



The effect of environmental change on human migration[☆]

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ARTICLE INFO

Article history:

Received 27 July 2011

Received in revised form 4 October 2011

Accepted 7 October 2011

Available online 21 October 2011

Keywords:

Migration

Environmental change

Climate change

Ecosystem services

ABSTRACT

The influence of the environment and environmental change is largely unrepresented in standard theories of migration, whilst recent debates on climate change and migration focus almost entirely on displacement and perceive migration to be a problem. Drawing on an increasing evidence base that has assessed elements of the influence of the environment on migration, this paper presents a new framework for understanding the effect of environmental change on migration. The framework identifies five families of drivers which affect migration decisions: economic, political, social, demographic and environmental drivers. The environment drives migration through mechanisms characterised as the availability and reliability of ecosystem services and exposure to hazard. Individual migration decisions and flows are affected by these drivers operating in combination, and the effect of the environment is therefore highly dependent on economic, political, social and demographic context. Environmental change has the potential to affect directly the hazardousness of place. Environmental change also affects migration indirectly, in particular through economic drivers, by changing livelihoods for example, and political drivers, through affecting conflicts over resources, for example. The proposed framework, applicable to both international and internal migration, emphasises the role of human agency in migration decisions, in particular the linked role of family and household characteristics on the one hand, and barriers and facilitators to movement on the other in translating drivers into actions. The framework can be used to guide new research, assist with the evaluation of policy options, and provide a context for the development of scenarios representing a range of plausible migration futures.

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1. Introduction

The natural environment is more than simply a backdrop to the social world. Ecosystem services, hazards, and deep human–environment relations affect every important social and cultural phenomenon, from the location of settlements through to attachment to place. In this context, it is surprising how standard theories and explanations of migration as an important social phenomenon do not incorporate environmental aspects in a meaningful manner. At the same time, academic discussions on environmental change have been, until recently, almost completely silent on the role of migration.

It is instructive that recent debates on climate change and migration have tended to focus on migration as a problem or threat (Hartmann, 2010). For example, a common theme in much media, policy and campaign group discourse on climate change is that future environmental change will lead to the displacement of millions of people as “environmental refugees” or “environmental migrants”. A paper at the AAAS in January 2011 prompted media reports repeating projections of ‘50 million environmental refugees by 2020’ (Zelman, 2011). Despite a number of bold claims, however, the evidence base in this field is both varied and patchy, with an absence of coherent frameworks for thinking about, and testing hypotheses on, environmental change and migration.

Myers (2002), for example, estimated that in 1995 there were approximately 25 million people displaced as a consequence of environmental change. Further, he projected that by 2050 this number would rise to approximately 200 million, taking into account demographic change and deteriorating environmental conditions. This figure was subsequently cited in the Stern Review on the Economics of Climate Change (Stern, 2007), and has been taken up by numerous campaign and advocacy groups. Yet other

[☆] While the Government Office for Science commissioned this review, the views are those of the author's, are independent of government, and do not constitute Government policy.

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studies have produced apparently contradictory assessments suggesting that climate change will lead to “substantial” (ADB, 2011) or “minor” (Tacoli, 2011) human migrations.

The empirical evidence base for major consequences is very weak (see Gemene, 2011), and assertions are largely based on “common sense” rather than insights from theory or evidence. Different studies apply different methodologies, and – most crucially – adopt different implicit or explicit definitions of migration. The apparent differences between the ADB (2011) and Tacoli (2011) reports, for example, relate to definitions rather than substance. Piguet (2010) highlights that there are diverse methods used in the analysis of migration and environment interactions, from environmental risk assessment through to social identity. Yet he suggests that these methods are rarely combined to bring a comprehensive view of migration systems in environmental contexts.

