriate climate policy responses may accelerate and amplify human insecurity including conflict.

There is much uncertainty about the future impacts of climate change on human security, as defined in this Chapter around the vital core of well-being and non-material elements. On the basis of current evidence about the observed impacts of climate change on environmental conditions, climate change will be an increasingly important driver of human insecurity in the future (see Figure 12-3).

At very high levels of projected warming, all aspects of human security discussed in this Chapter will be adversely affected (for example in high latitude regions - Box 12-6). At high levels of warming, the rate of changes in environmental conditions in most places will be without any precedent in human history (New *et al.,* 2011). Hence analysis concerning human security in those circumstances of very high impacts (as depicted in Table 12-4) is uncertain. Much of the current literature on human security and climate change is informed by contemporary relationships and observation and hence is limited in analyzing the human security implications of rapid or severe climate change.

Frequently Asked Questions

FAQ 12.1: What are the principal threats to human security from climate change?
[to be placed in Section 12.1.2]
Climate change threatens human security because it undermines livelihoods, compromises culture and individual identity, increases migration that people would rather have avoided, and because it can undermine the ability of states to provide the conditions necessary for human security. Changes in climate may influence some or all of the factors at the same time. Situations of acute insecurity, such as famine, conflict, and sociopolitical instability, almost always emerge from the interaction of multiple factors. For many populations that are already socially marginalized, resource dependent, and have limited capital assets, human security will be progressively undermined as the climate changes.

FAQ 12.2: Can lay knowledge of environmental risks help adaptation to climate change?
[to be placed in Section 12.3.4]
Lay knowledge about the environment and climate is deeply rooted in history, and encompasses important aspects of human life. This characteristic is particularly pertinent in cultures with an intimate relationship between people and the environment. For many indigenous and rural communities, for example, livelihood activities such as herding, hunting, fishing or farming are directly connected to and dependent on climate and weather conditions. These communities thus have critical knowledge about dealing with environment changes and associated societal conditions. In regions around the world, such knowledge is commonly used in adapting to environmental conditions and is directly relevant to adaptation to climate change.

FAQ 12.3: How many people could be displaced as a result of climate change? *[to be placed in Section 12.4.1.3]*
Displacement is the movement of people from their place of residence, and can occur when extreme weather events, such as flood and drought, make areas temporarily uninhabitable. Major extreme weather events have in the past led to significant population displacement, and changes in the incidence of extreme events will amplify the challenges and risks of such displacement. Many vulnerable groups do not have the resources to be able to migrate from areas exposed to the risks from extreme events. There are no robust global estimates of future displacement, but there is significant evidence that planning and increased mobility can reduce the human security costs of displacement from extreme weather events. Climate changes in rural areas could amplify migration to urban centres. However, environmental conditions and altered ecosystem services are few among the many reasons why people migrate. So while climate change impacts will play a role in these decisions in the future, given the complex motivations for all migration decisions, it is difficult to categorize any individual as a climate migrant [12.4].

FAQ 12.4: What role does migration play in adaptation to climate change, particularly in vulnerable regions?
[to be placed in Section 12.4.2]
Moving from one place to another is a fundamental way humans respond to challenging conditions. Migration patterns everywhere are primarily driven by economic factors: the dominant migration system in the world has been movement from rural to urban areas within countries as people seek more favorable work and living conditions.

FAQ 12.5: Will climate change cause war between countries? *[to be placed in Section 12.5.1]*
Climate change has the potential to increase rivalry between countries over shared resources. For example, there is concern about rivalry over changing access to the resources in the Arctic and in transboundary river basins. Climate changes represent a challenge to the effectiveness of the diverse institutions that manage relations over these resources. However, there is high scientific agreement that this increased rivalry is unlikely to lead directly to warfare between states. The evidence to date shows that the nature of resources such as transboundary water and a range of conflict resolution institutions have been able to avert rivalries in ways that avoid violent conflict.

Cross-Chapter Boxes

Box CC-GC. Gender and Climate Change

[Jon Barnett (Australia), Marta G. Rivera Ferre (Spain), Petra Tschakert (U.S.A.), Katharine Vincent (South Africa), Alistair Woodward (New Zealand)]

Gender, along with socio-demographic factors of age, wealth and class, is critical to the ways in which climate change is experienced. There are significant gender dimensions to impacts, adaptation and vulnerability. This issue was raised in WGII AR4 and SREX reports (Adger *et al*., 2007; IPCC, 2012), but for the AR5 there are significant new findings, based on multiple lines of evidence on how climate change is differentiated by gender, and how climate change contributes to perpetuating existing gender inequalities. This new research has been undertaken in every region of the world (e.g. Brouwer *et al*., 2007; Nightingale, 2009; Buechler, 2009; Nelson and Stathers, 2009; Dankelman, 2010; MacGregor, 2010; Alston, 2011; Arora-Jonsson, 2011; Resureccion, 2011; Omolo, 2011).

