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A Commissioned Report for the Norwegian Ministry of Foreign Affairs

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List of Abbreviations

AU	African Union
CBA-X	Community Based Adaptation Exchange
COP	Conference of Parties
CRA	Community Risk Assessment
CRED	Centre for Research on the Epidemiology of Disasters
DFID	Department for International Development
DRR	Disaster Risk Reduction
ENSO	El Niño-Southern Oscillation
ERM	Environmental Resources Management
GDP	Gross Domestic Product
HFA	Hyogo Framework for Action
HIV/AIDS	Human immunodeficiency virus/ Acquired Immune Deficiency Syndrome
IPCC	Intergovernmental Panel on Climate Change
ICSU	International Council for Science
LCA	Linking Climate and Adaptation
MDGs	Millennium Development Goals
NGO	Non-governmental Organizations
ODA	Official Development Assistance
OECD	Organisation for Economic Co-operation and Development
PAR	Pressure and Release
PTSD	Post-traumatic Stress Disorder
SBSTA	Subsidiary Body for Scientific and Technological Advice
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNISDR	United Nations International Strategy for Disaster Reduction
WHO	World Health Organization

1. Introduction

> Information on climate change is building a new perception of disasters as of our own making. The increase in storms, droughts and other hazards expected to arise from the accumulation of greenhouse gases in the atmosphere as a result of industrialization and deforestation is clearly not natural.
>
> (UNISDR 2008)[1]

The Norwegian Nobel Committee awarded the 2007 Nobel Peace Prize to the Intergovernmental Panel on Climate Change and Al Gore, in an effort to "contribute to a sharper focus on the processes and decisions that appear to be necessary to protect the world's future climate, and thereby to reduce the threat to the security of mankind."[2] In the wake of the 2007 award, the relationship between climate change and security has surfaced as a key concern among national governments and international institutions. Security concerns associated with climate change include the potential for conflict over natural resources, population displacement and migration as the result of sea-level rise or other large-scale biophysical, ecological or social disruptions, and the prospect of increasingly frequent humanitarian disasters as the result of extreme climate events.[3] Many of these concerns are, in fact, directly related to the notion of human security, which can be considered a state or condition where individuals and communities have the options necessary to end, mitigate or adapt to threats to their human, environmental and social rights; have the capacity and freedom to exercise these options, and actively participate in pursuing these options.[4] Enhancing human security in the 21st century is about responding to climate change and disaster risks in ways that not only reduce vulnerability and conflict, but also create a more equitable, resilient and sustainable future.[5]

Recognition of the threats to human security associated with climate change has generated growing interest in the relationship between disaster risk reduction and climate change adaptation (see Box 1 for definitions).[6] There is an intuitive understanding that the two are closely linked, yet it has been difficult to elaborate a common framework for addressing disaster risk in the context of climate change. Part of this difficulty is related to competing discourses and understandings of both hazards and climate change.[7] Although there is a growing recognition that climate change must be met by both mitigation and adaptation measures, most contemporary research and policy debates about adaptation remain focused on reducing the biophysical impacts associated with one or more scenarios of future climate change.

In spite of the increased attention, interest, and sense of urgency in understanding and responding to climate change, the broader social causes and consequences are seldom addressed. Many questions thus remain unanswered: How do factors such as gender, age, class, education, culture, traditions, and living conditions influence climate risk and vulnerability? How will climate change influence the capacity of individuals, communities, businesses, governments, and NGOs to respond to multiple and interacting stressors? How will gradual changes in climate affect people's vulnerability to disasters and erode their resilience and livelihoods? How do responses to climate change, including disaster risk reduction strategies aimed at reducing vulnerability, affect the diversity of needs and values that contribute to human well-being? Whose security is most threatened by climate change and why? Finally, what categories of action and which investments appear to be the most effective for promoting adaptation and risk reduction? The growing recognition that there may be an increasing number of disasters linked to floods, droughts, wildfires and other climate-influenced events, coupled with increasing concern over the social implications of climate variability and change, calls for a much deeper and broader assessment of the connections between disaster risk reduction, climate change adaptation and human security.

The findings of this report suggest a timely need to undertake a more thorough assessment of the role that disaster risk reduction and climate change adaptation can play in minimizing threats to human security. Although the relationship between disaster risk reduction and climate change adaptation is increasingly recognized by researchers, policy makers and practitioners within both communities, the two communities have yet to develop coordinated efforts towards reducing climate change risks and vulnerability, which includes increasing the capacity to cope with and adapt to rapid changes, complex emergencies, and considerable uncertainty about the future. Thus far, many of the discussions taking place on adaptation to climate change are not well-informed by disaster risk reduction strategies, tools, frameworks and experiences.[8] At the same time, the disaster risk community has not fully incorporated climate change dimensions and information on climate impacts into its work. The risk of more complex, frequent, intense or unpredictable extreme weather events associated with global temperature increases, changing precipitation patterns and sea-level rise, coupled with both gradual and non-linear changes to ecosystems and natural resources, suggests the need for a renewed focus on the ways that disaster risk reduction and adaptation can influence the context in which climate change occurs. Rather than creating or perpetuating contexts for disaster, it is possible to use disaster risk reduction and adaptation strategies to create a context that promotes human well-being and security.

Box 1. Definitions of Disaster Risk Reduction and Climate Change Adaptation

UNISDR[9] defines *disaster risk reduction* as "the conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development."

The IPCC[10] defines *climate change adaptation* as "adjustments in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities."

2. Disaster Risks and Climate Change

> . . . the type, frequency and intensity of extreme events are expected to change as Earth's climate changes, and these changes could occur even with relatively small mean climate change. Changes in some types of extreme events have already been observed, for example, increases in the frequency and intensity of heat waves and heavy precipitation events.
>
> (IPCC 2007)[11]

Disaster risk and climate change are two threats to human well-being that adversely reinforce each other. Disaster risk is an intrinsic characteristic of human society, arising from the combination of natural and human factors and subject to exacerbation or reduction by human agency.[12] While the adverse impacts of climate change on society may increase disaster risk, disasters themselves erode environmental and social resilience, and thus increase vulnerability to climate change. Although the relationship between climate change and extreme events remains uncertain, it is difficult to distinguish variability and changes in climate-related hazards from the impacts of long-term climate change. Improved knowledge on the linkages between extreme weather events and climate change is needed and can facilitate strategies to reduce vulnerability. Yet it is increasingly acknowledged that both preparatory actions and responses to climate variability and long-term climate change may often be similar.[13] Consequently, there are growing calls for a common framework for approaching the reduction of vulnerability to disasters, climate variability and long-term climate change.[14]

Disasters have an enormous impact on human development. Globally, events such as earthquakes, floods, and droughts contribute to tens of thousands of deaths, hundreds of thousands of injuries, and billions of dollars in economic losses each year.[15]In developing countries, disasters represent a major source of risk for the poor and can potentially destroy development gains and accumulated wealth.[16] This has been recognized by the UN Member States in the Millennium Declaration, which sees the mounting losses caused by disasters as a major threat towards meeting the Millennium Development Goals (MDGs).[17]

Records maintained by CRED show that disaster frequency appears to be increasing, from about 100 events per decade in the 1900-1940, to 650 per decade in the 1960s, to 2000 per decade in the 1980s. By the 1990s this number had reached almost 2800 events per decade.[18] The increase in reported disasters can be partly explained by a higher number of small and medium-level events that are related to natural and human-induced or socio-natural phenomena.[19] While the number of geophysical disasters has remained fairly steady, the number of hydrometeorological disasters has increased significantly over the last decades.[20] Bouwer et al. estimate that global costs of weather-related disasters alone have increased from an annual average of USD 8.9 billion in 1977-1986 to USD 45.1 billion in the 1997-2006 period.[21] According to ICSU about three-quarters of all disasters were triggered by weather-related events during the 1990s, and floods and drought are among the most prominent causes.[22] A revised assessment of historical droughts (from 1900 to 2004) by Below et al. concludes that "more than half of all deaths associated with natural hazards are now classified as drought related, and only floods rank higher in terms of the number of people affected."[23]

The geographical distribution of hazards during 1985-2005 was examined by Dilley et al.[24] Many of the "disaster hot spots" are located in the semi-arid tropics, in coastal areas, and along geological faults. This global assessment of mortality and economic losses related to disasters emphasizes the implications for socioeconomic development, particularly the covariate losses such as partial or total loss of household assets, income, or productivity. Dilley et al.[25] stress that "widespread disaster-related mortality can affect households and communities for years, decades, and even generations."