In the face of this vacuum there is a newly emerging conceptual literature on how migration interacts with environmental change and with climate change in particular. Several studies (Carr, 2005; McLeman and Smit, 2006; Perch-Nielsen et al., 2008; Warner et al., 2010) have sought to develop frameworks that go beyond the somewhat straightforward observation that people living in areas that experience negative consequences of environmental change, such as land degradation, declining land productivity, increased flood or storm hazard or sea-level rise, may be forced to migrate. An increasing number of papers have also presented local case studies describing the often complicated relationships between environmental drivers and migration (e.g. Abrar and Azad, 2004; Henry et al., 2003; Gray, 2009; Barbieri et al., 2010; Feng et al., 2010; Massey et al., 2010 and studies in Piguet et al., 2011 and Afifi and Jäger, 2010).

This paper seeks to build on this emerging theoretical and empirical case-based literature, presenting a conceptual framework for the understanding and assessment of the effects of the environment, and environmental change, on human migration, applicable to both internal and international migration. The framework sees the environment as just one of an assemblage of drivers of migration, and characterises environmental change as having both direct and indirect influences on these drivers. It also distinguishes between different types of migration outcome, recognising the diversity of space and time scales over which migration takes place. The framework recognises that there are usually multiple drivers behind decisions to migrate, and that it will rarely be possible to identify specific “environmental migrants”.

2. What drives migration?

2.1. *Environmental influences on migration: an overview of current frameworks*

As noted above, after a lengthy period in which writing on the environmental causes of migration drew relatively uncritically from early work by Myers, the last few years has seen the emergence of a new body of work that has thought to re-theorize the environment-migration nexus. For example, McLeman and Smit (2006) start with the concept of ‘vulnerability’, which they see as a function of exposure and adaptive capacity in a particular time and place, and in relation to a specific climatic stimulus. They rightly point out that neither exposure nor adaptive capacity (significantly influenced by household capital endowment) are static, and recognise the possibility of a range of types of migration outcome. This conceptual starting point is used to explain why in the historic case of dust-bowl migration in the United States, some people migrated whereas others did not, in spite of experiencing similar environmental conditions.

In contrast, Perch-Nielsen et al. (2008) focus on migration associated with sea-level rise and river and coastal floods, and outline a conceptual model of migration decision-making in the face of hazards, using inductive reasoning on evidence from a series of case studies. Their study is useful in highlighting that in affected areas there are a range of adaptation options that provide alternative outcomes to migration, leading them to conclude that floods, at least, “will not likely be a major mechanism by which climate change will trigger mass migration” (Perch-Nielsen et al., 2008: 390). Notably, they regard sea-level rise as having greater potential effects because, unlike flooding, it typically would lead to permanent loss of land. A similar approach is adopted by Warner et al. (2010) and Renaud et al. (2011) in relation to a broader range of environmental stimuli.

By focussing on the environmental hazard and individual decisions, however, the conceptual models developed to date underemphasise the role of in- and out-migration as already significant phenomena in many countries and regions with substantial observed environmental stresses and projected future change. This comes from the analytical focus on hazard, rather than seeing migration as a social phenomenon and well established system of social and demographic interaction and change. This is an important point, since acknowledgement of existing migration implies that environmental drivers need to be considered alongside other drivers. This is explicitly accepted by Warner et al. (2010), who note the complexity of migration as a human process, although they continue to focus on the search for a definition of ‘environmental migrants’, as distinct from other kinds of migrants.

Yet if this point that migration is an established social phenomenon is accepted the key question becomes less the identification of ‘environmental migrants’ who might be counted and possibly provided some form of legal or other protection, and more the question of the *net* effect of environmental change on migration in aggregate. This latter approach is explicit in Carr’s (2005) treatment of the role of environmental factors in migration from Ghana’s Central region. Carr draws on political ecology and a Foucauldian conceptualization of power to demonstrate the environment is rarely a sufficient basis for the decision to migrate, but cannot be excluded from migration decision-making because it is a key element of local power relations and local knowledge. A similar approach is adopted by Black et al. (2011) in developing a tentative approach to the sensitivity of migration drivers to climate change in Ghana and Bangladesh.