Gender dimensions of vulnerability derive from differential access to the social and environmental resources required for adaptation. In many rural economies and resource-based livelihood systems, it is well established that women have poorer access than men to financial resources, land, education, health and other basic rights. Further drivers of gender inequality stem from social exclusion from decision-making processes and labour markets, making women in particular less able to cope with and adapt to climate change impacts (Rijkers and Costa, 2012; Djoudi and Brockhaus, 2011; Paavola, 2008). These gender inequalities manifest themselves in gendered livelihood impacts and feminisation of responsibilities: whilst both men and women experience increases in productive roles, only women experience increased reproductive roles (Resureccion, 2011; 9.3.5.1.5, Box 13-1). A study in Australia, for example, showed how more regular occurrence of drought has put women under increasing pressure to earn off-farm income, and contribute to more on-farm labor (Alston, 2011). Studies in Tanzania and Malawi demonstrate how women experience food and nutrition insecurity since food is preferentially distributed among other family members (Nelson and Stathers, 2009; Kakota *et al*., 2011).

AR4 assessed a body of literature that focused on women's relatively higher vulnerability to weather-related disasters in terms of number of deaths (Adger *et al*., 2007). Additional literature published since that time adds nuances by showing how socially-constructed gender differences affect exposure to extreme events, leading to differential patterns of mortality for both men and women (*high confidence*) [11.3.3, Table 12-3]. Statistical evidence of patterns of male and female mortality from recorded extreme events in 141 countries between 1981-2002 found that disasters kill women at an earlier age than men (Neumayer and Plümper, 2007) [Box 13-1]. Reasons for gendered differences in mortality include various socially- and culturally-determined gender roles. Studies in Bangladesh, for example, show that women do not learn to swim and so are vulnerable when exposed to flooding (Röhr, 2006) and that, in Nicaragua, the construction of gender roles means that middle-class women are expected to stay in the house, even during floods and in risk-prone areas (Bradshaw, 2010). While the differential vulnerability of women to extreme events has long been understood, there is now increasing evidence to show how gender roles for men can affect their vulnerability. In particular, men are often expected to be brave and heroic, and engage in risky life-saving behaviors that increase their likelihood of mortality [Box 13-1]. In Hai Lang district, Vietnam, for example, more men died than women due to their involvement in search and rescue and protection of fields during flooding (Campbell *et al*., 2009). Women and girls are more likely to become victims of domestic violence after a disaster, particularly when they are living in emergency accommodation, which has been documented in the U.S. and Australia (Jenkins and Phillips, 2008; Anastario *et al*., 2009; Alston, 2011; Whittenbury, 2013; Box 13-1).

Heat stress exhibits gendered differences, reflecting both physiological and social factors (11.3.3). The majority of studies in European countries show women to be more at risk, but their usually higher physiological vulnerability can be offset in some circumstances by relatively lower social vulnerability (if they are well connected in supportive social networks, for example). During the Paris heat wave, unmarried men were at greater risk than unmarried women, and in Chicago elderly men were at greatest risk, thought to reflect their lack of connectedness in social support networks which led to higher social vulnerability (Kovats and Hajat, 2008). A multi-city study showed geographical variations in the relationship between sex and mortality due to heat stress: in Mexico City, women had a higher risk of mortality than men, although the reverse was true in Santiago and Sao Paulo (Bell *et al*., 2008).

Recognizing gender differences in vulnerability and adaptation can enable gender-sensitive responses that reduce the vulnerability of women and men (Alston, 2013). Evaluations of adaptation investments demonstrate that those approaches that are not sensitive to gender dimensions and other drivers of social inequalities risk reinforcing existing vulnerabilities (Figueiredo and Perkins, 2012; Arora-Jonsson, 2011; Vincent *et al*., 2010). Government-supported interventions to improve production through cash-cropping and non-farm enterprises in rural economies, for example, typically advantage men over women since cash generation is seen as a male activity in rural areas (Gladwin *et al*., 2001;13.3.1). In contrast, rainwater and conservation-based adaptation initiatives may require additional labor which women cannot necessarily afford to provide (Baiphethi *et al*., 2008). Encouraging gender-equitable access to education and strengthening of social capital are among the best means of improving adaptation of rural women farmers (Below *et al*., 2012; Goulden *et al*., 2009; Vincent *et al*., 2010) and could be used to complement existing initiatives mentioned above that benefit men. Rights-based approaches to development can inform adaptation efforts as they focus on addressing the ways in which institutional practices shape access to resources and control over decision-making processes, including through the social construction of gender and its intersection with other factors that shape inequalities and vulnerabilities (Tschakert, 2013; Bee *et al*., 2013; Tschakert and Machado, 2012; see also 22.4.3 and Table 22-5).