Recent research attention has also emphasized the linkages between rapid urbanization and disasters.[26] Urbanization has become the dominant feature of human settlement patterns over the past century. More than half of the world's current population lives in cities. By the year 2015 there are expected to be 60 megacities in the world, each with a population of 10 million or more people. Over the next several decades, the largest urban population changes are expected to occur in coastal areas, particularly in Asia and Africa.[27] The linkages between rapid urbanization and disasters have sometimes been described as reflexive: cities create their own risks by causing degradation of the local, regional, and global environments.[28] High concentrations of resources and people within cities also mean that the economic, social, and environmental costs of extreme events are high in urban areas.[29] Furthermore, these costs are likely to escalate as a result of growing populations in coastal cities, many of which are already highly vulnerable to sea-level rise, tsunamis, and other hazards.[30]

2.1. Climate change and extreme events

Climate change is expected to increase the frequency and magnitude of many types of extreme events, including floods, droughts, tropical cyclones and wildfires.[31] Table 1 summarizes the findings from the IPCC Fourth Assessment Report related to observed and projected changes in extreme events. New evidence also suggests that climate change is likely to change the nature of many types of hazards, not only hydrometeorological events such as floods, windstorms, and droughts, but also events such as landslides, heat waves and disease outbreaks, influencing not only the intensity, but also the duration and magnitude of these events.[32] This research suggests that there is good reason to be concerned about the dynamic, non-linear and uncertain relationships between climate variability, climate change, and extreme events, and their implications for human security.

Policy-makers, NGOs, and humanitarian agencies will require improved information about changing extremes in order to better manage changing risks and uncertainty. Nonetheless, the complexity of the climate system frustrates any simplistic conclusions about the relationship between climate change and extreme events. The difficulty and uncertainty of these relationships is exemplified by the case of tropical cyclones. Recent assessments of the relationship between climate change and cyclones produce a range of results.[33] Differences in the projected changes in hurricane activity depend on a number of factors, including location (e.g. southern vs. northern hemisphere, ocean basin, etc.). In some assessments, hurricane and tropical storm intensity is projected to increase, while in others it is projected to decrease. However, assessments indicating decreases also suggest possible increases in near-storm rainfall events, which may still present a potential challenge to disaster risk managers.[34] Statements about the frequency and magnitude of other hazards (e.g., droughts and floods) also need to be approached with caution.

New scientific literature is continually assessing and reassessing the relationship between climate change and extreme events, often raising new uncertainties.[35] However, there is a general consensus that change is expected to be the norm, rather than the exception. As stressed by Leary et al., past performance of the climate is becoming a less reliable predictor of future performance, thus future climate will be less familiar and more uncertain under climate change.[36] Milly et al. argue that in terms of water resource management, "stationarity is dead because substantial anthropogenic changes of Earth's climate is altering the means and extremes of precipitation, evapotranspiration, and rates of discharge of rivers."[37] Stationarity, which is the idea that natural systems fluctuate within an unchanging range of variability, has long been a key assumption in water resources engineering and management.

The IPCC Fourth Assessment Report also highlights new potential risks related to climate change. Table 2 summarizes some of the key vulnerabilities described by Schneider et al.[38] There are real and increasingly identified thresholds in the impacts of climate change, such as non-linear changes in ecosystems and physical systems brought about through

Table 1: Findings from the 2007 IPCC Fourth Assessment Report – The link between climate change and extreme events

Observations of changes in climate
– Widespread changes in extreme temperatures have been observed over the last 50 years (IPCC WG I, section 3.2.2.1). – Reductions in the number of frost days in mid-latitude regions, increases in the number of warm extremes and a reduction in the number of daily cold extremes (IPCC WG I, section 3.8.2.1). – Heat waves have increased in duration beginning in the latter half of the 20th century (IPCC WG I, section 3.8.2.1). – Significant increased precipitation in the eastern parts of North and South America, northern Europe and northern and central Asia (IPCC WG I, section 3.3.2.2). – Drying has been observed in the Sahel, the Mediterranean, southern Africa and parts of southern Asia (IPCC WG I, section 3.3.2.2). – Substantial increases in heavy precipitation events has been observed (IPCC WG I, section 3.8.2.2). – Increase of intense tropical cyclone activity in the North Atlantic since about 1970, correlated with increases in tropical sea surface temperatures. There is also suggestion of increased intense tropical cyclone activity in some other regions where concerns over data quality are greater (IPCC WG I, section 3.8.3.2). – More intense and longer droughts have been observed over wider areas, particularly in the tropics and subtropics since the 1970s (IPCC WG I, section 3.3.4). – Altered distribution of some infectious disease vectors (IPCC WG II, section 8.2.8).
Future climate change projections
– Increased warming with the greatest temperature increases in high northern latitudes, with less warming over the southern oceans and North Atlantic (IPCC WG I, section 10.3.2.1). – More frequent, intense and longer lasting heat waves (IPCC WG I, section 10.3.6.2). – An intensification and expansion of wildfires is likely globally (IPCC WG II, section 4.4.2-5). – Fewer, shorter, less intense cold spells/cold extremes in winter (IPCC WG I, 11.3.3.2). – Increased precipitation in high latitudes, and decreases in most subtropical land regions (IPCC WG I, 10.3.2.3). – More heavy precipitation events (IPCC WG I, section 10.3.6.1). – Increased risk of flooding (intense and heavy rainfall coupled with high runoff) (IPCC WG I, section 10.3.6.1). – Increases in areas affected by droughts (IPCC WG I, section 10.3.6.1). – Sea level is expected to continue to rise over the next several decades (IPCC WG I, sec. 10.6. 1). – More severe tropical cyclones, with greater wind speeds and more intense precipitation (IPCC WG I, section 10.3.6.3). – Widespread increase in thaw depth in most permafrost regions (IPCC WG I, section 10.3.3.2).

transitions in ecosystem function and process, often exacerbated by feedbacks at global and local scales.[39] These "key vulnerabilities" involve changes at rates at which ecosystems may not be able to adapt, as well as sea-level changes that threaten specific localities and settlements, thus they are likely to pose new challenges to disaster risk management and climate change adaptation.[40]

Table 2: Key vulnerabilities of human and biophysical systems

System	Temperature Rise +2°C to 4°C	Temperature Rise > 4°C
Water Resources	Decreased water availability and increased drought in mid latitudes	Hundreds of millions face reduced water supplies
Migration	Stresses will affect many locations; may lead to relocation within and between countries adding to migration pressures	
Biodiversity	Loss of one third of species	Widespread extinctions
Greenland Ice Sheet	Widespread to near-total deglaciation	Near-total deglaciation
West Antarctic Ice Sheet	Commitment to widespread deglaciation; increasing deglaciation with increasing temperature	

