Moving On: Towards a Policy Framework for Addressing Climate Change and Migration

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1. INTRODUCTION

Climate change is widely recognised as one of the principal challenges of the 21st century, and as a significant threat to human development (UNDP, 2007). There is widespread agreement that global mean surface temperature should be "stabilised" at or below 2° C above the late pre-industrial mean, in order to avoid "dangerous anthropogenic interference with the global climate system" (UNFCCC, 2009). Nonetheless, current policy regimes and trends in greenhouse gas emissions are incompatible with this objective, and an increase in global mean surface temperature in the region of 4° C above the late pre-

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industrial value by the end of the 21st century appears likely in the absence of rapid and drastic action to reduce emissions (Anderson and Bows, 2008).

While there is considerable uncertainty regarding the potential regional manifestations and impacts of climate change, significant changes in the availability and distribution of natural resources such as water and productive land are likely over the course of the 21st century and beyond (IPCC, 2007). The implications of climate change for the functioning of ecosystems and the provision of ecological goods and services are likely to be significant and profound. Increases in sea-level and long-term changes in water availability will result in some areas becoming less habitable and/or productive, while increases in temperature and changes in rainfall may increase productivity in some locations. Ocean warming and acidification will affect marine productivity with implications for livelihoods and food security in coastal zones. Climate change will also influence the behaviour of climatic extremes, exacerbating disaster risk in many locations (Meehl et al., 2007).

All of the above processes have the potential to affect livelihoods, food security, poverty, economic growth, international trade and governance, and therefore to influence migration, even where climate change does not result in the total loss of habitable or productive land through mechanisms such as sea-level rise and desertification. Given the projected magnitude of global anthropogenic climate change, it is reasonable to assume that the 21st century will be a period of profound climatic and environmental transition, during which societies will have to adapt to changes for which there is no historical precedent (see Box 1).

The First Assessment Report (FAR) of the Intergovernmental Panel on Climate Change (IPCC) stated that climate change "could initiate large migrations of people, leading over a number of years to severe disruptions of settlement patterns and social instability in some areas" (IPCC, 1990: 3). The FAR identified risks of migration from small islands states (SIDs) threatened by rising sea levels (IPCC, 1990: 2-22), from parts of southern Europe facing increased water stress (IPCC, 1990: 4-9), as a response to poverty and hunger (IPCC, 1990: 5-8), and in response to the loss of housing, livelihoods, and resources (social and cultural resources as well as basic resources such as food, water and energy) (IPCC, 1990: 5-9). It also highlighted the stress that migration can place on resources and infrastructure in destination areas, the role of policy in mediating migration choices, and the links between climate change, "natural" disasters and migration (IPCC, 1990: 5-10).

Since the publication of the IPCC FAR in 1990, the putative links between climate change and migration have been the subject of numerous reports and academic papers, many of which are drawn on throughout this review. Some individuals and organisations have attempted to estimate how many people may migrate as a result of climate change. Perhaps most famously, Myers and Kent (1995: 1) estimated that sea-level rise and "agricultural dislocations through droughts and disruption of monsoon and other rainfall systems, could eventually cause as many as 200 million people to be put at risk of displacement", and that "a still larger pool of potential environmental refugees" existed in the (then) population of around 900 million people living in absolute poverty in marginal environments. Much more recently, and drawing on this earlier work, Christian Aid estimated that up to 250 million people could be "permanently displaced by climate change-related phenomena such as floods, drought, famines and hurricanes" (Christian

Aid, 2007: 6). See Box 2 for a discussion of these figures in the context of statistics relating to present-day migration.

Nonetheless, such discourses have been widely criticized as overly simplistic, and failing to recognise the complexity and multiplicity of the social, political and economic factors that mediate migration linked to environmental stresses. For example, Boano et al. (2008) present such a criticism, and further argue that a generalised focus on climate change without reference to specific contexts obscures evidence of adaptation and resilience in the face of environmental change.

The arguments about the extent to which climate will influence migration may be framed in terms of what Surhke (1993) termed the "minimalist" and "maximalist" views (see also Lonergan, 1998). The former sees environmental (and climate) change as one factor among many that can influence migration, but stresses the highly contextual nature of this influence and emphasises the difficulty in decoupling the role of environmental change from that of other factors in migration. The maximalist view is one in which environmental change is seen as directly, and demonstrably, driving migration, and lends itself to attempts to quantify environmental migration (Jónsson, 2010; Laczko, F. 2010).

The maximalist view has much in common with what has been dubbed the "neomalthusian" framing of human-environment interaction (Gleditsch, 2003), which sees population growth and resource scarcity as drivers of violent conflict, as people compete for dwindling resources. Conflict driven by climate related resource scarcity is a common theme the climate change discourses, although the links between climate change and conflict have been widely challenged (Maxwell and Reuveny, 2000; Gleditsch et al., 2007). In contrast to the neomalthusian view is the "cornucopian" position (also known as the "promethean" or "eco-modernisation" view), which emphasises the role of innovation and human ingenuity in overcoming resource scarcity (Gleditsch et al., 2007). In the context of climate change, those adopting a cornucopian approach tend to emphasise the ability of people to adapt to climate change through technological and economic measures (e.g. Peiser, 2003).

This review attempts to navigate between the extreme ends of the minimalist-maximalist and neomalthusian-cornucopian continuums. It is acknowledged here that environmental change does indeed interact in a complex fashion with a host of other factors that all play a role in migration, and that it is generally difficult or impossible to isolate one single factor as a driver of migration in historical case studies. Even where migration has been associated with severe changes in climatic and environmental conditions, it has been mediated by social, economic and political factors that shape vulnerability contexts (addressed in more detail below). An example is the drought in the African Sahel in the early 1970s, which was associated with famine and displacement, but whose impacts were amplified considerably by policies that promoted agricultural expansion in historically marginal areas during an unusually wet period, stretching production and economies beyond sustainable limits and priming the region for disaster (Heyd and Brooks, 2009). It is also acknowledged that the links between climate change and conflict remain tenuous and highly contested, and that neomalthusian models are confounded by examples of sustained productivity and soil fertility where populations have grown and environmental conditions have deteriorated (Mortimore, 1998; Mortimore and Adams, 2001; Buhaug et al., 2008).

Box 1. Climate change and migration in a long-term context

An increase in global mean surface temperature (hereafter abbreviated to "warming") of 2º C would result in a mean surface temperature comparable to that of the last interglacial period some 120,000 years ago, when global mean sea-level was some 4-6 m higher than at present, and monsoon rainfall extended deep into today's northern hemisphere sub-tropical deserts (Jansen et al., 2007). A warming of 3º C would result in a global mean temperature comparable to that of the Middle Pliocene, some 3.5 million years ago, when sea-levels were some 15-20 m higher than at present, and palaeoclimatic evidence suggests permanent El-Niño like conditions (Jansen et al., 2007; Haywood et al., 2009; Wunsch, 2009). Analogues for a warming of 4º C do not exist within the period of geological time during which global continental configurations and surface topography have resembled those of the present day. The *magnitude* of the warming likely under current policy regimes could approach that associated with the transition from an ice age to a warm interglacial period, but occur up to 100 times more rapidly (REF NEEDED).

The last period of global climatic reorganisation (associated with cyclical changes in the Earth's orbit and with only a small negative change in global mean surface temperature) occurred some 5000-6000 years before present (BP). This period was bracketed by century-scale episodes of abrupt climatic change around 5900 and 5200 BP (Brooks, 2010). These episodes coincided with significant cultural transitions in many parts of the world, particularly the northern hemisphere sub-tropics, where they were associated with increased aridity. Evidence of migration is widespread during these episodes, and in the intervening centuries in northern Africa and western Asia, when marine dust records (shown in Figure 1) and terrestrial palaeo-environmental data indicate a transition from humid to arid conditions and the widespread collapse of vegetation systems (de Menocal et al., 2000; Brooks, 2006, 2010).

In the Sahara, increasing aridity associated with a weakening monsoon from 6000 to 5000 BP coincided with a southward expansion of human occupation into areas where less humid conditions are likely to have reduced disease burdens (Smith, 1984; Vernet and Faure, 2001). The collapse of the monsoon in the Sahara around 5200 BP coincided with a dramatic decline in the number of human occupation sites (Figure 1b ; Brooks, 2010;).

Across the northern hemisphere sub-tropics, increased aridity between 6000 and 5200 BP appears to have been associated with the aggregation of human populations in restricted geographical "refugia" where resources were still available, and the development of new livelihood, production and governance systems that ultimately led to emergence of the world's first cities and states (Brooks, 2006, 2010). There is some evidence from this period of increased violent conflict during times of environmental and social transition (Wright, 2001; Brooks, 2010).

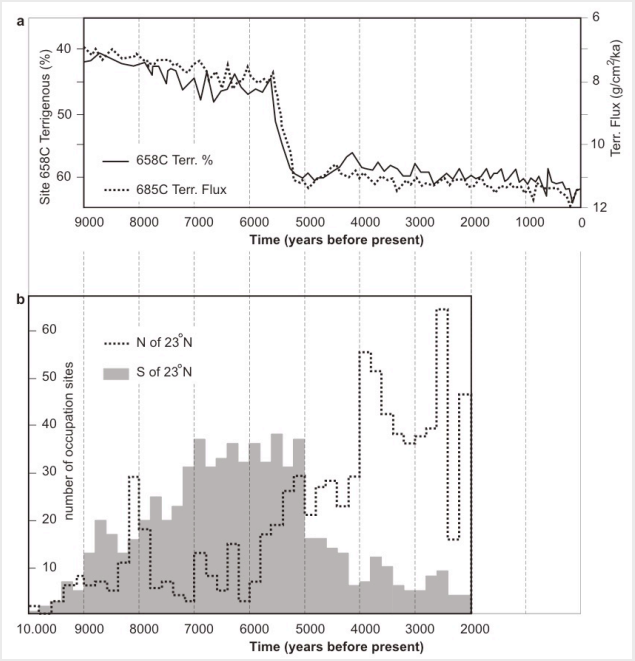


Figure 1. (a) Dust flux into the Eastern Tropic Atlantic based on marine sediment records (after deMenocal et al., 2000), and (b) variation in number of dated occupation sites over time in the Sahara north and south of 23º N, from 10,000 to 8000 years before present (after Vernet and Faure, 2001).

The maximalist and neomalthusian views are thus confounded by much of the available historical and contemporary evidence. However, it must be recognised that the vast majority of studies of the links between climate/environmental change, migration and conflict are based on evidence from the recent past, and the last few decades in particular. While this period has been one of great social, cultural, economic and (in many respects) environmental change, it is not representative of the kinds of climatic (and associated environmental) changes that are likely to occur over the course of the 21st century. In many respects, these changes are likely to be qualitatively and quantitatively different to any that have occurred over the past five thousand years, as the global climate undergoes what is likely to be a large-scale reorganisation in response to large greenhouse gas forcing (see Box 1). While extremely useful, studies of human-environment interaction based on data from the recent historical past are therefore limited in what they can tell us about potential future responses to climatic and environmental change.

This review necessarily draws heavily on recent studies, but the authors are careful to recognise the limitations of such studies as guides to a near future likely to be characterised by climatic and environmental changes that are unprecedented in recorded human history. It is also recognised that responses to climatic and environmental change will vary greatly with context, depending on the nature of the changes faced, the multitude of factors that mediate people's vulnerability to these changes, and their capacity to respond and adapt. This approach is guided by a risk framework, described in detail below.

The remainder of the review consists of three sections. The following section (§2) establishes a conceptual framework for understanding migration, and attempts to synthesise the different ways of characterising and understanding migration. Critical terminological issues are addressed, including the use of the term "climate/environmental refugee" and its relevance in international policy contexts. Different types of migration are identified, and the relation of these types to different drivers is discussed, emphasising the role of environmental factors in influencing migration. The key concepts of "linear" and "non-linear" migration, developed by Bardsley and Hugo (2010), and that will be used to frame much of the following discussion, are introduced. The concept of risk is discussed, and related to the concept of vulnerability and models of migration based on livelihood frameworks. The roles of risk, vulnerability and livelihood factors in migration decision-making, based on perceptions of risk and opportunity, are addressed. Finally, the potential consequences or outcomes of migration, and role of migration in adaptation, are addressed.

§3 Discusses three broad categories of climate change-related drivers of migration, relating to sudden-onset disasters, longer-term environmental change, and policy/development interventions. This discussion is framed by the understanding of migration developed in §2. Examples of migration associated with these drivers from the recent historical period, and the potential for climate change to mediate such processes, are discussed.

Finally, §4 discusses the implications of climate change for migration policy, and makes a number of broad recommendations regarding policy frameworks and approaches for addressing migration.

2. A FRAMEWORK FOR UNDERSTANDING MIGRATION

2.1 Terminological issues

The IPCC FAR employed the term "environmental refugees" to describe people displaced by land degradation, flooding and drought, and speculated that "even a modest rise in global sea-levels could produce tens of millions of such refugees" (IPCC, 1990: 5-10). Myers (2002: 1) defined environmental refugees as "people who can no longer gain a secure livelihood in their homelands because of drought, soil erosion, desertification, deforestation and other environmental problems, together with associated problems of population pressures and profound poverty".

In recent years, the terms "environmental refugee" and "climate refugee" have been widely adopted in both the popular and academic press to describe people displaced by environmental and climatic change (Boas, 2010; Hartmann, 2010). However, such terms are problematic and have no agreed definition in international law (Boano et al., 2008). Furthermore, they are at odds with the legal definition of the term "refugee" under Article 1 of the 1951 UN Convention relating to the status of refugees, which refers specifically to any person who "owing to well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his nationality and is unable or, owing to such fear, is unwilling to avail himself of the protection of that country; or who, not having a nationality and being outside the country of his former habitual residence as a result of such events, is unable or, owing to such fear, is unwilling to return to it" (UNHCR, 2007: 16). Crucially, this definition makes no provision for people escaping environmental stresses or environment-related disasters.

People who migrate in response to environmental factors (including climate change) often remain within their country of origin, falling into the category of Internally Displaced Persons (IDPs) (Brown, 2008). IDPs are defined as those "who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized State border" (Global Protection Cluster Working Group, 2008: 8).[3] However, despite the inclusion of disasters in this definition, more recent estimates of IDPs have not included those displaced by disasters (IDMC-NRC, 2010; Box 2).