Box CC-GC References

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Box CC-HS. Heat Stress and Heat Waves

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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 12-1: Illustrative examples of impacts of climate variability and change on immediate basic needs and longer term capabilities and assets from observational studies and from projections.

Dimensions of impact	**Illustrative examples of observed impacts due to aggravating climate stresses**	**Illustrative examples of potential changes in livelihoods and capabilities as a consequence of climate variability and climate change**
	Deprivation of basic needs	
Livelihood assets	• Household assets such as livestock sold or lost during drought: documented examples – 1999-2000 drought, Ethiopia and 1999-2004 drought, Afghanistan (Carter *et al.*, 2007; de Weijer 2007). • Riverbank erosion, floods, and groundwater depletion and salinisation associated with changed hydrological regimes, causes loss of agricultural land (Paul and Routray, 2010; Taylor et al., 2013).	• Simulated future climate volatility leads to reduced future production of staple grains and increases in poverty (Ahmed *et al.*, 2009). • Changes in the viability of livestock feed crops have an impact on smallholder farmers: maize yields are projected to decline in many regions (Jones and Thornton, 2003; Chapter 7.4). • Projections of land loss, riverbank erosion and groundwater depletion, in combination with environmental change and human interventions, suggest future stress on livelihood assets (Le *et al.*, 2007; Taylor et al., 2013).
Water stress and scarcity	• Glaciers lower river flows affect water stress and scarcity, with livelihood and cultural loss (Orlove *et al.*, 2008): glacier recession in the Cordillera Blanca in Peru is altering the hydrological regime with implications for local livelihoods and water availability in the arid coastal zone (Mark *et al.*, 2010).	• Projected stresses to water availability show increased populations without sustainable access to safe drinking water (Hadipuro 2007). • Projected reduction in glacier extent and the associated loss of a hydrological buffer is expected to increase (Vuille, 2008; Chapter 3.4.4).
Loss of property and residence	• Floods destroy shelter and properties and curtail ability to meet basic needs. Example – Fiji flood in 2009 resulted in economic losses of F$24 million affecting at least 15% of farm households (Lal, 2010). • Sea-level rise and increased frequency of extreme events increases risk of loss of lives, homes, and properties and damages infrastructure and transport systems (Adrianto and Matsuda, 2002; Suarez *et al.*, 2005; Philips and Jones 2006; Ashton *et al.*, 2008; Von Storch *et al.*, 2008).	• Changes in flood risk may increase and cause economic damages: in the Netherlands, the total amount of urban area that can potentially be flooded has increased six-fold during the 20th century and may double again during the 21st century (de Moel *et al.*, 2011). In England and Wales, projected changes in flood risk mean economic damages may increase up to 20 times by the 2080s (Hall *et al.*, 2003).
	Erosion of livelihood and human capabilities	
Agriculture and food security	• Interaction of climate change with poverty and other political, social, institutional and environmental factors may adversely affect agriculture production and exacerbate the problem of food insecurity (Downing 2002; Trotman *et al.*, 2009; Saldana-Zorrilla 2008). Examples: in Kenya, Oluoko-Odingo 2011; in Southern Africa, Drimie and Gillespie 2010; in Zimbabwe and Zambia (Mubaya *et al.*, 2012).	• Studies of African agriculture using diverse climate scenarios indicate increasing temperature and rainfall variation have negative impacts on crops and livestock production and lead to increased poverty, vulnerability and loss of livelihoods. Examples: Ethiopia (Deressa and Hassan 2009); Kenya (Kabubo-Mariara 2009); Burkina Faso, Egypt, Kenya and South Africa (Molua *et al.* 2010); and sub-Saharan Africa (Jones and Thornton 2009). • Potential livelihood insecurity among small-scale rain-fed maize farmers in Mexico is projected due to potential loss of traditional seed sources in periods of climate stress (Bellona *et al.*, 2011).