Source: Adapted from Schneider et al.[41]

2.2. Impacts of climate change

The IPCC Fourth Assessment Report from Working Group II describes a wide range of likely long-term climate impacts that will undermine human security, including increased water stress for millions of people in Africa; decreasing flows in rivers that supply water to millions in Latin America and a billion people in Asia; declining crop productivity in low latitudes, including a 50 percent decline in rain-fed yields in some parts of Africa and 30 percent decline in rain-fed yields in some parts of Central and South Asia; millions of people exposed to flooding in the densely populated and economically productive mega deltas of Asia; increasing malnutrition in low-income societies; increased deaths, diseases and injuries associated with extreme events such as droughts, floods, heatwaves, fires, and storms; decreasing yields of fish from most of the world's freshwater and coastal fisheries; and loss of lands and homes and possibly islands in many of the small island states in the South Pacific, Caribbean and Indian and Atlantic oceans.[42]

Climate change places at risk many of the basic things people need to be healthy and to live dignified lives. For example, in the low-lying atoll-country of Tuvalu, a 2ºC rise in temperature is likely to cause annual coral bleaching, changing rainfall patterns, more intense extreme events, and sea-level rise.[43] Local food production from the land and sea are likely to decline, water scarcity may increase, and coasts may erode to the point that the islands may cease to be able to sustain existing numbers of people, and in the longer-term may be subsumed.[44] In this case, climate change puts at risk basic human needs such as access to food and shelter.

Mortality due to climate change is very likely to increase further through a range of direct effects (such as more intense heat waves, floods, and fires), indirect effects (such as declines in water quality and food security, and changes in disease vectors), and through social and economic disruptions (such as increased poverty and migration).[45] Climate change is likely to exacerbate the incidence of infectious diseases such as malaria, waterborne diseases such as diarrhea

and cholera, and cardio-respiratory diseases. In Africa, for example, one estimate suggests that malaria exposure will increase by between 16 – 28 percent under a range of climate change scenarios, which is significant given that 445 million people are already exposed to malaria each year in Africa, leading to over 1.3 million deaths.[46] In relation to climate variability and extreme events, hydrometeorological extremes can have enormous impacts on livelihoods and well-being. For example, the World Bank estimated that following Hurricane Mitch, 165,000 Hondurans fell below the poverty line, the poorest lost 18 percent of their assets and 29 percent of crops were lost.[47] ERM estimated that even in the 1990s, some 35-40 percent of the worst disasters had a strong climate change signal, thus these statistics on losses are likely to increase in the absence of proactive climate change adaptation and disaster risk reduction.[48]

The private sector and their associated investments are also directly threatened by climate change. Ernst & Young describe climate change, coupled with its potential destabilizing affects linked to conflict and security, as the "greatest strategic risk facing the property and causality insurance industry."[49] Concerning the economic and financial consequences of extreme events, many studies have explored the local and regional economic impacts of specific events, such as hurricanes, floods, earthquakes, heat waves, and wild fires.[50] This research is generally focused on aggregate impacts including costs of business interruption, infrastructure damage and loss of business structures and productive capital, as well as on measures to reduce economic risks such as broader provision of private insurance, enforcement of building codes, and development of disaster preparedness plans.[51] Limited attention has been directed toward the effects of extreme events on industries, businesses, and workers, including which industries are likely to expand or contract, which firms are likely to survive, and which types of workers are likely to gain or lose jobs.[52]

Climate change may have a number of indirect effects as well. These may arise, for example, through changes in the costs of essential goods and services. Increasing water scarcity may lead to an increase in water prices; warmer temperatures are likely to influence demand for and the cost of energy for cooling; and climate-induced changes in the agricultural sector may drive up food prices. As with the direct effects of climate change, indirect effects will be unevenly distributed, with the burden falling most heavily on low-income households where a significant share of expenditures already goes towards food and energy, and where the opportunity costs of increased spending in these areas may lead to declining access to goods and services necessary to live dignified lives. Labor markets may also be affected, for example if production decreases associated with drought lead to a reduced demand for agricultural wage laborers.[53]

The human consequences of climate change have enormous implications for development, particularly for poverty reduction initiatives and global initiatives such as the Millennium Development Goals (MDGs).[55] Table 3 highlights the impacts of climate change on poverty and consequently on achievement of the MDGs. Agrawala has estimated that between 15 – 60 percent of official development assistance (ODA) flows will be affected by climate change.[56] Not only are large amounts of ODA exposed to climate risks, but also investments and infrastructure will be affected. Watson argues that the investments made by the private sector in developing countries are at an even greater risk, because adaptation options and risk spreading mechanisms remain inadequate.[57] More important, the whole public infrastructure on which these investments depend is highly vulnerable to any climate stress.

In summary, the 2007/2008 Human Development Report argues that failure to adequately address climate change now will "consign the poorest 40 percent of the world's population – some 2.6 billion people – to a future of diminished opportunity."[58] The Stern Review concurs, warning that warming above 2°C will lead to "major changes in human geography – where people live and how they live their lives."[59] Stern also cautions that inaction will lead to climate change costing about 20 percent of global GDP. Climate change is and will increasingly be a key contributor to morbidity, mortality, and poverty, particularly among populations that are resource dependent, have low incomes, and are constrained in their capacity to adapt by insufficient access to the social, environmental and economic resources needed to adapt. These effects will be most visible when combined with extreme events and disasters. In the next section, we examine the underlying factors behind vulnerability to climate change impacts and disasters.

Table 3: Impacts of climate change on poverty and the Millennium Development Goals

Changes in mean climate, variability, extreme events and sea level rise	**Impact on poverty**	**Impacts on the eight Millennium Development Goals**
Increased temperature and changes in precipitation **reduce agricultural and natural resources.** Change in precipitation, run-off and variability leads to **greater waterstress.** Increased incidence or intensity of climate-related disasters leads to **damage to assets and infrastructure** Temperature, water and vegetation changes contribute to **increased prevalence of disease**	Lowered industrial output and labour productivity, high inequality, impacts on trade, and fiscal and macro-economic burdens lead to **reduced economic growth**, and poverty- reducing effects Reduced productivity and security of **poor people's livelihood assets**, and reduced access for the poor to their livelihood assets Less effective coping strategies among the poor, and increased **vulnerability** of poor people	**1 Eradicate extreme poverty and hunger** Food security jeopardised; more intense disasters threaten livelihoods. **2 Achieve universal primary education** More vulnerable livelihoods mean more children engaged in employment; infrastructure damage from disasters. **3 Promote gender equality and empower women** Women make up two-thirds of world's poor and are more adversely impacted by disasters. **4 Reduce child mortality** Children more vulnerable to malaria and other diseases, which are spread more widely by climate change. **5 Improve maternal health** Pregnant women particularly susceptible to malaria. **6 Combat HIV/AIDS, malaria and other diseases** Increased prevalence of mosquito-borne diseases. **7 Ensure environmental sustainability** Climate change indication of unsustainable practices. Move towards more energy-efficient models of consumption. **8 Promote global partnerships** Wider forums must acknowledge the role of climate change in impacting MDGs.

Source: Mitchell and Tanner[54]

3. Vulnerability to Climate Change and Extreme Events

> …understanding who is vulnerable, and why, can help us to prevent our neighbour's home from washing into the sea, a family from suffering hunger, a child from being exposed to disease and the natural world around us from being impoverished. All of us are vulnerable to climate change, though to varying degrees, directly and through our connections to each other.
>
> (Leary et al. 2008)[60]

Climate change is associated with a myriad of socioeconomic and biophysical shifts, but potential and projected changes in climate variability, including increases in extreme event frequency or intensity, is well recognized as a central societal concern.[61] This has led to a growing body of research on the aggregate estimates of the economic and social costs of climate change in terms of human mortality and morbidity, GDP, infrastructure, and capital resources that may be affected by extreme events.[62] There is also a growing recognition of the need to prepare for and manage the effects of extreme weather events under climate change.[63] Although technical responses related to hazards and climate impacts have long been considered important, over the past decades attention has shifted to a focus on vulnerability, and particularly on the role that climate change adaptation and disaster risk reduction can play in reducing vulnerability to climate variability, hazards and extreme events.