Such definitional issues are of practical importance as well as semantic interest, as they frame institutional responses to migration at the national and international level. The framing of climate change related migration in terms of "refugees" may result in a disproportionate amount of attention being paid to international migration, even though most people displaced by factors related to climate change may be IDPs, and the links between climate change and international migration are highly controversial and generally

[3] In this context the definition of a natural disaster is that given in the 2006 IASC Operational Guidelines on Human Rights and Natural Disasters, namely "the consequences of events triggered by natural hazards that overwhelm local response capacity and seriously affect the social and economic development of a region".

rather tenuous.

Box 2. Migration statistics

In 2008, 36 million people were displaced by sudden-onset natural disasters, of which 20 million were displaced by climate-related disasters (OCHA-IDMC, 2009). These 20 million represented 13% of the people classified as "affected" by the same disasters[1]. Most of those displaced by climate-related disasters are likely to be internally displaced with their countries of origin, and many are likely to return home once conditions permit (*REF*). However, it is difficult to assess cumulative numbers displaced by climate-related or other disasters, as the 27.1 million people classified as internally displaced persons (IDPs) in 2009 are defined as those displaced by "conflict, generalised violence or human rights violations", and do not include those displaced by disasters, according the International Displacement Monitoring Centre (IDMC-NRC, 2010). The UNHCR[2] estimated that there were 43.3 million forcibly displaced people in the world in 2009, including both refugees (see main text for a definition) and IDPs as defined above.

The figure of 200-250 million projected by some studies to be displaced by climate change by 2050 (Myers, 1995; Christian Aid, 2007) is thus some five to six times the current number of IDPs and refugees combined, and some ten to twelve times the number of people displaced (in many cases temporarily) by climate-related disasters in 2008. However, the projected numbers displaced by climate change are considerably lower than the 645 million people that Christian Aid (2007) projects to be displaced by development projects over the same period.

The projections of Myers (1995) and Christian Aid (2007) are based on considerations of the numbers of people exposed to climate-related phenomena that have the potential to result in "forced" displacement (see Box 3). On the one hand these figures are based on implicit assumptions that exposure will translate into displacement, and therefore may overestimate future migration from exposed areas by neglecting the role of adaptation *in situ*, although the potential for such adaptation is likely to be limited in certain contexts such as permanent inundation due to sea-level rise. On the other hand, by focusing on "forced" displacement associated with disasters and sea-level rise, they may underestimate the impact of climate change by neglecting the many other pathways through which it may influence migration (Bardsley and Hugo, 2010; see main text for a further discussion).

In this context it is instructive to note that the International Organization for Migration estimates that there are currently some 214 million international migrants in the world, representing 3.1% of the world's population[3]. Many, and perhaps the majority, of these migrants will have decided to migrate as a result of economic factors. Climate change will have significant impacts on economic risks and opportunities, and will influence migration decisions based on economic factors even in the absence of displacement induced by climate-related disasters and impacts such as sea-level rise. While climate change may well lead to a large increase in the numbers of people displaced by disasters and other impacts, it may also have a profound impact on the numbers of economic migrants, through long-term, perhaps indirect, impacts on natural resource based livelihoods. Any consideration of the impacts of climate change on migration therefore must address economic migration as well as displacement.

[1] In this context, people "affected" by a disaster are defined as those "injured, homeless or otherwise affected by a disaster, including displaced or evacuated people, and who required immediate assistance following the disaster" (OCHA-IDMC, 2009: 8). This is based on the definition used by the Emergency Events Database (EM-DAT), which was used in the study, in conjunction with a wide variety of other data sources.

[2] http://www.unhcr.org/4c176c969.html, accessed 8 December 2010.

[3] http://www.iom.int/jahia/Jahia/about-migration/facts-and-figures/lang/en, accessed 8 December 2010.

While acknowledgement that climate change may be more likely to generate IDPs than refugees (based on the standard definitions cited above) is helpful, in the context of climate change, the definition of IDPs emphasises displacement due to disasters. While climate change is likely to increase disaster risk in many areas, disasters are not the only mechanisms through which climate change will influence migration. Furthermore, sudden-

onset disasters tend to receive more attention than slow-onset disasters. For example, Kolmannskog (2009: 11) reports that in Burundi, people undertaking migration in response to drought "do not receive the same level of attention and protection as refugees and persons displaced due to conflict and sudden-onset disaster." More broadly, policies and approaches that focus entirely or predominantly on displacement associated with discreet, climate-related disasters (whether sudden or slow-onset) may fail to address wider issues of migration in response to longer term climatically-driven changes (Box 2).

Piguet (2008) goes some way towards addressing this issue in a paper published by UNHCR, in which he suggests that the terms "environmentally displaced persons" (EDPs) and "environmentally induced population movements" (EIPMs) might be used "to describe a general category of migration movements where the environmental factor is decisive, but not necessarily unique". In a UNHCR presentation, Gorlick (2007) proposed a definition of EDPs as those "who are displaced from or who feel obliged to leave their usual place of residence, because their lives, livelihoods and welfare have been placed at serious risk as a result of adverse environmental, ecological or climatic processes and events".

International frameworks will need to address both international migration and internal displacement as a result of climate-related sudden-onset and slow-onset disasters. In addition, they will need to address international and internal migration resulting from other phenomena related to climate change, such as changing perceptions and experiences of risks and opportunities. Crucially, such frameworks will need to recognise that climate change will operate through a range of drivers to stimulate different types of migration, which will require different types of response. These issues are discussed in more detail below.

2.2 Types and drivers of migration

Migration takes many different forms, and may be permanent, temporary or cyclical, with the period spent away from the original place of residence varying from hours to years, as illustrated in Table 1. The type of movement undertaken will be closely related to the factors driving migration, and the activities and aspirations associated with it.

Migration does not necessarily involve a simple move from an origin to a destination, but frequently involves a complex sequence of moves that may involve several destinations and regular contact with the origin, and which eventually may involve return migration. Most moves are made within countries or regions rather than across international borders, and poor people tend to move over shorter distances, and for shorter durations, due to the costs of migration. The significance of internal migration is often overlooked, as the predominantly circular nature of movements remain undocumented (Skeldon, 1997). Evidence from South Asia suggests that internal, circular movements are much more important for the livelihoods of poor rural families than the much more visible international migration to countries in the North.

At least half of all *international* migrations from the South are to other countries in the South. South to south migration is particularly important in the context of sub Saharan Africa, where up to 70 per cent of all international migrants reside in other African countries (DRC Migration, 2009).

Table 1. A typology of migration

Time-span		Type of movement	Characteristics
SHORT-TERM	A few hours	Oscillation	Collecting fuel, wood, water etc.
	Daily	Commuting	Journey to work, education market
	Weekly	Commuting	Away during working week; entertainment, worship
	Season	Seasonal circulation, nomadism, pastoralism, transhumance, hunting and gathering; trading, visiting	Periodic Sojourn,
	Once in a lifetime	Pilgrimage	Pilgrimage, marriage, displacement by natural disaster
	Yearly	Contract labour	Target migration
	Several years	Shifting cultivation	Nomadism, frontier settlement
	Working life	Temporary circulation	Urban-bound employment related migration
LONG-TERM	Lifetime	Permanent migration	Emigration, resettlement, refugee movement

Migration may be undertaken at short notice out of necessity, for example in response to a sudden-onset disaster or violent conflict that present an immediate threat to life. Such displacement is often characterised as "forced" or involuntary migration (Box 3). Migration may involve a degree of compulsion without being "forced" by a sudden and immediate threat, occurring where people feel impelled to migrate as a result of hardship, for example due to slow-onset disasters or deteriorating environmental or economic conditions. Such migration is likely to be associated with intensifying stresses on livelihoods, and will very often involve movement from rural to urban areas. Where there is no systematic deterioration in economic or environmental conditions, or livelihoods, migration may be undertaken in order to exploit real or perceived opportunities elsewhere, or to avoid real or perceived current and/or future risks in a place of residence (Castles and Miller, 2003).

The three very broad categories of migration described above might be classified as forced, impelled, or voluntary respectively (Box 3). However, while such a classification may be conceptually useful, it represents a set of somewhat simplistic idealisations that only go part of the way towards capturing the complex realities of migration, which will often be driven by a combination of factors that may not fit easily into one category or another. An alternative way of viewing migration is as an activity involving varying degrees of duress, depending on the principle driver(s).

Bardsley and Hugo (2010) frame migration as a livelihood adaptation strategy driven by the experience of risk, the perception of risk, and changing resource conditions, all of which may be influenced by climate change. They distinguish between what they refer to as "linear" and "non-linear" migration. Linear migration has a significant voluntary component and occurs when there is a reduction in the (perceived) value of remaining *in situ*, and might be associated with climate change where its impacts increase stresses on

livelihoods, without making them untenable or an area uninhabitable. Non-linear migration occurs when stresses reach a threshold or "tipping point" beyond which people are unable to cope, and refers to a step change in the nature of migration, for example in terms of numbers migrating or migration patterns.

Box 3. "Forced", "voluntary" and other types of migration

Migration is often described as either 'forced' or 'voluntary'. However, this dichotomous classification does not do justice to the complexity of the interacting factors that drive migration. While migration may be said to be forced where it involves displacement resulting from violent conflicts or natural disasters which have made people's places of residence literally or effectively uninhabitable or placed their lives in danger, it can be argued convincingly that migration is rarely purely voluntary. While there are a host of 'direct' and immediate risks to which people will respond with immediate departure from their place of residence (e.g. catastrophic floods, the threat of war or other violence), people may also migrate in response to less immediate, and more indirect, risks to their livelihoods. These risks may be associated with climatic variability, or longer-term changes in environmental or economic conditions, which may slowly erode livelihoods and economic well-being. Migration in response to such risks will be the result of decision making by individuals or households, rather than an immediate need to migrate driven by the loss of a place of residence or a threat to life, and may involve the migration of certain members of a household in order to earn wages that can be used to buy food or other necessities during periods when the household is suffering hardship.

Recognising that decisions to migrate often involve a degree of duress, even if such migration is classified as economic in nature, Peterson (1958) employed the term "impelled migration" to describe situations in which people retain some power to decide whether or not to leave their place of residence (see also Hugo, 1996). Kolmannskog (2009: 11) reports that international humanitarian agency staff in Burundi referred to "distress migration" to describe migration by certain household members during drought, and suggests that we might talk about displacement (and arguably by inference forced migration) when an entire family leaves an area because there is "no possibility of survival there".

The environment-migration literature tends to distinguish between migration undertaken in response to sudden-onset disasters, and that undertaken in response to slow-onset disasters (e.g. Warnecke et al., 2010; Warner, 2010). In the context of climate change, some authors treat migration in response to sea-level rise separately to that associated with sudden and slow-onset disasters (Leighton, 2010). Most studies concerned explicitly with climate change and migration emphasise the role of physical processes associated with the manifestations and impacts of climate change as drivers of migration. However, climate change may also influence migration indirectly, for example through mitigation and adaptation policies and actions, and even – in the longer term – geoengineering interventions. Migration may also result where climate change acts as a driver of conflict, although the links between climate change and conflict are highly controversial (e.g. Burke et al., 2009; Buhaug, 2010).

The literature on environmental change and migration identifies a number of environment-related drivers of migration. Lonergan (1998) lists five such drivers, namely (i) natural disasters, (ii) progressive evolution of the environment, (iii) development projects with environmental impacts, (iv) industrial accidents, and (v) environmental consequences due to conflicts.

Addressing climate change drivers explicitly, the Inter Agency Standing Committee (IASC,

2008) suggests a variation on this list, identifying four climate change related "causes of movement", including (i) hydro-meteorological extreme hazard events, (ii) environmental degradation and/or slow onset extreme hazard events, (iii) significant permanent losses in state territory as a result of sea level rise, and (iv) armed conflict/violence over shrinking natural resources.

Guterres (2009: 4) describes five "climate change related scenarios that may directly or indirectly cause human displacement. These are (i) hydro-metereological disasters, (ii) the designation of areas by governments as too dangerous for human habitation, (iii) slow onset disasters and environmental degradation, (iv) "sinking" small island states, and (v) violent conflict triggered by climate change related resource scarcity.

Based on the characterisation of migration in the literature as summarised above, this review examines the implications of climate change for the following very broadly defined drivers of migration:

1. Sudden-onset disasters associated with climatic extremes
2. Longer-term changes in environmental conditions, including slow-onset disasters, environmental deterioration, and changes in resource distribution and/or availability
3. Development policies and related interventions

The aim of this categorization is to enable some disaggregation of the various mechanisms through which climate change is likely to influence migration, without "over compartmentalizing" these mechanisms, given that many of them will be closely related to each other. Each of these broad categories is addressed in detail below, with the greatest attention paid to category 2, which represents the most complex, and in many ways uncertain, set of potential climate change related migration mechanisms or drivers. It is within the context of climate change induced environmental and economic stresses that people will make decisions regarding migration, and understanding how and why migration decisions are made is one of the key challenges for migration policy. Conflict is not addressed separately, but in the context of the above drivers; insofar as climate change has the potential to result in conflict that triggers migration, conflict may also be viewed as a potential consequence of the above mechanisms/drivers.

2.3 Risk frameworks for understanding migration drivers

Viewed as a potential outcome of climate change, migration is amenable to analysis based on risk frameworks. These frameworks can help us to understand how a trigger event, or hazard[4], might result in a particular (and usually undesirable) outcome. In a broad framework based on the terminology widely used within the fields of disaster research and climate change adaptation, and by the International Strategy on Disaster Reduction (ISDR), an adverse *outcome* (e.g. a climate-related disaster) results from the interaction of a *hazard* (e.g. an extreme climatic event) with the underlying sensitivity or *vulnerability* of the population or system exposed to the hazard (Brooks, 2003; ISDR, 2004). Put simply,

[4] The term "hazard" is used throughout this review to refer to the physical manifestations of climate change that exist independently of societal contexts (e.g. individual climate extremes and changes in long-term conditions, including in the behaviour of extremes).

"hazards combined with vulnerability can result in disasters" (Kolmannskog, 2009). In this framework, a hazard is an event with the *potential* to trigger an adverse outcome. However, the precise nature and magnitude of an outcome will be mediated by the vulnerability of the exposed system or population. The concept of vulnerability is addressed in more detail in Box 4.