Human capital	Health: • Food shortage, absence of safe and reliable access to clean water and good sanitary conditions, and destruction of shelters and displacements, all have negative bearing on human health (Costello *et al.,* 2009; Chapter 11.4) Education: • Droughts and floods can intensify the pressure to transfer children to the labour market (Ethiopia and Malawi, UNDP 2007). Indian women born during a drought or flood in the 1970s were 19 percent less likely to ever attend primary school, when compared with women of the same age who were not affected by natural disasters (UNDP 2007).	Health: • Analysis of the economic and climatic impacts of three emission scenarios and three tax scenarios, estimates the impacts on food productivity and malaria infection to be very severe in some Asian countries (Kainuma *et al*., 2004). Loss of lives: • Studies of the impacts of future floods using a combination of socio-economic and climate change scenarios for developed countries show an increase in mortality. Example: in the Netherlands, sea level rise combined with other factors, potentially increases the number of fatalities four times by 2040 (Maaskant *et al*., 2009)

Table 12-2: Cultural dimensions of climate science, policy, impacts, and extreme events in the context of climate change.

Core climate change dimensions	**Cultural dimensions**	**Role in human security**	**Sources**
Climate science and policy	Framing of climate change in a dominant language. Global climate change policy implemented at international scales.	How concepts and uncertainties are translated, imported and incorporated facilitate or hinder adaptation: *Facilitate Adaptation*: Available explanatory tools; Successful translation of climate change impacts; Awareness of culture. *Hinder Adaptation*: Lack of trust in science and in policy; Policy not recognizing the connection between nature and culture. Policy and decision-making that is inclusive of cultural perspectives *increases security*.	Ifejika Speranza *et al*., 2008; Stadel, 2008; Jacka, 2009; Green, *et* al., 2010; Schroeder, 2010; Osbahr *et al*., 2010; McNeely, 2012; Gero *et al*., 2011; Sánchez-Cortés and Chavero, 2011; Roncoli et al., 2011; Kuruppu and Liverman, 2011; Rudiak-Gould, 2012.
Impacts of environmental conditions and extreme events and changing natural resource base	Elements of collective understanding such as: Worldviews Coupling of nature-culture Power relations Heterogeneity within groups and communities	*Facilitate Adaptation*: New technologies; Livelihood diversification and flexibility; Perceptions of resilience; Narratives and history about past changes and current conditions; Co-management of resources increases adaptive capacity. *Hinder Adaptation*: Limitations of local knowledge; Lack of awareness and understanding of culture constrains action; Knowledge and cultural repertoire limited for responding to new challenges; Perceptions of resilience; Erosion of cultural core potentially *decreases human security*. Institutional responses and resource management will impact human security either negatively or positively.	Nunn, 2000; Davidson *et al*., 2003; Desta and Coppock, 2004; Zamani *et al*., 2006; Ford *et al*., 2006, 2008; Kuruppu and Liverman, 2011, Rudiak-Gould, 2012; Roncoli *et al*., 2011; Gearheard *et al*., 2010; Hovelsrud and Smit, 2010; Nyong *et al*., 2007; Tyler *et al*., 2007; Angassa and Oba, 2008; Osbahr *et al*., 2010; Lefale, 2010; Crate, 2008; Gregory and Trousdale, 2009; Harries and Penning-Rowsell, 2011; Gero *et al*., 2011; Fazey *et al*., 2010; Furgal and Seguin, 2006; Sudmeier-Riuex *et al.,* 2012; Anik and Khan, 2012; Kuhlicke, 2010; Valdivia *et al*., 2010; Kesavan and Swaminathan, 2006; Jacka, 2009; Pearce *et al*., 2009; Adler, *et al*., 2012; Gómez-Baggethun *et al*., 2012; Burningham *et al*., 2008; West and Hovelsrud, 2010; Nursey-Bray *et al*., 2012; Armitage *et al.,* 2011; Dumaru, 2010; King, 2008; Nielsen and Reenberg, 2010; Onta and Resurrection, 2011; de Sherbinin *et al*., 2008; Kalikoski *et al*., 2010; Hovelsrud *et al*., 2010a,b; Rybråten and Hovelsrud, 2010; McNeeley, 2012; Marshall 2011; Berkes and Armitage, 2010; Ford and Goldhar, 2012; Eakin *et al*., 2012.