It is important to note that definitions, conceptualizations and interpretations of vulnerability differ both between and within the disaster risk and climate change communities.[64] Several definitions of vulnerability are presented in Box 2. The IPCC definition focuses on vulnerability as a function of: 1) exposure to a climate risk; 2) sensitivity or susceptibility to damage; and 3) adaptive capacity, including the capacity to recover from impacts.[65] Vulnerability can also be explained by different causal factors, including biogeophysical and technological conditions, institutional failures, and social, economic and political conditions and inequalities.[66] A "physical vulnerability" approach emphasizes biogeophysical and technological interpretations that relate vulnerability to locations in high-risk areas (e.g., low-lying coastal areas), high concentrations of population and physical capital in small areas, a dependency on large-scale infrastructure projects, an increased risk of disease transmission due to crowded conditions, and location in fragile or vulnerable environments, such as deforested mountain slopes.[67] This hazard-centered or impact-oriented paradigm focuses largely on the physical processes underlying vulnerability to climate change and disasters. Consequently, vulnerability reduction strategies often seek to control outcomes through monitoring and predicting, as well as through engineering projects and technological interventions that contain or reduce their effects.[68] A "social vulnerability" approach, in contrast, focuses on vulnerability as the result of an interplay among many contextual factors, including biophysical, social, economic, political, institutional, technological and cultural conditions that generate unequal exposure to risk and create differential capacities to respond to both shocks and long-term changes.[69] This vulnerability context is described in more detail below.

Box 2. Definitions of Vulnerability

"Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity." (IPCC 2007)[70]

"Vulnerability is the state of susceptibility to harm from exposure to stresses associated with environmental and social change and from the absence of capacity to adapt." (Adger 2006)[71]

"The conditions determined by physical, social, economic, and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards." (UNISDR 2007)[72]

"The characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard (an extreme natural event and process)." (Wisner et al. 2004)[73]

3.1. The vulnerability context

The vulnerability literature provides important insights regarding how and why some individuals, households, social groups, and public institutions are likely to be disproportionately affected by climate change, extreme events, and disasters.[74] Numerous vulnerability frameworks emphasize specific contextual factors that influence exposure and the capacity to respond to change.[75] For example, Turner et al. developed a place-based framework that focuses on the coupled human- environment system and examines how hazards can potentially affect the system.[76] Their framework recognizes that responses and their outcomes collectively determine the resilience of the coupled system and may, in fact, transcend the system or location of analysis to affect other scalar dimensions of the problem, creating potential feedbacks to the original system. Other types of vulnerability frameworks include capabilities, assets, and livelihoods approaches that focus on the factors that constrain or enable people in pursuing outcomes that they value.[77] The DFID framework on sustainable livelihoods views people as operating in a context of vulnerability, where they have access to certain assets or poverty-reducing factors that are influenced by the prevailing social, institutional, and organizational environment.[78] The Pressure and Release (PAR) model of Wisner et al.[79] explicitly discusses how "unsafe conditions" are transformed into disasters given exposure to biophysical, social, political, and economic stressors. This model describes how vulnerability is rooted in social processes and underlying causes (called dynamic pressures and root causes), which may often be quite remote from the disaster event itself.

An individual or group's vulnerability to climate change and climate-related disasters is thus influenced by the complex array of social, economic, political and environmental factors operating at a variety of levels that in combination affect vulnerability.[80] Consequently, vulnerability is not evenly distributed across society, and some individuals, households, or groups are likely to be disproportionately affected by climate change or disasters. Box 3 discusses some of the issues surrounding vulnerability of two important demographic groups; the elderly and children. Interestingly, most vulnerable people do not perceive themselves to be vulnerable – they instead refer to vulnerability in terms of "weakness," "problems," and "constraints."[81] Although structural and systemic factors can contribute considerably to vulnerability, it is recognized that people and institutions act from diverse histories and worldviews and consequently have different interpretations and perceptions of risk and vulnerability, hence they may develop differential responses to sim-

ilar conditions and processes.[82] Some individuals may consider that no risk is tolerable, and thus hold their government responsible for insulating them from all risks, whereas others may be willing or forced to live with considerable risk.[83] Nonetheless, as Hilhorst points out, "[n]arratives that people create about risk, vulnerability and disasters are not just statements about nature, but are also statements about state-society relations."[84]

In short, the possible effects of climate change extremes cannot be understood independently of larger social, economic and cultural changes. It is widely recognized within the disaster risk community that hazards themselves rarely create disasters, but instead it is the context in which the hazard occurs that contributes to disastrous outcomes.[85] This is relevant to climate change-related extreme events as well. Yet it is also important to recognize that the context in which climate extremes and hazards occur is constantly changing as the result of many factors, including rates of economic development and natural resource exploitation, urbanization, deforestation and land use changes. Among the many environmental and social processes that structure vulnerability, rising global food prices, warfare, corruption, trade dependency, macroeconomic policies, and a host of large-scale processes associated with globalization shape the social and economic entitlements that influence vulnerability.[86] There are also important path dependencies related to vulnerability; past processes such as colonization and war shape present insecurities, while ongoing processes such as climate change and changes to ecosystem services shape future insecurities.

Box 3. Children and the Elderly: Extremely Vulnerable to Extremes?

The climate change and disaster risk communities are paying increasing attention to differential vulnerability among demographic groups, particularly children and the elderly. The IPCC Fourth Assessment Report from Working Group II, for example, noted that the health risks associated with changing incidence of weather extremes were most concentrated in vulnerable populations that include the elderly and young children.[87]

More elderly will be exposed to climate change in the coming decades, particularly in OECD countries. By 2050, it is estimated that 1 in 3 people will be above 60 years in OECD countries, as well as 1 in 5 at the global scale.[88] The factors that contribute to the vulnerability of people over 60 years of age to climate change are similar to factors that make them vulnerable to hazards: deterioration of health, personal lifestyles, loneliness, poverty, or inadequate health and social structures are all elements that can contribute to vulnerability.[89] The context in which people are aging will also influence future vulnerability to climate change. This context includes changing health conditions, as well as issues of social exclusion; welfare programme reforms and their impact on the elderly income; developments in the health and social care system; and finally, the evolution of family structures.