Some factors will make people vulnerable to a range of hazards. For example, the very poor and the politically marginalized are likely to be worst affected by climate change due to their limited access to resources and lack of capacity to absorb and recover from the impacts of hazards ranging from flash floods to sea-level rise. However, other factors driving vulnerability will be highly contextual, and specific to certain types of hazard. For example, in pastoral societies, livestock numbers are important determinants of vulnerability to drought, as households with many animals can sell a proportion of their stock during drought periods while retaining sufficient stock to rebuild their herds, and by extension their livelihoods, when conditions improve. Those with few animals may need to sell all their stock, and lose the entire basis of their livelihoods with no possibility of recovery. This might result in their migration to urban centres to seek wage labour, in a process that may be characterised as linear migration where recurrent droughts result in the migration of a limited number of the most vulnerable every year or few years. However, the outcome of a drought will not depend on vulnerability alone, but also on the severity and duration of the drought hazard. A very severe drought might result in the deaths of large numbers of livestock, destroying the livelihoods of those with small and large herds alike, and forcing those who were previously relatively wealthy, and less vulnerable to less severe droughts, to migrate to urban centres in search of work. Where this results in the large-scale abandonment of rural areas and a large increase in rural-urban migration, it might be characterised as non-linear migration.

Risk frameworks are useful as they allow the physical manifestations of climate change (in the form of climate hazards), and the societal contexts in which climate change impacts are played out (in the form of vulnerability), to be treated as distinct but related subjects of analysis. This is particularly important when we are concerned with hazards that are changing and evolving as a result of climate change. As discussed in more detail below, and throughout the rest of this review, the evolution of risk may be driven by changes in the nature of climate hazards, changes in vulnerability, or both.

Risk frameworks are also useful in helping us to understand how risk is translated into different migration outcomes, particularly when the concepts of hazard and vulnerability are combined with those of linear and non-linear migration as proposed by Bardsley and Hugo (2010) and outlined above.

Some real or perceived changes in risk will be associated with linear migration, characterised by historically familiar migration flows and pathways, even if the precise nature of the migration is mediated by the evolution of risk. Linear migration might accommodate incremental changes in numbers of migrants, following well-worn migration routes and employing familiar strategies of assimilation and/or risk management at their destination(s), for example through existing networks and links between source and destination regions. Even where drivers and motivations for migration are affected by changes in climatic and environmental conditions, migration may be or remain linear

below certain thresholds of change.

Box 4. Vulnerability and risk

A very large body of literature addresses the concept of vulnerability, and many different definitions of vulnerability exist. The definition provided in the glossary of the report of Working Group II of the IPCC TAR is as follows:

> "Vulnerability is the degree to which a system is susceptible to, or 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 variation to which a system is exposed, its *sensitivity*, and its adaptive capacity." (IPCC, 2007: 883)

The IPCC TAR provided an additional definition of vulnerability, as the "

> "Degree to which a system is susceptible to injury, damage, or harm (one part - the problematic or detrimental part - of sensitivity)" (Smit et al., 2001: 894).

The first of these definitions views vulnerability as a function of both climatic and non-climatic factors, whereas the second views it as something arising from the internal properties of a system. These two otherwise incompatible definitions may be reconciled by viewing them as representing different phenomena, which may be labeled as "biophysical" vulnerability and "social" or "inherent" vulnerability respectively (Brooks, 2003). The first definition (of biophysical vulnerability) is somewhat similar to long established definitions of risk, in which risk to a system results from the interaction of an external hazard and the system's underlying sensitivity. When applied to human societies, the second definition refers to the societal factors that mediate sensitivity to hazards such as climatic extremes and longer-term changes in climatic conditions.

In this review, the term "vulnerability" is used to refer to "social vulnerability" as described above, and the concept of risk is used to describe the result of the interaction of (social) vulnerability and climate change related hazards. Vulnerability therefore encompasses all the societal factors that mediate the impacts of hazards associated with climate change, and may include factors related to livelihoods, assets, capabilities, housing, settlement location, policy, economic conditions, underlying environmental factors, the ability to respond to risks and adapt to change, and so on.

Within risk frameworks, we are concerned with the risk that a particular hazard will result in a particular outcome (e.g. that a drought will result in food insecurity or famine). In a risk context we might talk about people's *vulnerability to a specific hazard* as mediating the likelihood that a particular outcome (e.g. food insecurity, poverty, etc) will occur. In this context, people may not be particularly vulnerable to historically familiar climate hazards, but might be vulnerable to new or intensified hazards associated with climate change.

In a livelihoods context, we are more likely to talk about people's *vulnerability to an outcome*, for example their vulnerability to food insecurity or to falling into poverty. In this context, climate change related hazards may be viewed as among the many stresses that operate on people's livelihoods. Through a climate change "lens", we might view other stresses on people's livelihoods as factors that influence their vulnerability to climate hazards.

The risk and livelihood views of vulnerability are not incompatible. Given the focus on climate change, in both contexts we are concerned with people's vulnerability with respect to an undesirable outcome (e.g. food insecurity, poverty, famine, loss of livelihood, etc), when they are exposed to a climate change related hazard or set of hazards. We thus may talk about vulnerability to a hazard (understood to represent the set of factors that might translate the hazard into an undesirable outcome), or vulnerability to an outcome (understood as meaning the likelihood of a particular outcome given exposure to a hazard). The important point is that, when talking about specific contexts, vulnerability is defined with respect to *both* hazards and potential outcomes. Reference to "vulnerability to climate change" should be interpreted as referring to the range of climate change related hazards to which a population might be exposed, and the range of outcomes that might result.

Non-linear migration, involving a reorganisation of migration patterns, will occur where real or perceived risk crosses certain thresholds. A shift from linear to non-linear migration may occur when a resilience/vulnerability threshold is breached and a society or community can no longer function. This might be the result of one or more of the following factors:

i. the occurrence of a particularly severe hazard that simply overwhelms a population or area (e.g. catastrophic flooding or a large-scale collapse of productivity)
ii. the occurrence of repeated hazards that do not allow sufficient recovery time between events, resulting in increased vulnerability and perceptions of risk
iii. a transition from chronic to acute vulnerability, resulting in the collapse of livelihoods, due to poor long-term planning, ineffective management of risk, and/or policies that are "maladaptive")
iv. increased vulnerability (e.g. due to policy, economic trends, etc) combined with an intensification of hazard so as to make life for some or all members of a community untenable.

Climate change may precipitate non-linear migration associated with mechanisms (i) and (ii) above as a result of increases in the severity and/or frequency of climate-related hazards, even where vulnerability is not exacerbated by non-climatic factors. Where policies or other trends (including climate change, for example via its impacts on resources) act to increase vulnerability, non-linear migration might result even where climate hazards do not intensify (iii). However, vulnerability is unlikely to remain static, and changes in the nature and/or behaviour of hazards combined with changing patterns of vulnerability (iv) are likely to account for a significant proportion of non-linear migration.

The effects of climate change on both linear and non-linear migration will be mediated to a very large extent by livelihoods contexts. Non-linear migration may be precipitated by the large-scale failure of livelihood systems resulting from overwhelming hazards that destroy assets, repeated disasters or environmental deterioration that erode assets and/or productivity over longer periods, policies that increase input costs or restrict access to resources, or a combination of such factors. Where changes in vulnerability dominate over changes in hazards, non-linear migration might be prevented by livelihood interventions that focus on existing drivers of vulnerability. Where changes in hazard dominate over changes in vulnerability, policy responses might involve a combination of adaptation *in situ* (to address the new hazard context), and facilitated migration (where adaptation is impractical).

Where migration is linear, it will involve the migration of certain members of a community or society as a result of impacts that are socially differentiated as a result of unevenly distributed vulnerability. Vulnerability-based assessments that examine the differentiated impacts of different stresses (including climate change related hazards) on people's livelihoods are thus potentially very useful in understanding and addressing the factors that drive linear migration.. As livelihoods impacts are likely to be the main mechanisms

through which climate change drivers much migration, livelihoods frameworks are particularly important if we are to understand how climate change might affect migration.

2.4 Vulnerability, livelihoods and migration decision-making

Climate change will operate alongside, and interact with, a variety of other stresses faced by individuals, households, communities, and societies at large, as indicated in Table 2. These stresses may be related to conflict, economic change, social and political marginalisation, local anthropogenically-driven environmental change, and a host of other factors. Climate change may amplify existing stresses (e.g. exacerbating environmental degradation or driving up food prices), and/or result in additional stresses (e.g. the appearance of new pests and diseases due to shifts in ecological ranges). Whether or not such stresses trigger migration will depend to a large extent on their impacts on livelihoods, which in turn will depend on people's vulnerability, represented by their ability to cope with and absorb these stresses in the short term and on their ability to respond and adapt to them in the longer term.

Mediated by a host of non-climatic factors, people's vulnerability to climate change related hazards and the outcomes associated with them will vary considerably between individuals, households, geographical regions and population groups. People engaged in certain livelihoods may be more vulnerable than those engaged in others. At the household level, vulnerability will be influenced by internal factors related to resources and household capabilities, as well as external factors such as sociopolitical (in)stability, civil society institutions, cultural norms and the economic and the environmental capacity of a given society (Ellis and Harris 2004).

A wide range of migration theories attempt to capture the reasons for migration in the context of people's livelihoods, and the pathways via which such migration occurs (see Massey et al 1993; Castles and Miller 2003 for reviews). In recognition that migration is not a purely spatial and temporal event but also a cultural experience, more recent theories have attempted to capture the social, economic and cultural factors which influence migration decisions (de Haan, 2000a). Rather than individuals solely motivated by economic incentives, migrants are increasingly viewed as agents bounded by history and cultural norms who will make decisions based on their ability to act (Brettell and Hollifield, 2007). The livelihoods framework provides a useful tool to capture both the structural and local/individual factors that shape a migration experience by disentangling the financial, social and physical opportunities and constraints experienced by (prospective) migrants.

However, the relationship between vulnerability and migration is not simple. On the one hand, people may migrate because they lack the resources to adapt to climate change *in situ*, while the better off may be able to adapt through innovation and diversification. On the other hand, the poorest and most vulnerable people in society may lack the resources required to undertake migration, meaning it is the better off who migrate (Black et al., 2008). A number of studies indicate that is it not the poorest (or richest) who tend to migrate. For example, studies of migration in Africa demonstrate that those who are most likely to experience a decline in welfare as a result of environmental changes are the least able to migrate (Waddington, 2003; DRC Migration, 2009).

Table 2. Types of risk to sources of livelihood (adapted from Frankenberger et al., 2001: 77).

	Environmental risk	**Social State**	**Risk Community**	**Economic risk**	**Conflict**
Human capital					
Labour power, education, health	Disease epidemics due to poor sanitary conditions.	Declining public health expenditures, user charges, declining education expenditures	Breakdown in community support of social services	Privatisation of social services, reduction in labour opportunities	Conflict destroys social infrastructure, mobility restrictions
Financial and natural capital					
Productive resources (land, machinery, tools, animals, wells etc.) liquid capital resources (jewellery, granaries, small animals, savings)	Drought, flooding, land degradation, pests, animal disease	Land confiscation, insecure tenure rights, taxes, employment policies	Appropriation and loss of common property resources, increased theft	Price shocks, rapid inflation, food shortages	Conflict leads to loss of land, assets, and theft
Social Capital					
Claims, kinship, networks, safety nets, common property	Recurring environmental shocks, breakdown ability to reciprocate, morbidity and mortality affect social capital	Reduction in safety net support (school feeding etc)	Breakdown of labour reciprocity, breakdown of sharing mechanisms, stricter loan requirements, lack of social cohesion	Shift to institutional forms of trust, stricter loan collateral requirements, migration for employment	Communities displaced by war, theft leads to breakdown in trust
Sources of income					
Productive activities, process and exchange activities, other sources of employment, seasonal migration	Seasonal climatic fluctuations affecting employment opportunities, drought, flooding, pests, animal disease, morbidity and morbidity of income earners	Employment policies declining subsidies or inputs, poor investment in infrastructure, taxes		Unemploy-ment, falling real wages, price shocks	Marketing channels disrupted by war

With respect to migration as a response to climatic changes (McLeman and Smit 2006) outline these questions:

- How can the factors that influence whether members of a given population may adapt through migration, even temporarily, away from the area of exposure be identified?
- What conditions lead to migration instead of alternative adaptation options?

- Are all members in an exposed population likely to have the same disposition or ability to migrate?
- Under what conditions do migration decisions cease to be made willingly or voluntarily?

A number of factors have been identified as influencing migration decision making, and in driving the migration of certain members of a society. In the African studies mentioned above, economic inequality and unequal access to land have been identified as playing a key role in driving migration. Educational attainment is also identified as an important factor in predicting who moves and who stays behind, although the role of education as a predictor of migration has changed over time. Whereas the least educated and most educated tended to move to China in the past, India has become the favoured destination for these groups in more recent years, although the most recent data indicate that the best educated now avoid migration (Deshingkar, 2006).

The availability of labour power within families also influences the likelihood of migration, and it tends to be the young, economically active members of families who migrate. Very little information is available on the movement of children, but it is considered a significant part of the flow in South–South movements (DRC Migration, 2009). The increasing feminisation of migration has been noted, in particular in Asia, where opportunities for women in textile and manufacturing industries are expanding (Yamanaka, 2005).

It is generally accepted that migrants tend to move from high risk to low risk places in the hope of gaining access to better opportunities or higher incomes (Stark, 1991). However, perceptions of risks and opportunities at a potential destination are influenced by previous migrations of family members and friends. Contacts with previous migrants provide information, job opportunities, initial help to settle in destination areas, and a vital safety net at the destination. The last of these seems to be particularly important for female migrants who are less likely to move alone or to places without contacts. Thus migration is based not only on a rational assessment of the disparities between source and destination, but is also a social process involving historical, cultural and social factors that influence the perception of a place and its associated risks and opportunities (Faist, 2000; Gurak, 1992; Kabeer, 2000). The choice of destination is thus influenced by a number of factors, and is heavily mediated by social contexts.

4.6 Consequences of migration

The consequences of migration are many and varied, and may be positive or negative, or a combination of both. For example, out-migration of the most productive members of a society, community or household may have negative repercussions for that society, community or household in the longer term. Conversely, however, remittances sent home by migrants can be vital for household security and wider economic development in source regions[5].

[5] Recognising this, industrialized host countries have increasingly tended to view the billions of Dollars (or equivalent) earned by migrants and sent to their home communities as a form of foreign aid (House of Commons International Development Committee Migration and Development 2004).