The focus in the analysis presented here is on developing a model that incorporates both structural and behavioural drivers of existing migration, explicitly incorporates and distinguishes the environment and environmental change, and accounts for migration not only as a reaction to environmental change but also as a part of adaptive response to change. Such a framework changes the present emphasis and attempts to bring analytical rigour to a field that is vital for policy and where discourses have been dominated by unsubstantiated and casual empiricism.

2.2. *A new conceptual framework*

Most assessments of the effect of environmental factors on migration have started with the environment as a driver, and followed through to consequences for migration. The framework presented here focuses instead on the drivers of migration in general, and characterises how these may be affected by environmental change.

In doing this, it is important to step back to consider major theories of migration; yet this is a substantial task. For example, a comprehensive overview of migration theories by Massey et al. (1998) highlights six separate bodies of theory (neoclassical economics, the new economics of labour migration, segmented

labour market theory, world systems theory, social capital theory, and the theory of cumulative causation), concluding that all contain elements of truth supported by empirical research. As such, and despite their contention to provide an ‘empirically-grounded theoretical synthesis’, their conclusion is that the causes of migration essentially differ in different regions and empirical circumstances.

Notwithstanding the seminal contribution of Massey et al., over a decade later it is far from clear that there is any consensus on what the ‘drivers of migration’ are, with some recent work critiquing whether a comprehensive theory of migration is even possible, given, for example, different disciplinary perspectives on the issue (Portes and De Wind, 2007). At an empirical level, when people who have migrated are asked why they have done so, answers almost always cluster around economic and social factors, with environmental factors rarely mentioned, even when surveys specifically ask about such factors. Fig. 1, for example, shows self-reported motivations for migrating by international migrants to the UK from a range of countries. Whilst such reported motivations may suffer from bias towards ex post rationalisation of movement, they nevertheless show that economic and social reasons dominate perceptions of movement for most migrants in most circumstances. This empirically driven approach assumes that migrants have agency, and indeed are both self-aware in terms of their motivation for movement, and willing and able to express these motivations to social researchers. None of these assumptions are necessarily valid, with Bakewell (2011) referring to an ‘impasse’ in migration theory consequent on the complex relationship between causal explanations that relate to structures on the one hand, and agency on the other.

At a more theoretical level, the area of explanation of migration that has received perhaps widest interest and acceptance is that focusing on more social ‘causes’ of migration, and particularly the role of social networks (Boyd, 1989). Indeed, in addition it is clear from empirical evidence that many movements over shorter distances are associated with social factors, for example migration at the point of marriage. Yet here too there are difficulties. First, whilst there is a large body of evidence that demonstrates the importance of social networks in perpetuating migration flows once started, such an explanation is inadequate to explain why new migration flows might start in the first place. Moreover, as de Haas (2011) has pointed out, such theories also tend to ignore the ways that social networks sometimes facilitate migration, but sometimes inhibit it, through a series of negative feedback mechanisms.

Castles (2011) argues that the quest for an overarching theory of migration is elusive, as it is rooted in a sedentarist notion of

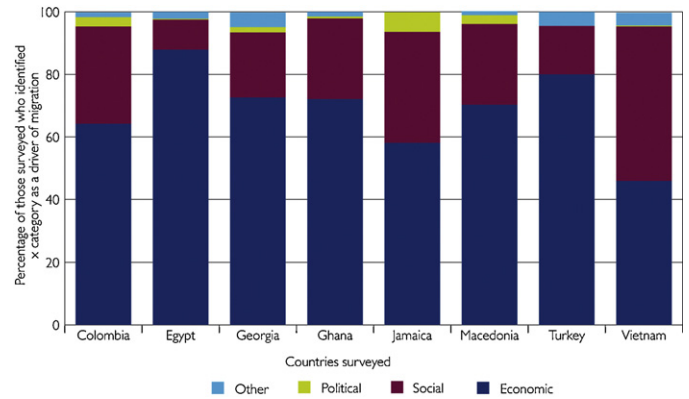


Fig. 1. Self-reported migration motivations in national surveys.