Children constitute a very large percentage of those who are most vulnerable to climate change. The effects of extreme events, especially for the youngest children, can be long term.[90] In explaining why children as a group are particularly vulnerable to challenges associated with climate change, Bartlett points out that children are in a rapid stage of development and are less equipped to deal with deprivation and stress, due to rapid metabolisms, immature organs and nervous systems, developing cognition, limited experience and various behavioral characteristics.[91] The adversity experienced by affected children tends to be intensified by poverty and the difficult choices low-income households make as they try to adapt to hardship. With climate change and the need to handle multiple stressors at various levels, children's voices and participation in policy and decision making is likely to become even more pressing and important, as their capacity to contribute to adaptation and disaster risk reduction has been largely overlooked.[92]

Hazards and extreme events themselves can alter the context for economic and social development, which can in turn reduce the capacity to respond to future extremes.[93] Cumulative effects of events such as hurricanes, floods, or droughts not only damage or destroy material assets and human lives, but they may also influence the capacity and resilience of individuals to recover their sense of well-being. Common emotional reactions after a disaster include shock, fear, grief, anger, guilt, shame, helplessness, numbness and sadness, which in combination with cognitive reactions such as confusion, indecisiveness, worry and difficulty concentrating, can make recovery a challenge for days, weeks, months, or years following a disaster.[94] The long-term implications of post-traumatic stress disorder (PTSD) have been witnessed in the aftermath of recent disasters such as Hurricane Mitch, Hurricane Katrina, and the Asian tsunami.[95] There is also an increasing body of research assessing the prevalence and severity of children's distress after an extreme event in the months following a disaster.[96] Kar finds that high exposure, lower educational levels and middle socioeconomic status significantly predicted the outcome of PTSD.[97] Whereas the shock just after a disaster is readily evident, children and their families report that the aftermath of traumatic events and the deprivations and humiliations associated with slow recovery process are particularly stressful.[98]

Vulnerability reduction is thus recognized as an important strategy for reducing disaster risks and minimizing the impacts of climate change. However, despite increased emphasis on the importance of social, political and economic contexts, climate change adaptation and traditional disaster risk management activities remain largely delinked from vulnerability reduction.[99] In fact, a synthesis of evaluation findings on humanitarian responses to natural disasters found relatively few examples of good practices related to vulnerability reduction.[100] There tends to be, instead, a disproportionate emphasis on relief and recovery processes that prioritize a return to 'normalcy,' rather than focusing on the conditions that cause risk and vulnerability. In many cases, these 'normal' conditions are directly or indirectly contributing to risk and vulnerability.[101]

4. Disaster Risk Reduction and Climate Change Adaptation

> Holistic management of disaster risk requires action to reduce impacts of extreme events before, during and after they occur, including technical preventive measures and aspects of socio-economic development designed to reduce human vulnerability to hazards. Approaches toward the management of climate change impacts also have to consider the reduction of human vulnerability under changing levels of risk. A key challenge and opportunity therefore lies in building a bridge between current disaster risk management efforts aimed at reducing vulnerabilities to extreme events and efforts to promote climate change adaptation.
>
> (Few et al. 2006)[102]

Recognition of the linkages between climate variability, climate change, and extreme events has fostered a small but growing literature on the connections between disaster risk reduction and climate change adaptation.[103] This literature shows that there is a great potential for coordinated efforts towards addressing adaptation. The disaster risk community advocates using the tools, methods and policies of disaster risk reduction as a basis for addressing the risk aspects of climate change. Methodologies and experiences in working with vulnerable people and their needs through community-based initiatives are emerging as a cornerstone for disaster risk reduction.[104] At the same time, the climate change community offers a growing body of research and experience on adaptation as a social process, with an emphasis on strategies and measures to reduce vulnerability and enhance the capacity to adapt to shocks and stressors.[105] This includes initiatives aimed at building resilience through community-based adaptation. Given these overlapping areas of expertise and empirical experience, there have been numerous calls for increased collaboration between the two communities.

Yet strategies for disaster risk reduction and climate change adaptation have until now evolved largely in isolation from each other through different conceptual and institutional frameworks.[106] The disaster risk management community has gone through various paradigm shifts since the early 1970s.[107] Throughout these stages the "disaster" or humanitarian community has refined its practical and conceptual approach from managing disasters by addressing the hazards, to understanding and addressing the underlying factors and vulnerabilities that turn hazards into disasters, culminating in the disaster risk reduction framework.[108] The Hyogo Framework for Action (HFA) was adopted by 168 countries in 2005, and provides a technical and political agreement on the areas that needs to be addressed to reduce risk. The HFA presents five priorities for action: 1) ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation; 2) identify, assess and monitor disaster risks and enhance early warning; 3) use knowledge, innovation and education to build a culture of safety and resilience at all levels; 4) reduce the underlying risk factors; and 5) strengthen disaster preparedness for effective response at all levels.

Climate change adaptation has a somewhat shorter history, emerging in the United Nations Framework Convention on Climate Change (UNFCCC) signed in 1992. However, the UNFCCC and the Kyoto protocol predominantly addressed

climate change mitigation and policies and measures to reduce the emissions of greenhouse gases. It was not until quite recently that adaptation came to the forefront as a key concern within the UNFCCC.[109] The possibilities for Least Developed Countries to develop National Adaptation Programmes of Actions (NAPAs) and the Nairobi Work Program—a 5-year (2005-2010) initiative under the UNFCCC,[110] were important first steps towards both enhancing the understanding of adaptation and catalyzing action on adaptation. The Bali Action Plan (BAP), agreed upon at the UNFCCC Conference of Parties (COP) in Bali, provides a roadmap towards a new international climate change agreement to be concluded by 2009 as successor to the Kyoto Protocol.[111] The BAP puts adaptation on an equal footing with mitigation. In the BAP, risk management and disaster risk reduction are identified as important elements of climate change adaptation. Further, the BAP emphasizes the importance of "building on synergies among activities and processes, as a means to support adaptation in a coherent and integrated manner."[112]

No comprehensive formal scientific assessment has been undertaken yet of the research findings and empirically-based activities that are emerging from the two communities. With increased attention to climate change and associated impacts within the disaster risk community, and growing recognition of the links between disaster risk reduction and adaptation within the climate change community, there is now both a need and an opportunity to learn from the experiences of both the disaster risk and climate change research and practice. Important lessons can be drawn from such an assessment, which can be used to better inform society on how to adapt to a changing climate, and to better integrate and coordinate adaptation and disaster risk reduction across different levels of governance.[113]

What might such lessons look like? Below, we extract and discuss four points that can be gleaned from a brief review of disaster risk reduction and climate change adaptation literatures. These points illustrate the potential synergies that might emerge from a more in-depth scoping or formal scientific assessment. In section 5, we then argue that such synergies are urgently needed to guide insights and actions that increase human security in the face of climate change.

4.1. Disaster risk reduction and climate change adaptation must be closely linked to development

As the uneven distribution of impacts and opportunities presented by climate change and disasters come into sharper focus, both disaster risk reduction and climate change adaptation have become core development issues. There are instrumental concerns about minimizing threats to progress on poverty reduction and the MDGs, but also justice and equity concerns because the impacts of climate change are often hardest felt by those who have contributed least to the problem.[114] For the climate change community, a collaboration with development researchers and practitioners has already contributed to a shift from a theoretical focus on adaptation based on future scenarios of climate change, towards identifying broad policy needs and a variety of practical adaptations than can reduce vulnerability.[115] For the disaster risk community, collaboration with the development community has played an important role in identifying vulnerability reduction strategies. Enhancing collaboration across the disaster risk, climate change and development communities may be the most effective means of promoting sustainable adaptation to climate change.