The extent to which the outcomes of migration may be characterised as positive or negative will depend to a significant extent on who is doing the characterization. For example, migration can be positive for migrants as a result of higher incomes and the prospect of further improvements in their economic and general well-being, while at the same time being negative for source regions as a result of loss of labour and skills. Within source regions, households benefiting from remittances might see migration as positive, even as it undermines development by removing some of the most potentially productive members of society. However, this may come at the expense of a dependency of source communities and families on income earned by migrants. Negative impacts may also pertain to emotional well-being and safety of migrants where migrants are expected to remain abroad against their wishes, sometimes experiencing harsh conditions, in order to support their families back home (Piper, 2004, 2006). On the other hand, while migrants may enjoy improvements to their quality of life in destination areas, the cheap labour they provide may result in a slow-down in transitions from labor-intensive to less exploitative and knowledge-based production systems host societies (IOM 2007). Conversely, this cheap labour may make a significant contribution to economic development, where indigenous labour is scarce. The impacts of migration on destination regions, and the nature of the opportunities available to migrants, will depend on the circumstances and nature of migration. For example migration involving large numbers of people arriving at a single destination may have profound impacts on the economy of the receiving region. Hill (1989), quoting Davies and Thiam (1987), describes how an influx of migrants into towns in Mali following the 1984-85 drought resulted in a fall in the daily wage rate of construction workers from 300 FCFA ($1) to 50 FCFA ($0.18).

Migrants move from one vulnerability context to another, and may experience new livelihood challenges in destination areas. The risks of any move are related to the short-term provision of food, shelter and personal safety as well the longer term opportunities for migrants to gain access to employment and other productive resources. In-migration will inevitably change the characteristics of destination areas. While additional labour and skills can be a welcome addition to local economies, there is little evidence that migration directly causes conflict in receiving areas. However, migrants can put pressure on limited resources, with repercussions for destination areas, as the example of migrant coffee farmers in Vietnam in Box 5 illustrates.

While migrants can impact on destination areas and their inhabitants in both positive and negative ways, the case presented in Box 5 also highlights how migrants' legal status can represent an important constraint on their activities. In countries where legal restrictions on internal movement are strict (e.g. China, Vietnam), internal migration mirrors migration across international borders in that migrants are frequently excluded from welfare services such as health care and education in destination areas (Kabeer, 2000; Rogaly, 2002). Waddington (2003) describes how the health of poorer migrants tends to decline as a result of such exclusion. This makes the existence of social networks and institutional support indispensable for migrants, if migration is to work as a livelihood strategy (Warner, 2010).

Migrants respond to new risks at destination with flexible migration behavior, illustrated by the non-linearity of many migration trajectories. Stage migration is common, in which migrants move on to new destinations in response to a lack of opportunities (or new risks)

at their initial or current destination, or as a result of knowledge of better opportunities elsewhere. Thus, rural to rural migrants (e.g. farm labourers, fisherpeople) may eventually become urban migrants attracted by prospects in the manufacturing and building sectors located in urban and peri-urban zones (Cohen, 2004). Being aware of the range of historical migration trajectories is crucial for predicting possible routes of migration in response to future climate change, although such prediction is likely to be more problematic when migration is non-linear in nature.

Box 5. Conflict over resources as a result of migration in Vietnam

Internal migration in Vietnam is motivated by resource pressures (due to high population densities and natural disasters), limited job opportunities in the lowland sending region, and by relatively freely available land and marketing opportunities for crops such as coffee and pepper in the Central Highland region. However, the expansion of coffee farms in the Central Highlands also has implications for sustainable development, equity and vulnerability for both migrants (the majority of whom are from the ethnic majority *Kinh*) and local inhabitants (mostly ethnic minorities). Diminishing environmental health in the forms of soil erosion, declining forest products and biodiversity has been observed in the past three decades (D'haeze, 2005). Further, evidence of unequal gains in poverty reduction between people from the majority *Kinh* population and minority groups, and recent episodes of social unrest in the highlands, are the result of an interplay of factors such as remoteness (affecting provision of public welfare), political exclusion of highland populations, and rapid in-migration for coffee farming (Dollar and Litvack, 1998; McElwee, 2001; Human Rights Watch, 2002). Thus, the continuing in-migration to the Central Highlands affects the distribution of land and resources. Land speculation, inequality and social conflicts provide an expensive and insecure environment for migrants and local inhabitants. The high prices of land and labour increase the burden of debt and may lead to greater vulnerability to losses of well-being when migrants have to cope with shocks such as a sudden collapse in the price of cash crops. Many migrants respond to these changing conditions at the destination either by returning home or by moving on to urban areas in search for other opportunities (Winkels, 2008).

Urban areas are important destinations for migrants and refugees, providing not only opportunities in many sectors, both formal and informal, but also a sense of community (Pavanello, 2010). However, managing rural-urban flows has been a major challenge for urban planners who aim at balancing the potential for economic development, poverty reduction and positive social and political changes that is associated with urbanization with the negative aspects of rapid and uncontrolled growth. Urbanisation often results in the loss of arable land to badly planned development projects. Limited infrastructure means people live in overcrowded, congested and polluted areas where inadequate housing contributes to ill health (Roberts, 2006). Where climate change adversely affects rural livelihoods and productivity it is likely to accelerate urbanization, as a result of increased rural-urban migration flows (Guterres, 2009).

The impact of migration on sending regions is intimately tied to the various determinants of migration - the perceived gap in potential incomes, the prospect of greater household security, the existence of social networks, the availability of information about migration outcomes at origin and destinations – and the differences according to age, sex and education and skills of migrants. The major impacts of migration and remittances on rural source areas occur directly through changes in the patterns of expenditure and investments of households having migrant members, and indirectly through multiplier effects and changes in labour markets. There is no consensus as to whether remittances are mainly

used by households and communities for consumption needs, or invested in productive assets. For example, in the case of China it has been shown that remittances accumulated abroad compensate for labour loss and allow households to improve their agricultural productivity. In other regions (south Asia, Eastern Europe) remittances have served to accelerate investment and economic growth. However, there is some consensus that the poorest are least likely to benefit from migration directly through remittances. This is because they are less able to fund expensive moves and are generally less well educated, which prevents them from benefiting from higher income activities. Where people use migration as a short term coping strategy, remittances tend to be used to serve short-term and basic needs, leaving no room for strategic accumulation of assets to increase resilience (Mendola, 2006).

2.5 Migration as risk management and adaptation

Migration is very often viewed as something that should to be prevented, and as a phenomenon associated predominantly with widespread negative impacts. From this viewpoint, migration is a risk to be managed. As discussed above, migration may well have negative impacts on both destination and source regions, although the extent of such impacts will vary considerably between contexts, and such negative impacts as do exist may be offset to varying extents by the beneficial consequences of migration. While migration may be viewed as a risk to be managed, it may also be viewed as representing opportunities for increasing resilience and delivering adaptation to climatic and other changes.

Migration is not necessarily a measure of last resort, and it has long been argued that migration should be considered as an integral part of people's livelihoods, and not as a breach with an assumed norm that postulates that most people seek place-based livelihood activities (de Haan 1999). Migration is used as a strategy by both individuals and households to manage risk, with the aim of reducing vulnerability (or increasing resilience) to shocks and stresses that are associated with potential economic losses and adverse impacts on well-being. This is true for most migrants, whether they are motivated by economic drivers (e.g. poverty, better opportunities elsewhere) or, more acutely, the impacts of natural disasters. Thus, households employ migration to either anticipate or respond to risks. Migration therefore represents a response to the perception of risks and opportunities, both at home and at the potential destination. In recent development discourse, migration is often referred to as a risk management strategy employed by households to secure their livelihoods (*REF*).

Migration often involves only certain members of a family or household, who migrate in search of opportunities to secure resources that are shared with those who do not migrate. Indeed, it has been shown in many cases that migration of one or more members of a family has the potential to enhance livelihood resilience through remittances and spreading of risk associated with climatic and economic variability at the origin (de Haas 2007, 2008). Migrant households often straddle labour markets in two or more locations, increasing resilience through their ability to respond to the opportunities and risks presented in these different locations (Rogaly, 2002; Deshingkar, 2009; Winkels, 2008).

In highly dynamic environments, cyclical migration in the form of mobile pastoralism has long formed the basis of entire livelihood systems, and indeed entire societies. Such mobility has enabled human beings to thrive in locations where environmental conditions are marginal and highly variable, and where resources are insufficiently abundant or predictable to permit the development of large, complex, resource-intensive, sedentary societies. In Africa, mobile pastoralism first emerged in the most marginal and climatically variable parts of the prehistoric Sahara, before spreading rapidly through northern Africa at a time of severe climatic deterioriation (Brooks, 2006, 2010). African pastoralism therefore originated as an adaptation to climate change, during the last period of systematic global-scale reorganisation (Brooks, 2010).

While migration is often perceived as something negative, it thus often represents an appropriate strategy for coping with certain environmental conditions and climatic stresses. Migration – whether cyclical, temporary or permanent, should therefore be viewed as a legitimate option to improve livelihood resilience in particular with respect to the challenges posed by climate change and particularly to the challenges posed by climate change. As indicated above, migration requires resources, and it is often the poorest and most vulnerable who do not migrate, due to a lack of resources. The implications of this observation for poverty are potentially profound, as people who are so poor that they lack the resources to migrate from an area in which climate change is eroding the basis of their livelihoods are likely to remain chronically poor, or experience worsening poverty as conditions deteriorate further. While policies may seek to reduce migration through poverty alleviation in source regions, poverty reduction might be achieved more effectively where policies provide assistance for people to migrate, at least in some contexts. A key question in the context of adaptation to climate change therefore relates to where migration should be viewed as a risk to be managed, and where should it be facilitated in order to enhance people's ability to cope with and adapt to climate change and other stresses. These issues are discussed in more detail below, and are revisited in the final section of this review.

3. POTENTIAL IMPLICATIONS OF CLIMATE CHANGE FOR MIGRATION

3.1 Introduction

The above framework provides us with a means of interrogating and understanding the potential mechanisms via which climate change might influence migration. The concepts of linear and non-linear migration allows us to bridge the gap between "minimalist" and "maximalist" formulations of migration, and to acknowledge that migration may evolve incrementally in response to certain climate change impacts, or catastrophically as certain thresholds of risk are crossed. Linking the concepts of linear and non-linear migration concepts with those of risk, vulnerability and hazard enables us to examine how climate change might interact with societal factors to generate different types of migration.

The following discussion is structured around the three categories of climate change related drivers of migration identified above, namely:

1. Sudden-onset disasters associated with climatic extremes

2. Longer-term changes in environmental conditions, including slow-onset disasters, environmental deterioration, and changes in resource distribution and/or availability
3. Development policies and related interventions

Each of these categories is discussed in more detail below.

3.2 Climate change and sudden-onset disasters

Climate-related sudden-onset disasters are already significant drivers of displacement, as the figure of 20 million persons displaced by such disasters in 2008 illustrates (OCHA-IDMC, 2009; Box 2). Risks associated with climate-related sudden-onset disasters are expected to increase in the future, as a result of an intensification of sudden-onset climate hazards, and increases in the exposure of human populations and economic assets due to population growth, urbanization, and economic development/growth. In some areas, increases in vulnerability resulting from factors other than physical exposure may also exacerbate disaster risks. Losses from climate-related disasters have increased in recent decades, in contrast to losses from non-climatic geophysical and geological disasters, which have remained relatively constant (UNFCCC, 2008). While increases in exposure and vulnerability are likely to have played some role this increase, an increase in the frequency and/or severity of climatic extremes associated with disasters is also likely to have contributed to this trend, although the proportional contributions of changes in climatic extremes and socio-economic trends currently cannot be quantified (UNFCCC, 2008). The IPCC AR4 reports increases in the incidence of extreme high temperatures and in the frequency of heavy and extreme precipitation events in many parts of the world (Trenberth et al., 2007). There is evidence for an increase in the intensity, duration and potential destructiveness of tropical storms, and in the numbers of category 4 and 5 hurricanes, since the early 1970s (Trenberth et al., 2007). Changes in extra-tropical cyclone activity, and in storm tracks, are also apparent (Trenberth et al., 2007).

Climate change will continue to influence the behaviour of extreme events in the future, and this influence is likely to intensify as human-induced warming accelerates. Increasing warming will mean that the incidence of extreme temperatures is likely to continue to increase over time, and higher temperatures are likely to be associated with a greater likelihood of wild fires, particularly where rainfall becomes less frequent. The frequency of extreme precipitation is projected to increase globally under the three scenarios examined by the IPCC, (A2, A1B and B2), with increases projected for the medium-emissions A1B scenario over most of Europe and Asia, central and northern North America, much of South America (particularly the north-west), and much of Africa (particularly East Africa) (Meehl et al., 2007). More intense precipitation events will be associated with a greater risk of flooding, and sea-level rise will increase flood risks associated with storm surges, even in the absence of changes in storm behaviour. Extreme rainfall and winds associated with tropical cyclones are likely to increase in East Asia, Southeast Asia and South Asia, according to the IPCC AR4 (Christensen et al., 2007). Intensified seasonal melting of snow and ice will also be associated with increases in flood risk, as well as catastrophic flooding associated with outbursts from lakes formed from melt-waters.

The future behaviour of phenomena such as El Niño remains uncertain, although there are indications that El Niño-like conditions may be more prevalent in the future (Jansen et al., 2007; Haywood et al., 2009, Wunsch, 2009; Box 1). Changes in El Niño and La Niña will have implications for the behaviour of climatic extremes in many parts of the world, and may result in large changes in risk. Any changes in monsoon behaviour could have similarly profound effects on disaster risk, particularly if monsoons migrate and/or intensify, and the IPCC AR4 describes increases in the frequency of intense precipitation events as very likely in East Asia and parts of South Asia (Christensen et al., 2007).

Climate change may also result in the emergence of new climate hazards in some areas. For example, the UK Meteorological Office reported that the first ever recorded tropical storm in the South Atlantic, Hurricane Catarina, formed in a region simulated to become a center of tropical storm formation in period 2070-2100[6]. Whether this indicates that tropical storms will become a regular feature of South Atlantic climate in the future is highly uncertain, but this example illustrates the potential for climate change to generate new regional risks. Other possibilities include changes in existing storm tracks, or the migration of monsoon systems into currently arid areas, bringing regular extreme rainfall events to areas in which such phenomena are historically rare.