Scientific observations monitoring, models, projections, scenarios	Local, traditional and indigenous knowledge through observations and experience	*Facilitate Adaptation*: Mutual integration of traditional, local and scientific knowledge; Climate projections with local relevance; Intergenerational knowledge transfers Local knowledge included in climate policy and decision-making *increases human security*. Knowledge not included in adaptation planning *decreases human security*.	Orlove *et al.,* 2000, 2010; Ingram *et al*., 2002; Tàbara *et al*., 2003; Alcántara-Ayala et al., 2004; Gearheard *et al*., 2010; Roncoli, 2006; Forbes, 2007; Anderson *et al*., 2007; Vogel *et al*., 2007; Nyong *et al*., 2007; Tyler *et al*., 2007; Catto and Parewick, 2008; Frazier *et al*., 2010; Marfai *et al*., 2008; Mercer *et al*., 2009; Pearce *et al*., 2009; Marin, 2010; Mark *et al*., 2010; Smit et al 2010; Burns *et al*., 2010; Hovelsrud and Smit, 2010; Kalanda-Joshua et al., 2011; Flint *et al*., 2011; Ravera *et al.,* 2011; Sánchez-Cortés and Chavero, 2011; Huntington, 2011; Eira *et al*., 2013; Dannevig *et al*., 2012.

Table 12-3: Empirical evidence on observed or projected mobility outcomes (migration, immobility or displacement) associated with weather-related extremes or impacts of longer-term climate change.

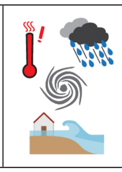
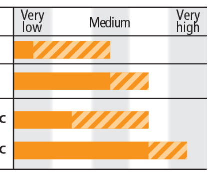
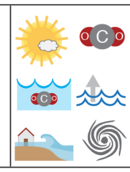
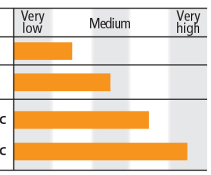
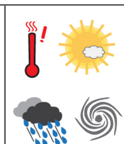
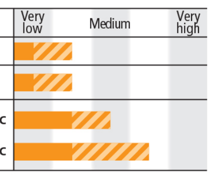
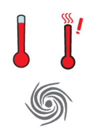
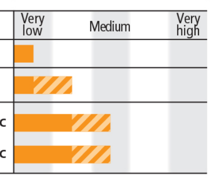
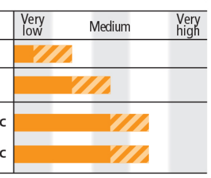
Change in migration trend or flow	**Impact on migration, by type of short term event and long term change**	**Source**
	Drought and land degradation	
Evidence for increased mobility or increased displacement	↑ Ethiopia: Outmigration of household heads due to drought-related famine. Different coping strategies lead to variations in the timing of migration.	Meze-Hausken, 2000;
	↑ Mexico: At the state level, a reduction in crop yields associated with an increase in international migration to the United States.	Feng *et al.*, 2010;
	↑ Western Sahara: Environmental factors influenced decisions to migrate internationally from refugee camps.	Gila *et al.*, 2011;
	↑ Kenya: Households farming high quality soil are less likely to migrate, especially for temporary labour migration; soil degradation therefore causes increased outmigration.	Gray, 2011;
	↑ India: Temporary migration identified as 'the most important' coping strategy in times of drought in rural villages.	Jülich, 2011;
	↑ *Burkina Faso: Simulated scenarios of dry climate increase migration fluxes compared to wet scenarios. Highest international migrant flows are shown with the dry climate scenarios.	Kniveton *et al.*, 2011;
	↑ Canada: Higher population loss was associated with settlements containing areas of poorer quality agricultural soils during droughts of 1930s.	McLeman and Ploeger, 2011;
	↑ Guatemala: Migrants to the expanding agricultural frontier commonly attributed their outmigration to soil degradation.	López-Carr, 2012;
	↑ Sahel: In three case regions, the pressure to migrate had significantly increased since the 1970s, with response to persistent droughts identified as a factor.	Scheffran *et al.*, 2012b; 2012c;
	↑ Burkina Faso: Drier region populations were more likely to engage in rural-rural migration, both temporary and permanent, than people from regions with more rainfall. Rainfall deficits have different impacts depending on the duration and distance of the migration.	Henry *et al.*, 2004;
Evidence for decreased mobility	↓ Mali: Reduced international migration during 1980s drought and an increase in cyclical migration.	Findley, 1994;
	↓ Nepal: Deforestation, population pressure and agricultural decline leads to local mobility, especially among women, but no increases in internal or international migration	Massey *et al.*, 2010; Bohra-Mishra and Massey (2011);
	↓ Uganda: High soil quality marginally increases migration, especially permanent non-labor migration; therefore soil degradation reduces outmigration.	Gray, 2011;
Evidence for socially-differentiated mobility outcomes	⇅ United States: Dustbowl migrants from Oklahoma to California in the 1930s had different social and economic capital endowments to those who stayed within state.	McLeman and Smit, 2006;
	⇅ Ecuador: Influence of natural capital on migration differed between men and women. Access to land facilitates migration in men; women are less likely to migrate from environmentally degraded areas.	Gray, 2010;
	⇅ Ethiopia: Male migration increases with drought. However, marriage related moves by women decrease with drought.	Gray and Mueller, 2012;
	⇅ Burkina Faso: Labour migration became a key off-farm livelihood strategy after droughts in the 1970s for groups dependent on rain-fed agriculture	Nielsen and Reenberg, 2010;
	⇅ Mongolia: Diversity in herders' mobility strategies in response to climate change. For a minority, responses entailed greater overall annual mobility. Other herding households experienced significant reductions in mobility.	Upton, 2012;