However, in an analysis of the links between adaptation, disaster risk management and development, Schipper and Pelling point to the difficulty of integrating the three agendas because of the distinct sets of actors and institutions involved (see Figure 1).[116] Rather than consulting each other on common topics, these groups often "reinvent the wheel" and come up with separate frameworks within the same meta-narratives. Yet a key contribution to all of these frameworks from development researchers and practitioners is the recognition that risk reduction and adaptation strategies must be carefully tailored to individual, household and community needs. Approaches that treat communities as homogeneous (i.e., able to adapt or reduce risks as a group) are prone to failure, as are adaptation and disaster risk reduction measures that do not explicitly and simultaneously address poverty.[117]

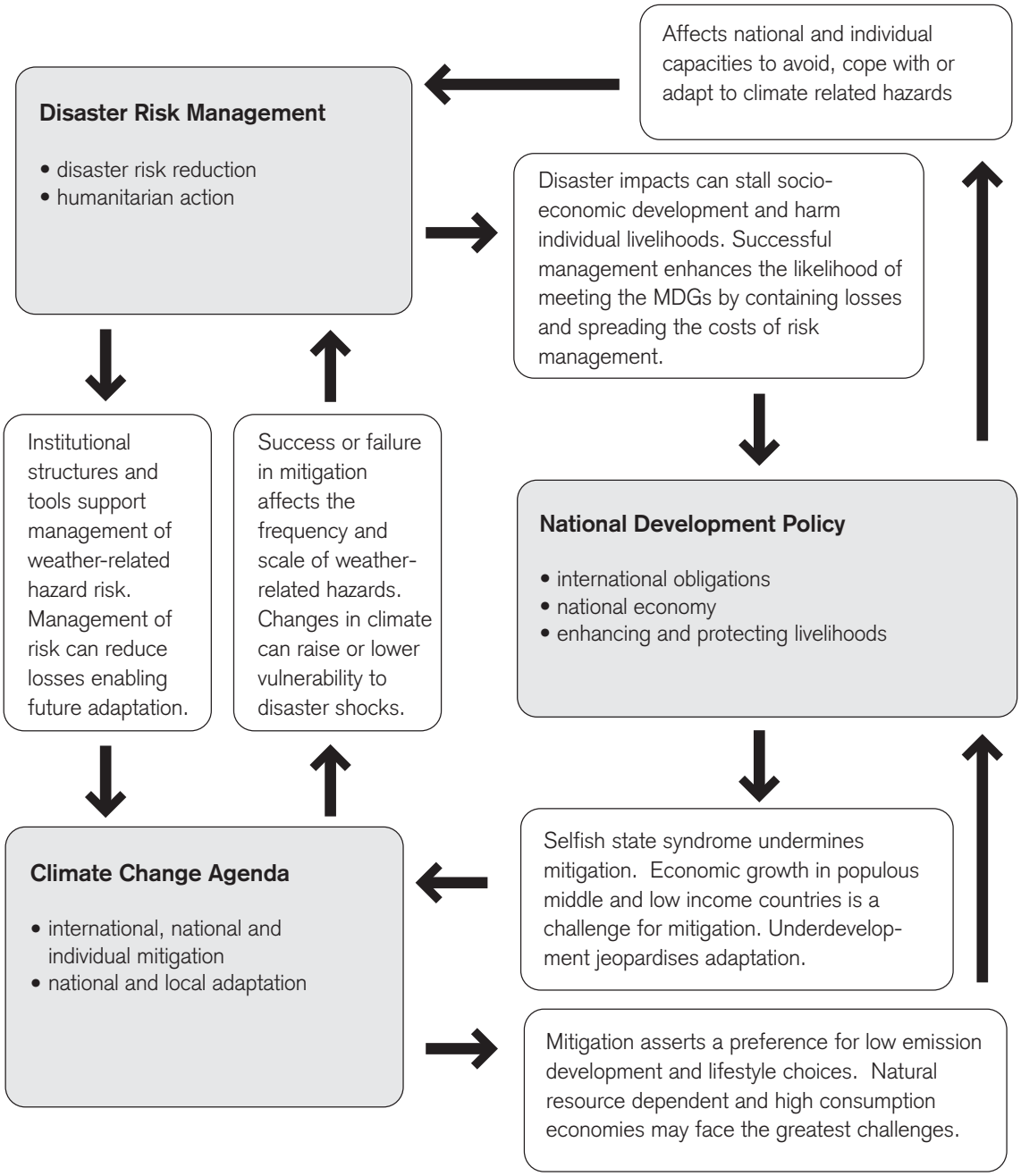

Figure 1. Relationship between disaster risk management, climate change adaptation, and national development policy

Source: Schipper and Pelling, 2006

4.2. Disaster risk reduction and climate change adaptation must address local needs

Local-level experiences can be considered the front-line of impacts from hazards and extreme events, thus they can provide important insights on the most urgent challenges associated with extreme weather events in a changing climate. The disasters community has a long history of experience in working at the local level, and a body of work on community-based adaptation is also emerging to link climate change, disaster risk reduction and development.[118] Numerous examples of local needs and challenges have emerged from community level case studies carried out in relation to both

disaster risk reduction and climate change adaptation (see Table 4). These case studies have much in common, particularly in their emphasis on vulnerability and capacity assessments at the local level to identify existing coping capacities as the basis for meeting future hazards. Such community-based assessments draw from participatory methods to link vulnerability with entitlements and access to resources, often employing a sustainable livelihoods framework.[119]

Early lessons from community-based adaptation and disaster risk reduction suggest that there is considerable potential for reducing vulnerability at the local level.[120] These lessons have stressed the need for working with trusted local intermediaries who have a firm understanding of community circumstances and dynamics, basing new activities, technologies or practices on existing coping practices. Good local development practice is crucial to the process, allowing the introduction of knowledge around current and future climate risks based on existing activities and knowledge. Addressing deficits in current coping and risk management to climate-related hazards is crucial to this approach, particularly regarding extreme events. The social vulnerability approach in particular has played a critical role in reorienting traditionally top-down methods in both disaster risk reduction and climate change adaptation towards the community or local level.[121] Engagement at the community level is underpinned by a reframing of vulnerable people not as passive victims but as capable of preventing disasters and adapting to climate change within their own communities. Bottom-up approaches promote locally-appropriate measures, empower people to change their own lives, and encourage greater ownership of disaster risk reduction and adaptation actions. Communications have been highlighted as extremely important, which suggests an emphasis on presenting knowledge in a community's own language, through innovative media, and in understandable non-scientific terms.

Table 4: Examples of major community based disaster risk reduction and adaptation tools and platforms

Tools and knowledge sharing platforms	Notes
Community Risk Assessment Toolkit ProVention Consortium www.proventionconsortium.org/?pageid=39	The toolkit draws together a diverse range of community risk assessment (CRA) methods, mainly from NGOs and community-based organizations. It documents CRA methods and applications, and assists users in identifying a method or case study of particular relevance to their context.
Climate Guide Red Cross / Red Crescent Centre on Climate Change and Disaster Preparedness http://www.climatecentre.org/downloads/File/reports/RCRC_climateguide.pdf	Highlighting the experiences of Red Cross / Red Crescent staff and volunteers, the Climate Guide provides a basic issue primer and introduces six thematic modules to work through in Red Cross/Red Crescent National Societies' activities. Each module begins with a background section with real-life experiences and perspectives, followed by a "how-to" section with specific step-by-step guidance.
Community Based Adaptation Exchange (CBA-X) IIED – Eldis www.cba-exchange.org	An initiative stemming from international workshops on community-based adaptation, CBA-X builds on the Eldis climate adaptation portfolio to support the exchange of information and experiences on community based adaptation to climate change, including case studies and tools.