Future increases in risks associated with sudden-onset disasters will be driven by a combination of changes in the behaviour of climate hazards, and socio-economic and demographic factors that affect vulnerability. The contribution of the hazard component of risk to disaster outcomes, including displacement and migration, is likely to increase over time as atmospheric greenhouse gas concentrations rise and warming accelerates. The likelihood of "abrupt" changes in global, regional, and local climate (i.e. non-linear, effectively irreversible transitions in climatic conditions, occurring over years to decades) is likely to increase over time, meaning that changes in disaster risk will not necessarily be incremental in nature, particularly in the medium to long term (i.e towards the mid to late 21st century). The emergence of new hazards might result in non-linear migration, as people struggle to respond to novel disaster impacts that might threaten the viability of existing settlements and livelihoods. However, non-linear migration might also result where hazards that are historically familiar increase in frequency and/or severity to such an extent that coping strategies begin to break down, for example due to insufficient time for communities to recover from one disaster before the next one strikes.

In the context of increasing disaster risk, it is noted that the 20 million people displaced by climate-related sudden-onset disasters in 2008 represented only 13% of those affected by the same disasters (see Box 2 for further explanation of "affected"). It is reasonable to propose that, where disasters become more severe, the proportion of people displaced may increase, and that one possible result of climate change will be an increase in the ratio of people displaced to those affected.

An increase in the frequency of sudden-onset disasters in a particular location may result in increased migration via a number of mechanisms other than immediate displacement, and the following processes are identified:

[6] http://www.metoffice.gov.uk/weather/tropicalcyclone/catarina.html. Accessed 13 December 2010.

1. More severe and/or frequent disasters may simply displace more people, either in single disaster events or cumulatively over time.
2. Increased disaster risk may encourage people to migrate as a means of reducing their exposure to disasters, resulting in a general increase in migration flows over time as an area becomes, or is seen as, less secure.
3. The repeated impacts of increasingly frequent disasters may undermine livelihoods, resulting in greater migration as people seek opportunities elsewhere in a process similar to that in (2) but driven more by the long-term economic consequences of disaster impacts than by concern about exposure to disasters *per se*.
4. Increased actual or perceived risk may make it less likely that those displaced by sudden-onset disasters will return to their homes, and more likely that they will stay in the locations to which they are evacuated, or move to a second location.
5. Governments might encourage migration from areas subjected to increasingly frequent sudden-onset disasters, either through deliberate relocation of populations and/or economic activities in the name of adaptation, or inadvertently through neglect in areas where investments are likely to be lost to disasters.

Hurricane Katrina provides us with a model of how an unprecedented disaster (whether resulting from changes in climate hazards, chronic vulnerability, or a combination of both), and/or successive disasters, can influence migration. Of the approximately 1.5 million people evacuated from Louisiana, Mississippi and Alabama, some 270,000 had not returned to either their original homes or home counties in October 2006, more than a year after the disaster (Groen and Polivka, 2008). Across the three states affected by Hurricane Katrina, 64.9% of evacuees returned to their original homes, and 73.4% to their home counties, by late 2006. The county return rate was lowest (69%) in Louisiana, where damage was greatest, and where Hurricane Katrina was followed a month later by Hurricane Rita (Groen and Polivka, 2008). Katrina illustrates how considerations of exposure and impact influence people's decisions about whether to return to their original place of residence after a disaster, and how particularly large disasters are likely to increase the likelihood that those displaced will remain outside their place of origin.

While intensified risks associated with sudden-onset climate-related disasters are likely to increase migration pressures, the relationship between disaster risk and migration flows in not straightforward. People who are not immediately displaced by a disaster, but whose livelihoods are adversely affected by its impacts, may be less able to migrate as a result of reduced resources and incomes. While the poorest among society may be the most vulnerable to disasters, they may also lack the resources to evacuate in advance of sudden-onset climate extremes, as was the case in New Orleans prior to Katrina (Fussell, 2006).

3.3 Climate change and longer-term environmental changes

Long-term climatic and environmental change, and slow-onset disasters associated with processes such as drought and climatically-induced or mediated environmental degradation, are likely to play a significant role in future migration. Nonetheless, assessing the role of longer-term environmental changes in migration remains difficult. While displacement associated with sudden-onset disasters may be readily identified and reasonably quantified, migration associated with longer-term environmental changes is

arguably much more complex, due to the interaction of such changes with other stresses, and the role of decision-making that includes at least some degree of voluntarism. In the 1990s it was estimated by various authors that between 10 and 25 million people living today have already been "displaced" by environmental degradation, although these figures are highly uncertain and strongly contested (Lonergan, 1998).

Longer-term changes in climatic and environmental conditions will be associated with both linear and non-linear migration. Bogardi and Warner (2009) argue that increased pressures on livelihoods due to phenomena such as drought, desertification and other manifestations of water scarcity are likely to increase migration flows along existing pathways, and cite the example of migration from sub-Saharan Africa to Europe in this context. Guterres (2009), concludes that longer term manifestations of climate change will result in the movement of large numbers of people over substantial time periods in more diverse directions than at present, resulting in new forms and patterns of movement within and between countries.

3.3.1 Classification of longer-term climate change related drivers of migration

Longer-term climatically-mediated changes will encompass a variety of processes including drought and environmental degradation, both of which may result in slow-onset disasters. Drought will become more frequent and severe in some regions as a result of climate change. Environmental degradation will be associated with processes such as desertification, recurrent sudden-onset disasters, increased water scarcity, erosion (e.g. in coastal areas), saline intrusion linked with sea-level rise, ocean acidification and warming resulting in reduced marine biological productivity, and so on. All of these processes have the potential to drive linear migration, through increased pressure on livelihoods, and non-linear migration, where drought or degradation results in disasters and the breaching of resilience thresholds.

Other longer-term processes mediated by climate change are also likely to influence migration. Changes in climatic variability, which may or may not be associated with declines in annual rainfall, will have impacts on people's livelihoods via their impacts on seasonal activities such as agriculture. For example, anecdotal evidence suggests that changes in variability, combined with drought, have contributed to rural-urban migration flows in Kenya (UN-OCHA, 2010).

The processes summarised above all represent stresses or "push factors" that can drive migration (Meze-Hausken, 2000). However, climate change will also operate on the "pull factors" that attract migrants to certain areas, with push and pull factors operating in tandem to alter the balance between real and perceived risks and opportunities in both source and destination areas. Meze-Hausken (2000) identifies factors such as labour demand, land availability and fertility, as well as rainfall reliability, as potential pull factors. While climate change will result in a reduction in the availability and fertility of productive land in some areas, it may increase the productive potential of others. This may be the result of an extension of the growing season (particularly at high latitudes and altitudes), or of changes in rainfall patterns that bring increased rainfall to previously arid or semi-arid areas (e.g. via changes in monsoon behaviour).

Climate change may also mediate risks and opportunities via its impacts on commodity prices and international trade. Increases in the global price of agricultural products may mean result in increased incomes from agriculture, meaning that certain activities and livelihoods, and indeed certain geographical areas, that previously were marginal or economically unattractive, become much more viable. Where climate change results in increased productivity or previously marginal activities becoming more viable, in-migration by those seeking economic opportunities is a plausible outcome. Such in-migration may be more likely if areas where opportunities are enhanced are located close to areas where livelihood stresses are increasing, although migration between such areas will be mediated by a host of factors that determine ease of movement.

In any given location, migration might be influenced by longer-term climate change related processes that fall into one of the following categories:

1. Slow-onset disasters associated with more severe or frequent slow-onset, long-duration climate-related hazards such as drought (likely to be associated with both linear and non-linear out-migration, depending on the severity and frequency of disasters).
2. Slow-onset disasters linked to long-term environmental and resource degradation associated with problematic, and effectively irreversible, environmental transitions (likely to be associated initially with linear out-migration, and ultimately with non-linear out-migration).
3. Long-term adverse changes in climatic and environmental conditions (including climate variability) that do not result in disasters, but which change the nature of risks and opportunities in (potential) source regions (most likely to be associated with linear out-migration).
4. Long-term changes in climatic and environmental conditions that make an area more attractive to potential migrants (potentially associated with both linear and non-linear migration into the area in question, and out-migration from other/adjacent areas).
5. Changes in commodity prices and other economic factors driven by global trends associated with climatic and environmental changes in other parts of the world (potentially associated with both linear and non-linear migration into or out of an area, depending on local economic impacts).
6. Long-term changes that result in the actual loss of land (e.g. sea-level rise) or the loss of productive land (e.g. desertification), including the actual or effective loss of sovereign territory (likely to be associated with linear migration initially, but ultimately with non-linear migration).

The above processes will interact with each other to a considerable extent. For example, long-term degradation (e.g. desertification) may be accompanied by more frequent and severe slow-onset hazards (e.g. drought), and culminate in an outcome that makes certain areas uninhabitable (e.g. extreme aridity and a collapse in productivity). Long-term changes in climatic and environmental conditions that put additional pressure on livelihoods without causing disasters might be offset by increased agricultural commodity prices that increase household incomes and enable people to engage in diversification and adaptation.

Policy will play a key role in mediating the impacts of the processes identified above, for example by facilitating or preventing adaptation. Policy may itself be a significant determinant of migration in the context of climate change, as discussed below.

Other factors will also influence migration decision-making. For example, Kolmannskog (2009: 7) describes "massive and abnormal movement to areas that receive rains" in Somalia, a process that is roughly analogous to the "pull factors" represented in category (4) above, but which is also linked with the "push factor" of drought in adjacent areas. The scale and rapidity of movement from drought areas to areas receiving rainfall are enabled by technology, with information about rainfall spreading via mobile phones, and large movements of livestock made possible by the use of trucks (Kolmannskog, 2009).

A large number of studies address impacts of and responses to drought and related environmental changes, and a growing body of literature addresses the potential impacts of sea-level rise. These two phenomena are therefore used to illustrate and explore some of the issues related to migration associated with longer term climate change related processes.

3.3.2 Illustrative examples: drought and migration

Drought is a common phenomenon in many parts of the world, particularly in marginal, semi-arid regions, which are characterised by a high degree of variability in rainfall on multiple timescales (Brooks, 2004). It has been estimated that more than 26.5 million people were affected by 12 droughts in 2008, although no estimates are available for the numbers displaced by these droughts (Kolmannskog, 2009; OCHA-IDMC, 2009) Responses to drought and climatic variability have been widely studied in the Africa, and particularly in the Sahel, in large part as a result of the protracted decline in rainfall and severe droughts that affected the region from the early 1970s to the late 1990s, and which represent one of the largest and most persistent changes in regional climate during the period of instrumental records (Hulme, 2001; Brooks, 2004).

Hill (1989) sums up the role of mobility in the Sahel by stating that "The principal individual-level strategy for coping with drought in the Sahel is to move." The role of mobility in the Sahel is embedded in the role of mobile pastoralism as a key livelihood strategy, that allows people to respond to scarce, highly variable and unpredictable rainfall. In periods of hardship associated with drought, pastoralists may extend their geographical range. For example, in 1973, 20,000 "displaced" persons, mostly pastoralists, congregated around the town of Gao in Mali, in what Hill (1989) describes as an extension of their usual transhumance. This example illustrates the ambiguities associated with such movements: should such movements be seen as "normal" extensions of habitual patterns of mobility, or as "displacement" requiring formal intervention or assistance? While such distinctions might be more-or-less irrelevant to those faced with the consequences of such movement on the ground, they are pertinent to any attempts to develop international frameworks to address migration and displacement.

While ambiguities may exist regarding the "normality" of internal (or even cross-border) movements of large numbers of people in response to drought, the studies cited here illustrate the breakdown of resilience in the face of overwhelming slow-onset hazards. Hill

(1989) describes how traditional redistributive mechanisms based on loans of animals to the destitute who had lost their herds played a role in recovery from drought in Mali following the initial severe drought in 1973. However, because of the extent of livestock mortality during the drought of 1984-85, these mechanisms could not function, resulting in the migration of pastoralists to "refugee" camps. Kolmannskog (2009) describes an analogous situation in Somalia in 2008 and 2009.

A report of the multi-agency *Security in Mobility* (SIM) initiative in the Horn of Africa and East Africa concludes that climate change will force pastoralists "to migrate … more often than usual, further than usual, and with longer-than-usual time spent in 'foreign territory' outside of their traditional grazing areas", and reports that pastoralists have been engaging in such patterns of movement in response to drought in Kenya, Somalia, Ethiopia, Uganda and Tanzania (UN-OCHA, 2010). The SIM report also states that drought in 2009 forced pastoralists from Kenya's North East Province "to migrate deep into the Lower Juba region of Somalia", where many stated for up to a year and a half, only returning with the onset of the rains in Kenya. Drought is also reported to have disrupted traditional patterns of mobility among the Maasai, pushing Maasai pastoralists into new areas inhabited by other ethnic groups (UN-OCHA, 2009). Overall, drought is reported to be associated with "increasingly frequent out-migration of pastoralists within Kenya or across the border", with new patterns of movement contributing to conflict in the Kenya-Uganda-Sudan-Ethiopia border area, although other factors such changes in district boundaries, land privatization, and the proliferation of small arms also play a role in conflict (UN-OCHA, 2009). Again, this situation is reflected elsewhere in Africa (Kolmannskog, 2009).

Examples of responses to drought also illustrate how migration can evolve in response to climatic and environmental changes that occur over longer timescales than those associated with sudden-onset disasters. For example, Kolmannskog (2009) describes how, during the 2008 drought in Kirundo province in Burundi, migration was undertaken primarily by male heads of households who left their homes in search of work. However, he refers to a "tipping point" when an entire family leaves an area as a result of drought. We thus can envisage a process in which protracted or recurrent drought initially is associated with the migration of certain household members, and then by entire households or even communities. Depending on the magnitude and pathways of migration, such a phenomenon might be seen in terms of a transition from linear to non-linear migration. Kolmannskog (2009: 7) also describes how drought can turn internal into international migrants, citing how people who had fled to the Somali countryside to escape the conflict in Mogadishu had been "forced to move further", including to neighbouring countries, due to "drought and environmental degradation".