		Flooding	
Evidence for increased mobility or increased displacement	↑	USA: Ten counties and parishes in Louisiana, of the 77 impacted counties, experienced 82% of the total population increase in the year following Hurricane Katrina.	Frey and Singer, 2006;
	↑	Vietnam: Cumulative impacts of seasonal flooding increases outmigration rates in the Mekong Delta.	Dun, 2011;
	↑	Bangladesh: 22% of households affected by tidal-surge floods, and 16% affected by riverbank erosion, moved to urban areas.	Penning-Rowsell *et al.*, 2013;
Evidence for decreased mobility or trapped populations	↓	Bangladesh: No out-migration detected after 2004 tornado in Bangladesh as a result of the effective distribution of disaster aid.	Paul, 2005;
	↓	Senegal: Over 40 percent of new migrant populations located in high risk flood zones in Dakar.	Quoted in Black *et al.*, 2011b;
Evidence for socially-differentiated mobility outcomes	⇅	USA: Emergency evacuation responses and return migration after Hurricane Katrina highly differentiated by income, race, class and ethnicity.	Elliott and Pais, 2006; Falk *et al.*, 2006; Landry *et al.,* 2007;
	⇅	Bangladesh: Wide variation among groups in attitudes towards, and capabilities for, migration as an adaptation to the impact of cyclone Aila.	Kartiki, 2011;

		Sea level rise	
Evidence for increased mobility or increased displacement	↑	United States: Relative sea level rise caused island depopulation in Maryland. Final abandonment was a result of the population falling below the threshold required to support local services.	Arenstam Gibbons and Nicholls, 2006;
	↑	Vanuatu: Contemporary example of whole village displacement associated with inundation, both from sea level rise and tectonic movement on Torres Islands.	Ballu *et al.*, 2011;
	↑	United States*: The impact of future sea-level rise is projected to extend beyond the inundated counties through migration networks that link inland and coastal areas and their populations.	Curtis and Schneider, 2011;
	↑	Papua New Guinea: Population considering resettlement on Bougainville to the main island due to coastal erosion, land loss, saltwater inundation and food insecurity.	Oliver-Smith, 2011;
	↑	United States: Coastal villages in Alaska affected by sea-level rise and coastal erosion to the point where resettlement is the only viable adaptation.	Bronen, 2010; Oliver-Smith, 2011; Marino, 2012;
Evidence for decreased mobility or lower migration	↓	Tuvalu: On the island of Funafuti, surveyed residents emphasize place attachment as reasons for not migrating, and do not cite climate change as a reason to migrate.	Mortreux and Barnett, 2009.

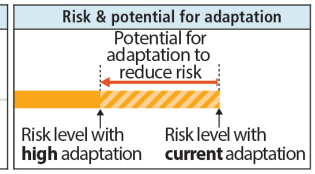
Note: * indicates study based on simulations or projections

Table 12-4 Examples of important risks from climate change for elements of human security and the potential for risk reduction through mitigation and adaptation. These risks are identified based on this Chapter assessment and expert judgments of the authors, with supporting evaluation of evidence and agreement in the relevant chapter sections. Each risk is characterized as very low, low, medium, high, or very high. Risk levels are presented for the near-term era of committed climate change (here, for 2030-2040), in which projected levels of global mean temperature increase do not diverge substantially across emissions scenarios. Risk levels are also presented for the longer-term era of climate options (here, for 2080-2100), for global mean temperature increase of 2°C and 4°C above preindustrial levels. For each timeframe, risk levels are estimated for the current state of adaptation and for a hypothetical highly adapted state. Relevant climate variables are indicated by symbols. As the assessment considers potential impacts on diverse and incompatible elements and systems, risk levels should not be used to evaluate relative risk between the rows.