4.3. Climate information must capture complexity and uncertainty to support adaptation and disaster risk reduction

Research has shown that scientists need to collaborate more closely with local knowledge networks and take into account people's risk perceptions, as well as the decision-making processes these communities use.[122] However, reducing disaster risk and vulnerability also requires close interaction between scientists who produce knowledge about changing patterns of risk and researchers and practitioners who use such information for disaster risk reduction and climate change adaptation. Currently, the spatial resolution of many climate change projections is too coarse to enable effective disaster risk reduction at the local or regional scale. The gap between climate forecasts and projections and the needs of resource managers may pose some challenges to effective responses. Past experiences with reducing risks associated with climate variability can provide some important insights into disaster risk reduction and climate change adaptation.[123] In southern Africa, for example, research has demonstrated strong linkages between El Niño Southern Oscillation (ENSO) and rainfall patterns. In particular, drought events in parts of southern Africa in the early 1980s were closely correlated to ENSO events. However, more recent evidence (particularly from the late 1990s ENSO events) suggests that the relationship between ENSO and summer rainfall does not always hold in this region, particularly at the local scale where many important livelihood decisions are made.[124]

One lesson from this area of research is that over-reliance on only one indicator (e.g., ENSO signals) can be problematic for effective disaster risk reduction and climate change adaptation. Consequently, there is a need for a better understanding of complex and compound hazards, both from physical and social perspectives. The complexity of future extreme events, which are likely to be characterized by one or more hazard that is compounded by other factors (e.g. flooding combined with a cholera outbreak that coincides with an economic crisis), requires more robust and flexible disaster risk strategies and institutional responses than has been typically used in the past. Indeed, a recent report on disaster risk reduction in sub-Saharan Africa calls for better identification, assessment and awareness of disaster risks, which will require efforts from both the disaster risk reduction community and climate scientists.[125] Communication about climate change needs to be made accessible in order to engage vulnerable people without compromising scientific credibility.[126]

4.4. There are thresholds and limits to disaster risk reduction and adaptation

There are likely to be some thresholds and limits to the potential for disaster risk reduction and adaptation to enhance human security in the face of climate change. Schneider et al. note that "the risk-reducing potential of planned adaptation is either very limited or very costly for some key vulnerabilities, such as loss of biodiversity, melting of mountain glaciers or disintegration of major ice sheets."[127] In other words, there are absolute limits that are faced by many ecosystems and individual species in adapting to new climatic conditions, particularly given constraints of urban land use and conversion of natural habitats to agriculture; over-exploitation of resources such as fisheries; and other stresses such as pollution loading to terrestrial and marine environments.[128] Hence there are major non-linearities and uncertainties related to climate change. Schneider et al. also argue that "adaptation assessments need to consider not only the technical feasibility of certain adaptations but also the availability of required resources, the costs and side effects of adaptation, the knowledge about those adaptations, their timeliness, the incentives for the adaptation actors to actually implement them, and their compatibility with individual or cultural preferences."[129] Adger et al. elaborate on this by discussing six broad categories of limits to adaptation closely linked to the rate and magnitude of climate change, as well as associated key vulnerabilities: physical and ecological limits, technological limits, informational and cognitive limits, social and cultural limits, institutional political limits, and financial limits.[130]

Financial barriers to both adaptation and disaster risk reduction have been highlighted, but primarily in policy documents around the international climate regime, rather than in scientific and economic literatures. The SBSTA body of

the UNFCCC, the Stern Review, the World Bank, OECD, Oxfam and UNDP have estimated adaptation costs for developing countries.[131] The Stern Review presents the lowest estimate of USD 4 billion per year to adapt to climate change.[132] The highest estimate is made by UNDP which estimates adaptation costs to USD 86-109 billion a year. An OECD study on the economics of adaptation demonstrates that these numbers, which have already been widely used in political statements and demand for more funds, should be handled with caution.[133] Baer, and Paavola and Adger, have discussed principles by which such estimates could be derived (compensation for damage; transfers to the most vulnerable, fair allocation and others).[134] The important point made by all of these analyses is that the costs of adaptation are significant and hence there are real financial barriers, especially in developing countries, to implementing adaptation in a sustainable manner. This area is significantly under-researched and emerging insights from public choice theory and other could be applied to enlighten the international costs of adaptation and disaster risk reduction in the context of the international strategies for mitigation.[135]

Reducing vulnerability to weather-related disasters also faces constraints associated with behavior and cognition of risk.[136] New research from social psychology, some highlighted in the IPCC Fourth Assessment Report, has shown that individuals deny risks, feel powerless to act, or have little adaptive capacity. For example, by examining elderly people's perceptions of heat wave risks, Wolf et al. show that individuals with low self-efficacy do not perceive themselves as able to act on perceived threats. Because they do not perceive their own vulnerability, they do little to adapt.[137] These studies also demonstrate that decision-making is not a uni-directional and sequential process; instead it is incremental and at times multi-directional. In other words, one step towards a decision may be contradicted by new information and experiences. This suggests that individual responses to climate change may not be as rational as many assessments of adaptive behavior assume.[138] Such findings have important consequences for both disaster risk reduction and climate change adaptation.

5. Human Security Implications of Climate Change

> …climate shocks also erode long-term opportunities for human development, undermining productivity and eroding human capabilities. No single climate shock can be attributed to climate change. However, climate change is ratcheting up the risks and vulnerabilities facing the poor. It is placing further stress on already over-stretched coping mechanisms and trapping people in downward spirals of deprivation.
>
> (UNDP 2007/2008)[139]

There is growing recognition among scientists, practitioners, and policy-makers that climate change will increase the frequency and magnitude of extreme hydro-meteorological events with potentially devastating economic and social impacts at the local and regional levels.[140] Disasters are increasing in impacts and scope, not due to hazards alone, but because of the combined effects of large-scale environmental, economic, social, demographic, and technological changes.[141] Climate change and the potential for increased disasters related to extreme events also raise critical concerns for long-term human security.[142] Human security, broadly defined, includes the means to secure basic rights, needs, and livelihoods, and to pursue opportunities for human fulfilment and development.[143] The promotion of human security is also closely linked to a "positive vision" of society that is encapsulated in notions such as well-being, quality of life, and human flourishing.[144] This positive vision has been elaborated through the capabilities approach, which emphasizes the freedom of people to choose among different ways of living, and to pursue opportunities to achieve outcomes that they value.[145]

A number of recent studies have assessed the relationship between climate change and human security, demonstrating that the linkages are often both complex and context-dependent. For example, negative impacts of climate change on food security over the medium- and long-term are likely to create greater emergency food aid needs in the future.[146]Among the most widely-discussed humanitarian and human security issues surrounding climate change are the possibilities of mass migration and/or violent conflict as the result of biophysical or ecological disruptions associated with climate change. Below, we discuss how migration and conflict, both of which are emerging as key security concerns among national governments and international institutions, are intricately tied to the vulnerability context that disaster risk reduction and climate change adaptation are targeting.

5.1. Climate change and migration

Concerning migration, disasters linked to both extreme events and more gradual changes often lead to displaced people, refugees, relocated communities, and temporary or permanent migration. The relationship between climate risk and displacement is a complex one and there are a myriad of factors that affect displacements and migration. However, recent studies suggest that climate change and associated adverse environmental impacts have the potential to trigger displacement of an increased number of people.[147] Research further suggests that the bulk of migration will take place internally in individual countries; that the majority of migration will come as a result of gradual changes in climate and not so much from individual catastrophic events;that in most cases when hydro-climatic disasters occur in developing countries they will not lead to net out-migration because people tend to return to re-establish their lives after a disaster; and that long term environmental changes are likely to cause more permanent migration.[148]

Recent studies distinguish between migration driven by 1) the increasing frequency and intensity of slow onset disasters such as drought and desertification; 2) rapid onset disasters such as floods and cyclones, and 3) incremental changes driven by sea-level rise.[149] Most studies agree that the most important climate change-related driver of migration will be sea-level rise, with the more careful assessments recognizing that the severity of migration will depend critically on the rate of localized changes in sea-level, and the degree to which adaptation takes place and is successful.[150] These studies also recognize that the rate of migration driven by sea-level rise is likely to be slow, but steady, which suggests that disaster risk reduction and adaptation strategies may help avoid humanitarian crises and political instability.