While climate change will intensify drought risk in many areas, much can be learned regarding drought and population dynamics from recent historical case studies. Such studies illustrate the key role that migration plays in livelihoods and climate risk management in marginal areas, and also help us to understand how climate change might increase the likelihood of non-linear migration through an intensification of drought risk. On the one hand, traditional strategies for coping with drought (including migration), and support for such strategies through policy interventions, have a key role to play in managing the risks associated with climate change. On the other hand, climate change has the potential to overwhelm such strategies where it results in recurrent, severe droughts

that are unprecedented within people's historical experience, and where traditional coping strategies are undermined by development policies (see below). Policy interventions therefore need to support existing coping strategies, and provide additional support where such strategies may be inadequate in the context of climate change.

3.3.3 Illustrative examples: sea-level rise and migration

Sea-level rise (SLR) is often treated as a special case of long-term climatic and environmental change (e.g. IASC, 2008; Leighton, 2010). The IPCC AR4 projections indicated an increase in global mean sea-level (gmsl) of up to around half a metre 2100, across six scenarios (Meehl, 2007; Table 3). However, the methods used to calculate these values did not incorporate considerations of key processes associated with the dynamics of ice sheets, and the ranges are therefore likely to be conservative. Subsequent studies have concluded that sea level rise by 2100 is likely to be significantly greater than indicated in the AR4 (Table 3). Studies reviewed by Nicholls and Cazenave (2010) provide a range of about 0.3-1.8 m by 2100, and a consensus appears to be emerging among researchers in the field of sea-level rise that an increase in gmsl of around 1m or more by 2100 is likely (e.g. Kintisch, 2009). Palaeoclimatic evidence indicate that a warming of around 3° C could be associated with an eventual rise in sea-levels of some 25±5, and that rates of SLR of 1.6 m per century are physically realistic (Rohling et al., 2008, 2009).

Table 3. Recent projections, with uncertainties, of sea-level rise (SLR) by the late 21st century. The three scenarios used by Pfeffer et al. (2008) were based on different assumptions about future changes in surface mass balance of land ice and discharge velocities of marine-terminating glaciers.

Source	Scenario(s) used	SLR by 2100 (m)
IPCC AR4 (Meehl, 2007)	Across 6 IPCC scenarios	0.18-0.59
Rahmstorf (2007)	Across 6 IPCC scenarios	0.5-1.4
Pfeffer et al. (2008)	3 scenarios based on ice loss assumptions	0.8-2.0
Grinsted et al. (2010)	A1B (medium emissions)	0.9-1.3

A key element of vulnerability to SLR, particularly when assessed at the national, regional or societal level, is the physical exposure of populations to SLR, based on their proximity to the shoreline and elevation above gmsl. McGranahan et al. (2007) provide statistics for the global, regional and national populations living in the low-elevation coastal zone (LECZ), defined as the zone within 100 km of the coastline and below 10 m above gmsl, which contains some 2 per cent of the world's land and 10 per cent of its population (based on population figures for the year 2000). Of the approximately 600 million people living in the LECZ, the majority live in low income countries (247 million) or lower-middle income countries (227 million). Most residents of the LECZ (466 million) live in Asia, with 56 million in Africa, 50 million in Europe, 29 million in Latin America, 24 million in North America, and 6 million in small islands states (SIS). Globally, 360 million people live in urban areas in the LECZ. In 21 countries more than half the population resides in the LECZ. Of these, 16 are SIS with populations of less than 100,000; the remainder are listed in Table 4.

Li et al. (2009) estimate the global population in areas within 1 m and 6 m of gmsl at 108 million and 431 million respectively. Within the LECZ, Anthoff et al. (2006) conclude that

more land, people, and economic activity are concentrated in the most low-lying areas (within 1m of gmsl) than in higher elevation areas, based on gradients of plots of land area, population and GDP against elevation. However, Lichter et al. (2010) find large differences in estimates of land area and population within the LECZ, with the most extreme differences associated with estimates for elevations below 1 m. The Expert Group for the Pilot Programme on Climate Resilience also report that data on population in the LECZ grossly underestimate populations in this zone for SIS when compared with national data (PPCR Expert Group, 2009). Nonetheless, it appears clear that the number of people likely to be affected directly by the impacts of SLR over the course of the 21st century (including permanent loss of land and ancillary hazards and impacts such as intensified storm and flood hazards and environmental degradation) is somewhere in the low hundreds of millions.

Table 4. Countries with high proportions of their population, and large absolute numbers, in the LECZ. Data from McGranahan et al. (2007).

Country	No. of people in LECZ	% of population in LECZ
Countries with high percentage of population in LECZ		
Bahamas	267,000	88
Suriname	318,000	76
Netherlands	11,717,000	74
Viet Nam	43,051,000	55
Guyana	415,000	55
Bangladesh	62,524,000	46
Djibouti	289,000	41
Belize	91,000	40
Egypt	25,695,000	38
Gambia	494,000	38
Countries with large absolute numbers in LECZ		
China	143,880,000	11
India	63,188,000	6
Indonesia	41,610,000	20
Japan	30,477,000	24
USA	22,859,000	8
Thailand	16,478,000	26
Philippines	13,329,000	18

Coastal populations continue to grow as a result of the economic opportunities available in coastal zones, and this process is reinforced by the global trend of rural-urban migration and the tendency of large urban centres to be located wholly or partly within the LECZ (McGranahan et al., 2007). The growth of large urban centres in coastal areas will continue to increase the population exposed to SLR and associated hazards in the near to medium term.

The preponderance of poor countries in the lists of nations with large populations in the LECZ is striking, and many people living in the LECZ are highly vulnerable to existing climate-related stresses, and are regularly affected by climate-related disasters. The development and exploitation of coastal zones has contributed to the vulnerability of coastlines and coastal populations to coastal climate risks as a result of the degradation of

coastal systems that provide livelihoods, food security, and protection against floods and storm surges (Agardy et al., 2005). Coastal development is also likely to reduce the capacity of ecosystems to respond and adapt to SLR, for example where settlements and infrastructure represent physical barriers to the inland migration of coastal ecosystems such as wetlands and mangroves.

Vulnerability to coastal erosion, storm surges and SLR is also increased where development prevents the nourishment of coastal systems by sediment carried by rivers (e.g. through the construction of dams or the diversion of river channels) or ocean currents (e.g. through the construction of coastal defences in sediment source areas). Abstraction of groundwater can result in subsidence, and/or accelerated saltwater intrusion, increasing relative sea-level rise and compromising water resources. A further mechanism likely to impact on people's livelihoods in coastal areas is a reduction in marine biological resources as a result of a combination of ocean warming and acidification, which could also have very serious implications for food security.

Migration in the context of SLR will be driven by a combination of factors that will interact in a complex manner. Current estimates of the global population living at very low elevations above sea-level, combined with the most recent projections of SLR, suggest that somewhere in the region of 100 million people are living in areas likely to be permanently inundated by rising sea-levels by 2100. On the one hand, rural-urban migration, migration to coastal zones, and population growth will act to increase this number. On the other hand, intensified risks associated with storms and floods, pressures on livelihoods due to environmental degradation and reduced ocean productivity associated with warming and acidification, and incremental loss of coastal land, are likely to increase migration out of such areas. Increased disaster risks and impacts on livelihoods may also help to drive migration out of areas that are not at existential risk from SLR, but which are strongly affected by climate change. These considerations suggest scenarios in which continuing migration to coastal areas is accompanied by significant migration within such areas, as people leave particularly high-risk areas but relocated within the coastal zone. Under such scenarios, linear migration to coastal areas associated with current trends is likely to continue, although this is increasingly likely to be complemented by non-linear migration within such areas as SLR and other (e.g. related) risks intensify. Coastal regions are therefore likely to be characterised by strong population dynamics, coupled with increased pressure on resources resulting from both climate change and local anthropogenic factors. Policies for managing these processes will be vital in order to secure development in coastal zones, where climate change impacts and migration are likely to prevent profound challenges that will intensify as the century progresses.

3.4 Climate change and development policies

Development policies will mediate risks and opportunities associated with climate change via their impacts on livelihoods (e.g. enhancing or reducing livelihood opportunities), and by influencing the extent to which adaptation *in situ* is feasible and practical. At best, policies will act to promote resilience and facilitate adaptation, for example through opportunities for livelihood diversification and support for specific adaptation measures. Such policies may reduce pressures that drive migration undertaken for economic or livelihood reasons, and may prevent or reduce non-linear migration where adaptation *in*

situ represents a realistic response to the localised manifestations of climate change. Such policies might also facilitate adaptation *through* migration, reducing the potential negative impacts of migration and perhaps preventing non-linear or mass migration by enabling some people to move while others undertake *in situ* adaptation according to circumstances and preferences.

While development policies have a key role to play in reducing migration pressures through actions to reduce vulnerability, enhance resilience and promote adaptation, policy may also act as a driver of migration. Such "policy-driven" migration may take a number of forms. Policies and related development interventions may increase migration pressures where they increase vulnerability to climate change and undermine livelihoods. Such outcomes are likely to be unintended and unforeseen, and may result from a poor understanding of the impacts of policies in local contexts, or from a failure to consider how policies will interact with climate change impacts. However, in some instances migration may be viewed as an inevitable and necessary by-product of a development policy or initiative. This may be the case where an initiative involves the construction of infrastructure (e.g. a dam) that involves the displacement of certain groups or communities, or a denial of access to certain areas that are play a key role in livelihoods. Climate change will influence decisions about such initiatives, and infrastructure projects associated with inevitable and foreseen displacement may be developed and implemented as a direct response to climate change risks. Migration may also be associated with relocation as a direct and deliberate means of managing climate change risks.

We may therefore identify three broad categories of policy-related migration in the context of climate change, namely:

1. Migration driven by policies that inadvertently increase vulnerability to climate change and therefore undermine livelihoods.
2. Migration associated with the displacement of certain (minority) groups as a by-product of development interventions designed to address climate change.
3. Migration resulting directly from relocation schemes whose purpose is to move people away from high-risk or existentially threatened areas, or from areas where a combination of climatic and local anthropogenic stresses is threatening resources, landscapes or ecosystems.

These categories of policy-related migration are discusses in more detail below.

3.4.1 Migration associated with policy-driven increases in vulnerability

Development policies that are developed without any consideration of how their impacts may interact with the impacts of climate change may exacerbate climate change-related risks. Such policies might increase the vulnerability of certain groups to climate (change) hazards. At worst, they might be "maladaptive" (Box 6), increasing the vulnerability of society at large to climate change and its impacts.

Policies that are successful in terms of their intended outcomes may result in the marginalisation of certain groups, increasing their vulnerability to climate change. Such groups are likely to be those that are already socially, politically or economically

marginalized, and further marginalisation, associated with worsening poverty, may force such people to migrate. An example is the loss of pastoralists' dry season grazing lands to agricultural expansion. While this may increase agricultural productivity and help economic growth, it is likely to reduce the ability of pastoralists to cope with drought and increase the likelihood that they will lose their herds and thus their livelihoods. Once destitute, such individuals are likely to migrate to urban centres in search of wage labour, contributing to rural-urban migration flows. Such a policy-driven marginalisation of pastoralism in favour of agriculture has occurred across the Sahelian region (Hill, 1989, Bloch and Foltz, 1999; Box 7).

Box 6: Maladaptation

Maladaptation occurs when development activities inadvertently increase vulnerability to climate change, or result in "lock-in" to patterns of development that might be unsustainable under future climatic conditions, increasing the risk of economic and wider societal disruption. Typically, maladaptation occurs when longer term climatic and environmental change and variability is ignored in development planning. This may result in development strategies being developed under implicit or explicit assumptions of climatic stationarity (e.g. assuming current climatic conditions will continue indefinitely), or that current levels of key resources such as water will be sustained into the future when climate change will in fact alter the availability of such resources. The OECD (2009: 49) defines maladaptation "*as business-as-usual development which, by overlooking climate change impacts, inadvertently increases exposure and/or vulnerability to climate change. Maladaptation could also include actions undertaken to adapt to climate impacts that do not succeed in reducing vulnerability but increase it instead*"[7].

Policies risk being maladaptive where they act to increase dependence on resources and activities that are threatened by climate change, or where they result in additional pressures on climate-stressed resources. Increased dependence on climate sensitive resources might involve an intensified use of water resources in areas where surface runoff and groundwater recharge are projected to decline, or the expansion of agriculture into areas that are currently productive but where rainfall is highly variable on multi-year timescales, or is projected to decline in the future (see Box 7). Economic growth predicated on the expansion of the fisheries sector may be unsustainable due to the impacts of ocean warming and acidification (Guinotte and Fabry, 2008; Allison et al., 2009). Intensified use of natural resources such as groundwater or fish stocks may act in combination with stresses associated with climate change to accelerate a decline in such resources.

While such policies might increase productivity or generate growth in the short-term, they may result in patterns of development that are not viable in the longer term (Brooks et al., 2010). Such policies might result in food insecurity, conflict and even economic collapse, increasing the likelihood of out-migration. The risk of maladaptation will be particularly high where development strategies, policies and interventions involve climate-sensitive activities that are predicated on explicit or implicit assumptions that current climatic conditions will persist into the future.

[7] OECD. 2009. Policy Guidance on Integrating Climate Change Adaptation Into Development Co-Operation. ISBN-978-92-64-05476-9

Box 7: Policy, drought, vulnerability and migration in the Sahel

In the context of the instrumental record, the 1950s and 1960s were unusually wet in the Sahel region of Africa. This wet period was followed by a protracted dry period from the early 1970s to the mid 1990s, which represents the largest and most sustained reduction in rainfall in the global instrumental record (Hulme, 2001). Severe droughts in the early 1970s and 1980s were associated with famine, the collapse of pastoral and agricultural livelihoods, and large movements of people, particularly from rural to urban areas (Swift, 1977).

One of the key characteristics of development policy in the Sahel since the 1950s has been agricultural intensification, expansion and modernisation. Agricultural expansion during the 1950s and 1960s into areas that were temporarily wet but historically marginal was maladaptive in that it predicated development on practices that were not viable in the medium to long term, making Sahelian societies and economies highly sensitive to drought. Agricultural expansion also resulted in the further marginalisation of pastoralists, who were pushed into less productive areas and denied access to historical grazing lands, contributing significantly to the collapse of pastoral livelihoods during severe drought years. In this sense the famines, population movements and widespread societal disruptions associated with the droughts of the 1970s and 1980s were driven as much by development policies as by climate change (Thébaud and Batterby, 2000; Heyd and Brooks, 2009; Brooks et al., 2010).