Example risks	Adaptation issues and prospects	Climatic risks	Supporting ch. sections	Timeframe	Risk for current and high adaptation
Displacement associated with extreme events (*high confidence*)	Adaptation to extreme events are well understood, but poorly implemented even under present climate conditions. Displacement and involuntary migration are often temporary. With increasing climate risks, displacement is more likely to involve permanent migration.		12.4.1	Present Near-term (2030-2040) Long-term (2080-2100) 2°C / 4°C	
Loss of land, cultural and natural heritage disrupting cultural practices embedded in livelihoods and expressed in narratives, world views, identity, community cohesion and sense of place (*high confidence*)	Cultural values and expressions are dynamic and inherently adaptable and hence adaptation is possible to avoid losses of cultural assets and expressions. Nevertheless cultural integrity will be compromised in these circumstances.		12.3.2, 12.3.4	Present Near-term (2030-2040) Long-term (2080-2100) 2°C / 4°C	
Violent conflict arising from deterioration in resource dependent livelihoods such as agriculture and pastoralism (*high confidence*)	There are options for buffering rural incomes against climate shocks, for example through livelihood diversification, income transfers, and social safety net provision. There are early warning mechanisms to promote effective risk reduction. There are well-established strategies for managing violent conflict which are effective, but require significant resources, investment and political will.		12.5.1	Present Near-term (2030-2040) Long-term (2080-2100) 2°C / 4°C	
Geopolitical competition over access to Arctic resources that escalates into dangerous tensions and crises (*high confidence*)	There are international organizations and elements of international law that regulate competition and access and provide mechanisms for resolving disputes. There are strong transnational networks which are relevant for joint problem-solving. Hence adaptation action has significant potential to reduce risks associated with geo-political rivalry.		12.6.2	Present Near-term (2030-2040) Long-term (2080-2100) 2°C / 4°C	
New or exacerbated conflict through land acquisition for climate change mitigation and adaptation (*medium confidence*)	Climate change mitigation (e.g. expansion of biofuel production area) and adaptation action (e.g. set-back of coastal land) can exacerbate conflicts when they are already manifest around land and water availability and scarcity. The extent of insecurity and instability from such mitigation and adaptation activities depends on the displacement of populations and the inclusiveness of the planning processes. Careful planning processes can therefore be used to ameliorate the risk of conflict.		12.5.2	Present Near-term (2030-2040) Long-term (2080-2100) 2°C / 4°C	

Climatic drivers of impacts				
Warming trend	Extreme temperature	Drying trend	Extreme precipitation	Sea level
Snow cover	Storm surge	Carbon dioxide concentration	Extreme wind episodes	Ocean acidification

Risk & potential for adaptation



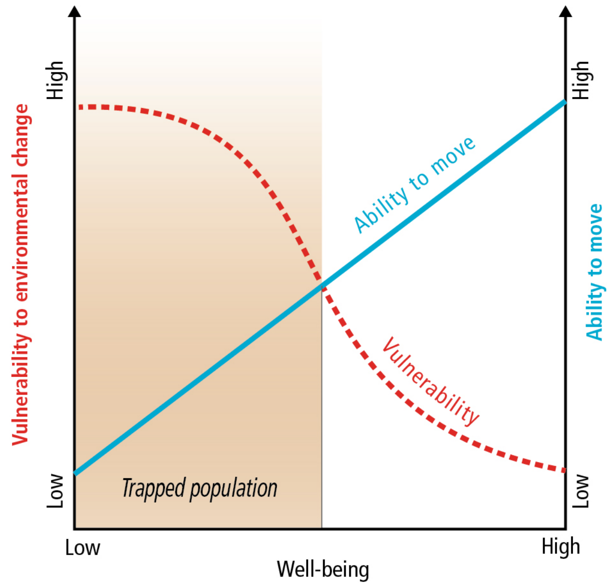


Figure 12-1: Relationship between vulnerability to environmental change and mobility showing that populations most exposed and vulnerable to the impacts of climate change may have least ability to migrate. Source: Adapted from Black *et al.,* 2013.