Some studies also recognize that there may be some degree of exaggeration surrounding discussions of "environmental refugees" driven by climate change, creating the danger of inappropriate policy responses that do little to ensure the rights of those most at risk from climate change.[151] While it does seem likely that climate change will be an additional contributor to migration, many studies emphasize that it is very unclear how many migrants there may be, where they may move from and to, and over what time scale. This uncertainty suggests that some of the more alarmist predictions, including those by Myers and Christian Aid, should not be used as a basis for policy.[152]

It is also widely recognized that environmental change is never a sole cause of migration, and that there are always one or more underlying economic, political or other social factors that make environmental change a proximate trigger, rather than an underlying driver of migration.[153] Whether an individual may migrate due to climate change depends on what is understood of the risks posed by climate change, and to what extent the benefits and costs arising from migration are understood by the individual.[154] Many variables shape an individual or family's decision to migrate, including factors at the point of origin, factors at the destination, intervening obstacles such as distance and institutional constraints, and personal circumstances.[155] Many studies also show that in most cases migration in response to disasters is only possible after a certain level of wealth is reached, meaning that the larger humanitarian problems may be in places where people *cannot* afford to move, rather than the places to which they do move.[156] In terms of slow-onset disasters such as drought, the evidence is more mixed: repeated drought events such as occurred in the Sahel in the 1970's and 1980's did lead to large scale migration, although it is more often the case that drought was only a trigger, with the underlying drivers being changes in livelihood systems driven by dependence on exports of a few primary commodities as a result of colonization.[157] In other cases, such as drought in Bangladesh in 1994, large-scale migration was not an outcome.[158]

It is important to point out that migration as a form of adaptation is not unproblematic. For example, if recent estimates of a 140cm rise in sea-level rise and annual coral bleaching are correct,[159] then there is little that can be done to avoid or adapt to losses of land on low-lying atoll islands, with a worst case outcome being the collapse of the ability of island ecosystems to sustain human habitation and subsequent risks to the sovereignty of the world's five atoll-island states. The result may be increases in morbidity and mortality, as well as an increased demand for migration.[160] In the Arctic, too, there is arguably little that can be done to avoid or adapt to absolute losses of snow and ice, melting of permafrost, and resultant changes in social-ecological systems.[161] As with low-lying atoll islands, increased morbidity, mortality and migration may result. In both cases there are other significant losses as well, including of place and culture and the right to a nationality and a home.[162] In each case migration cannot be seen as an 'adaptation' but rather as a loss of culture, livelihood, place and the right to a home.

5.2. Climate change and conflict

The magnitude of environmental changes expected to result from even 2°C of warming above pre-industrial levels may cause significant negative social outcomes in certain social systems—in particular low income and resource-dependent societies.In recent years there has been considerable attention to the relationship between climate change and violent

conflicts. Many studies propose that climate change heightens the risk of violent conflict between countries.[163] Others, however, are more circumspect, arguing that while there is cause for concern, there is as yet only limited research to substantiate the argument that climate change will increase violent conflict.[164] These debates notwithstanding, some recent research suggests that certain aspects of climate do influence the likelihood of violent conflict. Miguel et al. use rainfall variation as a proxy for economic growth in 41 African countries and find that decreases in rainfall strongly increase the likelihood of conflict in the following year.[165] Hendrix and Glaser, and Meier et al. also find associations between rainfall variability and violent conflict.[166] Nel and Ringharts show that rapid onset disasters related to climate and geology increase the risk of violent civil conflict, particularly in low and middle income countries.[167] All of these studies use aggregated data sets, and are not without their empirical and methodological problems as explained by Buhaug et al.[168] Yet they do indicate the possibility of a connection between climate and conflict, and justify grounds for concern about the possibility that climate change may increase the risk of violent conflict.

There is some evidence that some of the likely outcomes, such as dwindling resource stocks, a decline in livelihoods, decreasing state revenues, and increasing inequality across space and class, may create opportunities for some elites to harness resentment and mobilize people to fight, and this is more likely in states where regimes are weakened by decreasing revenues from resource-based rents or taxes.[169] If climate change causes migration, this too may be a cause of violent conflict in certain circumstances.[170]

Many studies recognize that there are multiple options for reducing the risk of conflict arising from climate change.[171] It is also important to recognize that conflicts resulting from climate change will not necessarily be violent and can instead lead to changes in the distribution of power and resources, and protection of the things that are valued. Furthermore, research on international river basins shows that issues of water access and water scarcity in many cases lead to cooperation, rather than conflict.[172] In short, the evidence about the links between environmental change and violent conflict is currently inconclusive. Neither qualitative examination of cases, nor research seeking generalizable findings based on statistical data, have produced robust findings.[173] There is, however, ample evidence that human insecurities associated with a lack of basic needs such as food, water, and shelter, limit capabilities and freedoms, and thus have negative implications for human development.[174]

6. Conclusions

> Both mitigation and adaptation should be seen as human security imperatives in a broader sense.
>
> (UNDP 2007/2008)[175]

Adaptation to climate change will be an enormous challenge for society over the next several decades. While mitigation measures are expected to reduce or slow the growth of future emissions, these efforts will not halt climatic changes that are already underway due to carbon dioxide and other greenhouse gases that are currently present in the atmosphere.[176] Key points emphasized throughout this report are that disaster risk reduction and climate change adaptation are of critical importance to the security of millions of people, and that vulnerability reduction can serve as a cornerstone for strategies to reduce the negative outcomes of climate change. There is a considerable body of knowledge on disaster risk and climate change that can be used as a basis for developing coordinated efforts for climate change adaptation. However, this literature has not yet been systematically assessed.

There are also many areas where new interdisciplinary research is needed. For example, the increasing occurrence of "complex extremes" and "complex emergencies" is likely to pose pressing challenges for the climate change adaptation and disaster risk communities and the development community at large.[177] The risk of more complex, frequent and intense extreme weather events will be exacerbated by both gradual and non-linear changes in climate and climate variability, suggesting the need for a renewed focus on the ways that disaster risk reduction and other adaptation strategies can influence the context in which climate change is experienced. Such research efforts must take into account the critical role that non-climatic factors, such as development levels, inequality, and cultural practices play in these complex extremes.[178] It is becoming clear that neither disaster risk reduction nor climate change adaptation is about addressing disasters or climate change *alone*, but rather about confronting the societal context in which these changes are occurring.[179] An assessment of the literature on disaster risk reduction and climate change adaptation represents an important first step towards identifying the strategies and frameworks for meeting present and future challenges related to climate change.

In considering the linkages between disaster risk reduction, climate change adaptation and human security, it is important to recognize that human security is not simply about freedom from conflict or prevention of population displacement.[180] Human security is closely linked to the development of human capabilities in the face of change and uncertainty. Individuals and communities faced with both rapid change and increasing uncertainty are challenged to respond in new ways that protect their social, environmental, and human rights. Considering human security as a rationale for disaster risk reduction and climate change adaptation in the face of climate change emphasizes both equity issues and the growing connections among people and places in coupled social-ecological systems.[181] Never in history has the management of threats to the environmental, social and human rights of individuals and communities been as important at local, regional and global scales, and never before have human security concerns been so closely interlinked across regions, groups, and generations. As many references cited in this report convincingly show, it is possible to reduce risk and vulnerability to disasters of our own making.

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Global Environmental Change and Human Security (GECHS)

GECHS is a core project of the International Human Dimensions Programme on Global Environmental Change. The goal of GECHS is to promote an understanding and recognition of global environmental change as an issue of equity, sustainability and human security. We situate environmental changes within the larger socioeconomic and political contexts that cause them, and which shape the capacity of communities to cope with and respond to change. Our research focuses on the way diverse social processes such as globalization, poverty, disease and conflict combine with global environmental change to affect human security.

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