The marginalisation of pastoralists in the Sahel has continued throughout the post-colonial period, increasing their vulnerability to drought and contributing to migration and conflict. For example, Hill (1989) describes how state legislation, the commercialisation of the rural economy, and the privatization of land have destabilized complex traditional systems of land tenure, reciprocity and the sharing of limited land and water resources, contributing to rural instability and localized pressure on resources. In Niger, state erosion of common property rights and encouragement of outright ownership have made pastoralism among the Fulfulde a marginal activity, reducing the capacity of herders to cope with successive drought years (Hill, 1989). In Mauritania, a move towards formal private ownership of land in the Senegal river valley to the detriment of pastoral groups and ethnic minorities contributed to ethnic violence in 1989 (Block and Foltz, 1999).

The marginalisation of pastoralists and the undermining of pastoral livelihoods, combined with severe drought, has contributed significantly to migration in the Sahel. In Mali the loss of herds and livelihoods contributed to the migration of Tuareg to urban centres, "refugee" camps, and neighbouring countries, and was a contributing factor to conflict (Keita and Henk, 1998). A couple more examples to be inserted here.

It is now well-established that Sahelian monsoon variability is driven principally by patterns of ocean surface temperature (Giannini et al., 2003), and two recent papers provide strong evidence that one of the key drivers of the Sahelian desiccation is likely to have been cooling of the North Atlantic resulting from anthropogenic aerosols originating in industrialised northern hemisphere nations (Evan et al., 2009; Kawase et al., 2010). Theories of the Sahelian drought based on widespread land degradation resulting from human activities, and invoking systematic desertification associated with a progressive southward encroachment of the Sahara desert have been thoroughly discredited (Brooks, 2004). Nonetheless, the future of rainfall in the Sahel is highly uncertain. Averaged across the models used in the IPCC AR4, rainfall increases in the central and eastern Sahel and declines in the west, although individually these models simulate very different outcomes ranging from wetting to drying (Christensen et al., 2007). Other studies have concluded that models that perform well in representing 20th century Sahel climate simulate drier conditions in the future (Held et al., 2005; Cook and Vizy, 2006). Given these uncertainties, development policies in the Sahel need to be based on flexibility and resilience. Migration will continue to be a key livelihood strategy in the region, and support for pastoralism and mobility offers significant potential for adaptation to future climate variability and change.

3.4.2 Migration as a "by-product" of climate change interventions

Development projects are already a major driver of displacement and migration. Castles et al (2005) cite World Bank figures indicating that development-induced displacement and resettlement (DIDIR), associated with large-scale development projects such as dams, airports, roads and urban housing, results in the displacement of some 10 million people per year. DIDR affects large numbers of people who are already politically and economically marginalized or who are not integrated into national economies, such as indigenous communities and smallholder farmers (de Sherbinin et al., 2010). Many of those displaced by development projects become permanently impoverished and socially and economically marginalized. DIDR contributes to rural-urban migration, and displacement by development projects may spill over into international migration (Castles et al., 2005). Migration associated with DIDR exceeds that associated with the movement of refugees (Castles et al., 2005; OCHA-IDMC, 2009), and Christian Aid's (2007) contested figure of 250 million people likely to be displaced by climate change by 2050 may be compared with the 645 million the same study estimates will be displaced by development projects over the same period.

The nature of large development projects will be influenced by climate change as governments and development planners seek to respond through mitigation and adaptation initiatives. The potential for large-scale climate change adaptation and mitigation projects to result in population displacement, and the recent appropriation of land for such projects, is discussed by de Sherbinin et al. (2010).

Transitions to low-carbon economies will require the development and installation of new energy infrastructure (e.g. wind, wave, solar, geothermal, nuclear, associated transport networks and distribution grids), and the creation of such infrastructure may result in DIDR where it is constructed in areas that are inhabited or used by certain groups. Mitigation schemes have the potential to result in displacement and migration via a number of mechanisms. Carbon sequestration through the Reduction of Emissions from Deforestation and Forest Degradation (REDD) scheme may restrict indigenous and other forest-dependent people's access forests as a result of conservation initiatives. Small-scale forest agriculture and the gathering of forest resources such as fuel wood may be prohibited, undermining livelihoods. The lack of clear, established rights to forest resources by indigenous and other groups may result in governments or private interests claiming forests in order to benefit from carbon credit schemes, restricting access to those whose livelihoods depend on forest resources, or forcing them to settle elsewhere (Olander et al., 2009). Conversion of land for the production of biofuels has similar potential for marginalisation and displacement (de Sherbinin et al., 2010).

Adaptation may also involve large development projects with the potential to undermine livelihoods or physically displace people. In areas facing potentially large reductions in rainfall and surface runoff, the construction of dams and the flooding of land to create reservoirs may displace communities, destroy productive land, and disrupt existing patterns of movement associated with mobile livelihoods. The construction of coastal defences and the protection, rehabilitation or assisted migration of coastal ecosystems may also result in displacement. The restructuring of national economies and the resetting of economic and development priorities in order to make countries more resilient in the face of climate

change may also result in migration, as support for some existing economic activities and livelihoods is withdrawn, and other activities are promoted.

3.4.3 Resettlement in the name of adaptation

The relocation of communities and the resettlement of certain groups is likely to increase as governments seek to adapt to climate change. However, while relocation from certain areas that are existentially threatened by climate change will be inevitable, resettlement in the name of adaptation is fraught with problems.

The most obvious context in which resettlement and relocation will occur is that of sea-level rise (SLR). As discussed above, it is estimated that some 100 million people currently live within 1m of mean sea level, in areas that are likely to be permanently inundated by SLR by 2100. In many parts of the world life in such areas, and in adjacent locations subject to flooding, storms, and environmental degradation associated with processes such as saltwater intrusion into groundwater, will become increasingly untenable, and people will have little choice but to relocate. Such relocation is likely to be encouraged or enforced by governments in many instances. Governments may also relocate people from other areas where increased disaster risks are seen as unacceptable or the costs of disaster prevention and/or reconstruction are viewed as prohibitive. Such areas may be subject to increasingly frequent droughts or floods, or at risk from hazards such as glacial lake outbursts or catastrophic subsidence due to melting ice and permafrost. In Rwanda, UNEP and UNDP are supporting a project that involves the resettlement of communities established by returning refugees, from areas at high risk of flooding and landslides to lower risk areas[8].

Resettlement may be undertaken to address issues of wider environmental sustainability that may or may not be related to climate change. For example, in Inner Mongolia, identification of pastoralists as agents of desertification (via overgrazing) has resulted in a Chinese government programme to resettle nomadic pastoral populations. This "Ecologic Reinstallation" programme to fight desertification resettled an estimated 650,000 people between 2001 and 2008 in this region (de Sherbinin et al., 2010). Such measures may become more common in the future, and might be promoted as adaptation initiatives, as climate change-induced desiccation places additional pressures on ecosystems, particularly in semi-arid areas. In this context, the discrediting of explanations of desertification based on assumptions of overgrazing by pastoralists in the Sahel provides a cautionary lesson, and illustrates the need for adaptation interventions, particularly those involving resettlement, to be based on sound empirical evidence (Brooks, 2004).

4. POLICY IMPLICATIONS AND RECOMMENDATIONS

As recognised in much of the literature, existing international policy frameworks for addressing migration are inadequate for anticipating and managing the potential impacts of

[8] Adapting to Climate Change through Land and Biodiversity Conservation in Gishwati Area in the Nyabihu District. For project details see the CCDARE website (http://www.ccdare.org/Countries/Rwanda/tabid/29633/Default.aspx) or the project document, available at: http://www.ccdare.org/Portals/131/Rwanda/RENGOF%20CC%20DARE%20PROJECT.doc.

climate change. Furthermore, at the international level, the debate on climate change and migration is very often driven by somewhat simplistic "maximalist" views of migration that fail to address the complex factors that influence migration decision-making based on perceptions of risks and opportunities. On the other hand, much of the migration literature takes a "minimalist" view, based on historical case studies that are arguably inadequate for understanding migration to the very large changes in climatic and environmental conditions that are likely to occur as anthropogenic climate change accelerates in the coming decades.

4.1 Policy frameworks and classification issues

New or modified frameworks are required that recognise the complexities, and different types, of migration that might be associated with climate change (Guterres, 2009). These frameworks need to bridge the maximalist and minimalist views of migration, and recognise that migration will take many different forms depending on the factors that drive it and the contexts in which it takes place. The concepts of "linear" and "non-linear" migration developed by Bardsley and Hugo (2010) are particularly useful in this regard.

Frameworks are required that can address climate change-related migration both within countries and across international borders. While the current classification of IDPs can accommodate internal migration associated with climate-related sudden-onset disasters, migration associated with longer-term environmental changes is not easily accommodated under the definitions of IDPs.

While people displaced across international borders by sudden-onset disasters may effectively be treated as refugees, the frameworks for dealing with international migration are even less well suited to addressing migration associated with climatic and environmental change, as refugee conventions do not acknowledge environmental change as a factor in displacement.

A key question for international migration policy is the extent to which new frameworks and/or categories are required, such as those of Environmentally Displaced Persons (EDPs) and Environmentally Induced Population Movements (EIPMs), as suggested by Piguet (2008). Alternatively, existing frameworks and definitions might be modified or updated to accommodate those migrating in large part as a result of exposure to climate change-related hazards.

A critical issue will be how to identify the role of climate hazards in migration, given that drivers associated with these hazards will not act in isolation. Identifying a climate fingerprint in migration will be most problematic in the context of long-term climate change-related environmental changes that increase livelihood stresses but which do not result in the catastrophic collapse of livelihood systems. Even where such collapse does occur, it may be difficult to disentangle climatic from local anthropogenic factors.

One possible approach to identifying climate change-related migration in such cases is analogous to that employed in weather-related insurance, and would involve classifying people as EDPs if they have migrated from an area in which climatic or climate-related environmental conditions have demonstrably deteriorated, and in which links between

deteriorating environmental conditions and adverse livelihood or other outcomes can be demonstrated beyond reasonable doubt. Such environmental deterioration might be identified through analyses of trends in mean annual or seasonal rainfall, rainfall variability and predictability, water availability or quality, or the frequency and/or severity of extremes. Given sufficient data on climatic, environmental and migration trends, and on development, poverty and related indicators, it should be feasible to establish relationships between climatic/environmental change and migration. Such an approach would require considerable resources, adequate data collection and management, and the establishment of links between bodies concerned with poverty/development, migration, environmental monitoring, the gathering and interpretation of meteorological and climatic data, and perhaps climate modelling. This approach would also benefit from the establishment of a task force or agency to identify and monitor "hot-spots" where climate change-related migration is likely.

The above approach is very wide-ranging, and could identify those migrating as a result of economic stresses deriving in whole or in part from climate change impacts. In many instances, such individuals are likely to contribute to linear migration, and within current frameworks would be classified as economic migrants. Even where out-migration from areas experiencing demonstrable climatic or environmental deterioration takes place, the extent to which individuals migrate as a result of such deterioration may be highly ambiguous, rendering impractical the operation of policy frameworks intended to assist those migrating as a response to climate change.

An alternative approach would be for such assistance to be targeted at non-linear migration associated with climatic or climate-related environmental deterioration. Bardsley and Hugo's (2010) framing of non-linear migration, or a version of it, might be used to define and identify EIPMs and EDPs (Piguet, 2008). The distinction between linear and non-linear migration could thus be used to identify thresholds for assistance and intervention.

A key issue for international policy frameworks, and one that might be addressed somewhat independently of the issues discussed above, is that of statelessness and the loss of sovereign territory resulting from climate change. The loss of national territories as a result of sea-level rise (SLR) represents the most obvious example of this phenomenon. Projections of SLR can be employed to predict where the loss of sovereign territory and statelessness will occur, and such outcomes are already being anticipated by the governments of some low-lying island nations in plans to buy land for the resettlement of national populations (Russell, 2009). However, the purchasing of land by the governments of nations that are existentially threatened by climate change may not be practical in all cases, due to financial and other constraints. International mechanisms for addressing this issue are therefore desirable. The nature of these mechanisms is a matter for debate and negotiation, but they might be accommodated within existing adaptation frameworks, or addressed independently. Byravan and Chella Rajan (2006) suggest that the responsibility for absorbing such "climate exiles" could be shared among host countries in a manner proportional to the responsibility for climate change of potential host nations, based on cumulative emissions of greenhouse gases.

4.2 Tailoring policy responses to risk contexts

Regardless of how international frameworks for addressing migration may evolve, policy (whether at the international, national or sub-national level) will be a vital tool in addressing and managing migration. International and national policies will play a key role in mediating climate change risks and opportunities in (potential) source and destination areas, and therefore in mediating the factors that influence migration.

The discussions above are based on a framing of migration with respect to three categories of climate change-related drivers of migration, namely (1) sudden-onset climate-related disasters, (2) longer-term changes in environmental conditions associated with climate change, and (3) development policies and related interventions that are sensitive to climate change or that seek to address climate change through adaptation or mitigation. A variety of policy responses will be required to address migration associated with each of these categories of driver, depending on the nature of the climate hazards faced, the role of vulnerability and livelihood impacts in mediating migration, and the type of migration that needs to be addressed.

Crucially, policy responses and development interventions need to recognise that migration represents a viable and legitimate mechanism via which people can address risks to their livelihoods and wider well-being, and a means of adapting to climate change and its impacts. A key question for migration policy is therefore where migration should be treated as a risk to be managed and mitigated, and where it should be treated as an opportunity to be facilitated or even encouraged.

The extent to which migration represents a risk to be managed or an opportunity to be taken will depend strongly on context, and on the relative roles of changes in hazards and changes in the factors governing vulnerability in driving migration "risk". Where migration is driven predominantly by increased vulnerability resulting from poor governance, resource management or other socio-political factors, the drivers of migration might be addressed through policy interventions that seek to reduce migration pressures. Where migration is driven largely by the intensification of climate-related hazards, policies will need to be based on careful considerations of the potential for vulnerability reduction and adaptation interventions to reduce migration pressures. Incremental changes in hazards might be addressed through incremental adaptation and vulnerability reduction interventions. In contrast, where hazards intensify so as to overwhelm the capacities of societies or communities to cope, the potential for addressing migration through vulnerability reduction and adaptation might be limited. In such circumstances, i.e. where the scope for adaptation *in situ* is limited, or where such adaptation is impractical or impossible, policy interventions might seek to facilitate and manage migration rather than reduce it.