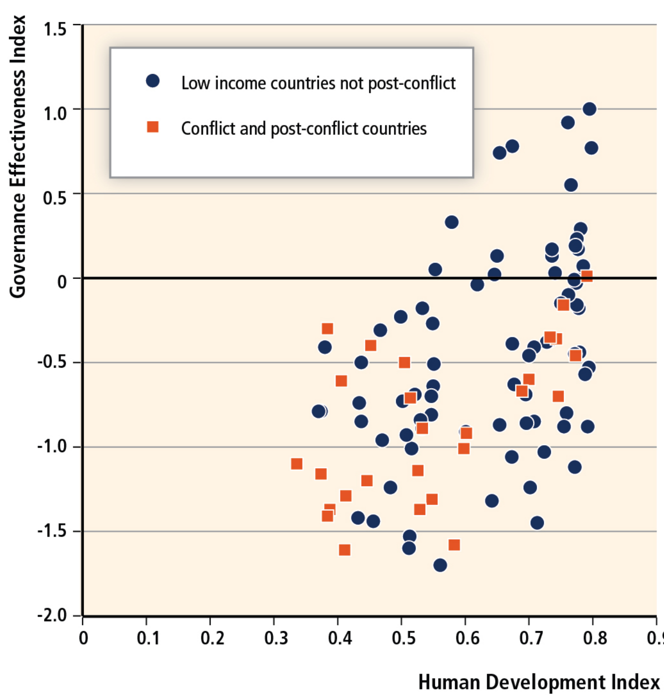


Figure 12-2: Conflict and post-conflict societies exhibit low levels of governance and human development. Data based on UNDP Human Development Index and World Bank index on Governance effectiveness. Source: Adapted from Adger, 2010.

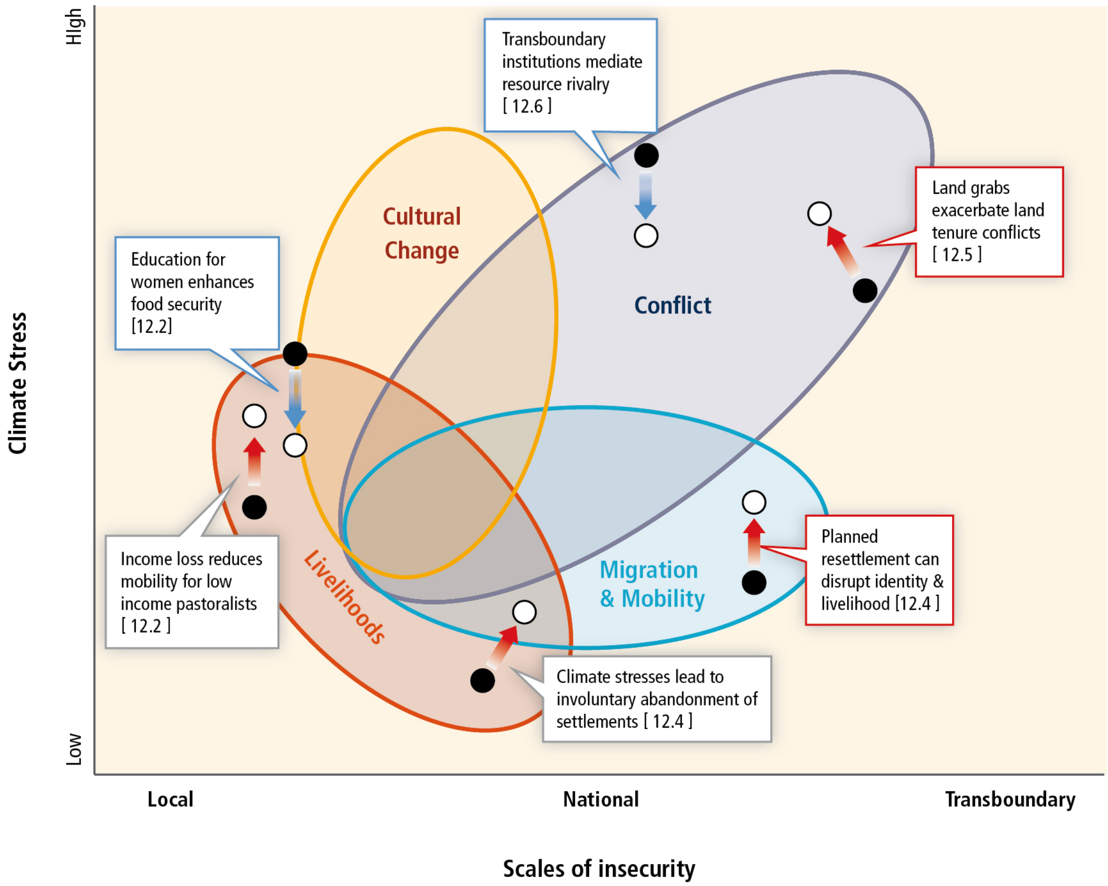


Figure 12-3: Synthesis of evidence on the impacts of climate change on elements of human security and the interactions between livelihoods, conflict, culture, and migration. Interventions and policies indicated by difference between initial conditions (solid black) and outcome of intervention (white circles). Some interventions (blue arrows) show net increase human security while others (red arrows) lead to net decrease in human security.