Policy responses for addressing migration associated with sudden-onset climate-related disasters

Increased risks associated with sudden-onset disasters may be driven by increased societal exposure and vulnerability, increases in the frequency and severity of sudden-onset climate-related hazards, or a combination of both. There is a very large body of literature

on disaster risk reduction (DRR), and much current adaptation practice and discourse focuses on improving DRR and reducing vulnerability to disasters, in order to address evolving climate-related hazards and associated risks (e.g. Mirza, 2003; Linerooth-Bayer and Mechler, 2006; O'Brien et al., 2008).

Improved DRR in areas that regularly experience disasters associated with evolving climate-related hazards will contribute to livelihood resilience and help to secure economic development, and is therefore likely to reduce migration pressures in many areas. Such an approach will be an appropriate means of addressing migration in areas where disaster risks increase incrementally as a result of incremental increases in hazard intensities or frequencies, or where increased disaster risk is the result of enhanced exposure or vulnerability due to factors such as in-migration, urban expansion, the deterioration of infrastructure, and so on.

In contrast, where the nature of climate-related hazards changes, or where there are step-changes in the intensity or frequency of such hazards, better DRR based on existing models and frameworks may need to be augmented by novel adaptation measures. However, there may be instances where climate-related hazards intensify to such an extent that DRR and adaptation cannot evolve sufficiently rapidly, or be sufficiently effective, to reduce risks or losses or even to maintain risks/losses at current levels. In such instances, migration will be a viable, and likely inevitable component of adaptation, and practical climate change policies will seek to facilitate migration and to anticipate and manage its impacts on both migrants and host communities.

Migration in response to incremental changes in disaster risks is likely to be linear in nature, at least initially. The likelihood of non-linear migration will increase where hazards associated with sudden-onset climate-related disasters change abruptly, either in nature, frequency or severity. Where migration becomes non-linear, this might be an indication that existing DRR and adaptation policies are inadequate, and that a combination of improved DRR, adaptation, and assisted migration is appropriate. In the most extreme cases, risks associated with sudden-onset climate-related disasters may intensify to the point where abandonment of certain areas is the most practical response.

Policy responses for addressing migration associated with longer-term climate-related environmental changes

Longer-term environmental changes associated with climate change will be associated with a variety of migration responses, mediated by vulnerability and related to impacts on livelihoods and real and perceived risks and opportunities. Changes in environmental conditions and natural resources may be driven by changes in climate, changes in local anthropogenic stresses (e.g. environmental degradation and intensity of resource exploitation), or a combination of both. Where environmental degradation is associated predominantly with local anthropogenic factors it may be addressed through policies and practices that seek to reduce anthropogenic pressures on ecosystems, landscapes and natural resources. Where local anthropogenic stresses combine with climatic stresses, policies aimed at reducing the former may ensure environmental sustainability in the face of the latter. In both of these instances, improved environmental management and the development of sustainable livelihoods is likely to reduce migration pressures. However, in

some instances existing environmental management regimes may be unsustainable in the face of climate change. Under such circumstances adaptation involving the development of new management regimes and alternative livelihood opportunities may reduce both pressure on the environment and migration pressures. Where such adaptation is not feasible, or is not sufficient to offset the impacts of climate change, assisted migration might be a viable alternative or complement to adaptation *in situ*. A transition from linear to non-linear migration in the face of longer-term climate-related environmental changes might be indicative of a need for significant adaptation intervention and/or migration assistance.

Some longer-term climate-related changes, such as sea-level rise, inundation of inland areas as a result of snow and ice melt, and extreme desertification, will ultimately result in certain areas becoming uninhabitable. In most instances, such processes are likely to unfold slowly, although not necessarily smoothly. Migration responses to such changes are likely to be linear initially, with the likelihood of non-linear migration increasing over time. Policy responses to such hazards will ultimately involve the facilitation of migration, although this may not be necessary for some time after the hazard has been identified and the final outcome of abandonment has been predicted. In such circumstances, policies might strike a balance between initial vulnerability reduction and adaptation, and eventual assisted relocation. The balance between these interventions over time will depend on a number of factors, including the willingness of people to relocate, the level of certainty regarding the eventual outcome, and the costs of adaptation and assisted relocation integrated over time.

Policy responses for addressing migration associated with climate-sensitive or climate change-related development interventions

Development policies will play a major role in mediating migration, either directly or indirectly, and intentionally or inadvertently. The three mechanisms via which policies and related interventions are most likely to generate migration are (i) inadvertent increases in the vulnerability of certain groups as a by-product of policies and projects that may or may not address climate change directly, (ii) maladaptation associated with interventions that a founded on unjustified assumptions about future climatic conditions, which increase dependence and/or pressure on resources threatened by climate change, and (iii) adaptation initiatives involving resettlement and relocation.

The extent to which mechanisms (i) and (ii) above are associated with unintended or unnecessary migration can be addressed through the incorporation of safeguards into development policy and planning. The purpose of such safeguards would be to minimise the likelihood that development initiatives will result in negative impacts in general. However, such safeguards will also reduce risks that such initiatives will create conditions likely to encourage migration as a result of livelihood deterioration or worsening outcomes associated with climate hazards.

Mechanism (i) may be addressed within existing safeguards frameworks such as those addressed in environmental and social impacts assessments and strategic environmental frameworks. Crucially, climate change projects such as those under REDD need to incorporate measures to safeguard the rights of indigenous peoples and other potentially

vulnerable groups. Currently, such measures are lacking (Griffiths, 2008; Olander et al., 2009).

In order to address the specific issue of vulnerability, development interventions (policies, programmes, projects, etc) will need to consider how their outcomes and impacts might be mediated by climate change. This can be achieved by incorporating climate change screening into policy/programme/project development, and by following such a screening with a climate risk assessment (CRA) where required. Methodologies for screening and performing CRA are emerging in the international development community (e.g. European Commission, 2009), and UNDP is currently developing guidance for the incorporation of climate change "safeguards" into development projects.

Mechanism (ii) may be addressed through the screening of development initiatives and detailed CRA where appropriate, as described for mechanism (i). However, systemic maladaptation is likely to be driven by strategic policy decisions made at the level of central government, meaning that screening and CRA will need to be applied at the level of such strategic decision making. This requires the mainstreaming of climate change considerations into government planning, which might be supported by development agencies, for example through budget support mechanisms.

Mechanism (iii) is associated with potential risks involving the use by governments and other actors of climate change and adaptation as justifications for resettling "troublesome" populations (e.g. nomadic pastoralists, indigenous groups) and for land expropriation. International frameworks might be developed to reduce the risk of such outcomes by ensuring that resettlement and relocation is voluntary and based on incentives rather than coercion, by identifying high risk areas where such responses are likely to be necessary and planning accordingly, and by developing international protocols for climate change-related resettlement and relocation.

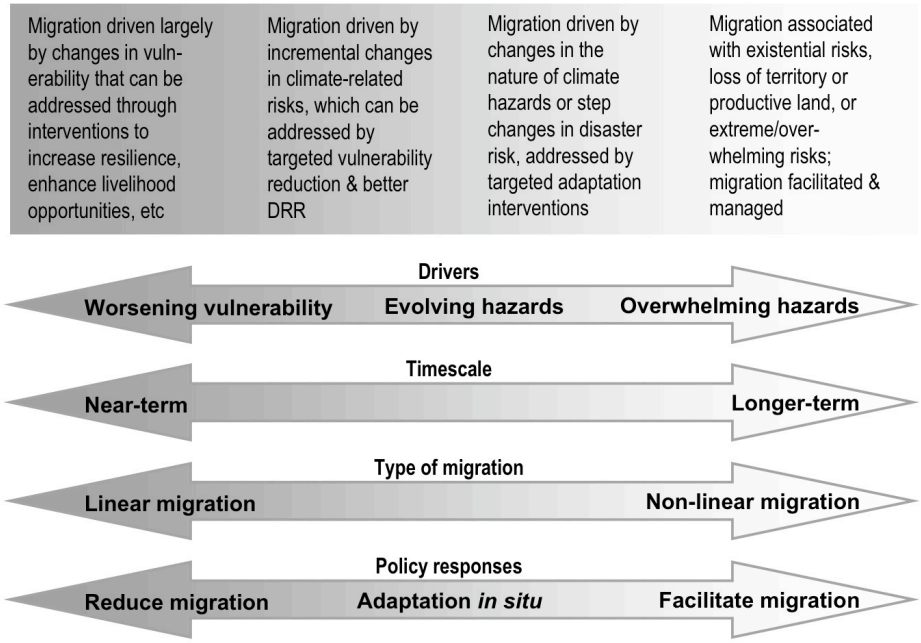
4.3 A conceptual framework for tailoring policy responses to migration

The above review suggests a policy framework for migration in which different policy responses are deployed to address migration in different contexts, with the nature of the response depending on the balance between socially constructed vulnerability and changing climate hazards in driving climate-related risks and hence migration, the types of hazards contributing to migration flows, the mechanisms through which these hazards are operating, the type of migration being undertaken, and the timescales associated with the evolution of climate change-related hazards and risks.

These factors are represented schematically in Figure 2, which describes migration and associated policy responses in terms of a continuum based loosely on the adaptation continuum developed by McGray et al. (2007) and subsequently by Tanner and Mitchell (2008). This "migration policy continuum" distinguishes between migration driven (i) largely by societally-driven changes in vulnerability to climate change-related hazards/risks, (ii) by incremental changes in risks related to the incremental or gradual evolution of climate hazards, (iii) more fundamental changes in the nature of climate hazards (e.g. the emergence of new hazards and step-changes in frequency or intensity), and (iv) overwhelming hazards and existential risks. These four categories of change

represent progressively worsening manifestations of climate change, from left to right in the continuum in Figure 2. In this schematic representation, the increasingly problematic nature of climate change hazards towards the right of the continuum is associated with a greater likelihood of non-linear migration, a greater need for policy interventions involving assisted migration on a large scale (e.g. of entire communities), and time horizons further into the future. This representation is very broad and intended to be indicative rather than precise. For example, it is recognised that non-linear migration can result from an extreme heightening of vulnerability driven by societal factors alone, even in the absence of climate change. Furthermore, linear migration associated with changes in vulnerability and incremental increases in risk resulting from the evolution of climate hazards will continue into the longer term, while relocation may well be necessary in the very near term (e.g. where communities are threatened by overwhelming hazards glacial lake outbursts of a loss of water resources from disappearing glaciers). Similarly, adaptation will be required over all timescales. Nonetheless, the continuum provides a means of framing thinking on migration-climate change linkages, and of assessing which policy responses might be appropriate in which circumstances.

Figure 2. A "migration policy continuum", illustrating how different policy responses may be deployed to address migration associated with different climate change-related drivers.



Policy responses may also be framed by asking the following questions regarding actual or potential migration, particularly in the context of climate change risk assessment exercises, where the potential for migration to be driven by climate change, non-climatic factors that mediate vulnerability, or a combination of both, is of relevance to the development of policies, strategic plans, programmes and projects.

1. What are the most likely climate change-related drivers of migration?

- Intensification of sudden-onset hazards associated with disasters
- Longer-term changes in climate, environment and resources
- Policies likely to generate migration intentionally or inadvertently
- *Will climate change amplify existing drivers of migration, or result in new drivers of migration?*

2. What are the mechanisms through which these drivers are likely to operate?
    - Physical displacement
    - Impacts on livelihoods
    - Changes in (e.g. natural) resources and risks and opportunities
    - Increased vulnerability of certain groups
    - Systemic maladaptation
    - Intentional relocation
    - *is migration most likely to be taken in a deliberative fashion on economic grounds and have a significant "voluntary" element, or will it be triggered by climate hazards resulting in involuntary displacement? Will it be permanent (e.g. as a result of people leaving areas that are likely to become uninhabitable), short-term (e.g. in response to disasters), or temporary but long-term (e.g. with more household members migrating to find work as a means of household livelihood diversification)?*
3. How is migration likely to manifest itself?
    - Linear or non-linear migration
    - Forced displacement or entire households/communities
    - Migration of certain household/community members
    - *Who is likely to migrate, and why? E.g., who are the most vulnerable, and are they the most likely to migrate? Alternatively, do the most vulnerable lack the resources to migrate, and if so, what are the factors that drive decisions to migrate among the less vulnerable?*

1. What are the potential outcomes of migration, and where are the most likely destinations?
    - Is migration likely to be internal or international?
    - What risks will migrants face at their destinations?
    - *E.g., is migration likely to be rural-urban (e.g. economic), within country (e.g. IDPs), cross-border (e.g. displacement of people in border areas with cross-border cultural links)? If rural-urban, is sufficient employment available for migrants? If cross-border, what are the implications for bilateral relations with destination countries? Is there adequate infrastructure to serve the needs of host and migrant populations in destination areas?*
4. What are the appropriate policy approaches?
    - Reduce migration pressures by addressing vulnerability
    - Facilitate migration as appropriate/best response to climate change risks
    - Combination of above, perhaps varying over time
    - *Are there realistic options for enhancing livelihood opportunities that will reduce migration pressures, or are the drivers of migration (including those linked to climate change) so strong that attempts to encourage people to stay in their places of residence are likely to fail? Should policies focus instead on accommodating migrants and providing new opportunities in destination regions? Is a combination of both approaches required? What measures should be implemented?*

While policies will generally seek to reduce migration pressures, it is vitally important that policies to address migration recognise migration as a viable and legitimate means of addressing risks associated with climate change. Migration and mobility have enabled people to survive in marginal, variable and unpredictable environments throughout human history and prehistory. Climate change will certainly result in some environments becoming more marginal, variable and unpredictable, and evidence from many parts of the world indicates that such changes are already underway. As the nature of climate-related risks and opportunities, and the distribution of climate-sensitive resources, changes, migration will represent an essential tool for adapting societies to cope with changed climatic circumstances.

In this respect, migration can make a key contribution to sustainable development - if development is to be sustainable, it needs to be based on the recognition that human societies are embedded in a dynamic environment in which processes of change are accelerating as a result of human action. Societies need to be flexible and responsive in order to address climatic and environmental change, and migration has a key role to play in this context. Realistic approaches to adaptation will involve finding a balance between alleviating the stresses that drive migration on the one hand, and facilitating migration in order to enhance societal responsiveness to climatic and environmental change on the other, without needlessly driving migration through ill-conceived policies and development activities.

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