the world in which migration is seen as a problem or exception from the norm, which needs explanation. In contrast, he argues that migration needs to be understood as one part of a broader set of processes of social transformation, arising from ‘major changes in global, political, economic and social relationships’ (Castles, 2011: 1566). Yet even here, there is an implicit statement that migration is rooted in a series of political, economic and social factors

In this context, this article seeks to develop a framework which, rather than setting out theoretically what leads to migration, attempts instead to encompass the range of drivers that might affect the volume, direction and frequency of migratory movements, as well as the different levels of analysis at which migration might be considered. Fig. 2 summarises this framework, which has four components:

- a distinction between different *types of migration* (the right hand side of Fig. 2), rather than types of migrant;
- the identification of five primary families of *drivers of migration* (the pentagon on the left hand side of Fig. 2), and the recognition that it is (actual or perceived) differences across space in these drivers which influence migration;
- the incorporation of agency in determining how drivers translate into outcomes, and specifically the representation of *barriers and facilitators* to movement;
- the incorporation of *environmental change* as a direct influence on migration, through changes to environmental drivers, and also as an indirect influence through changes to the other four drivers.

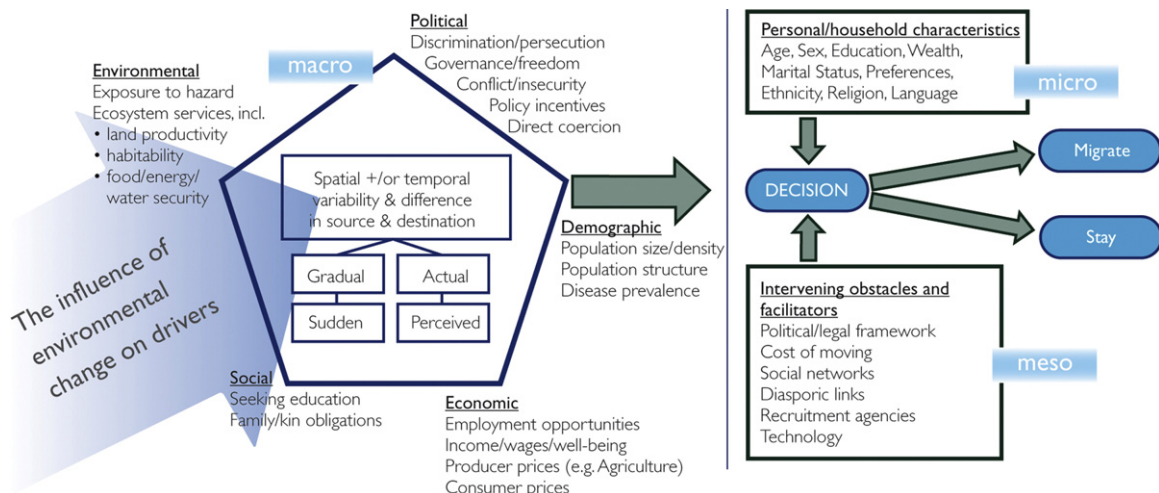


Fig. 2. A conceptual framework for the ‘drivers of migration’.

Although a distinction is drawn between mobility and displacement, it is recognised that these can be seen as two ends of a continuum. Displacement is movement associated with discrete events that challenge safety, security or livelihoods. Much displacement is, in effect, involuntary or forced, and sometimes sudden if associated with rapid onset hazards. Mobility is broadly interpreted as a proactive move to improve livelihoods and opportunities, and is typically voluntary and planned.

The focus is on decisions to move, yet for policy and in terms of social and economic impact, key issues are whether migrants move across borders, or whether migration takes the form of temporary, seasonal or permanent mobility and displacement. But underlying these fine-grained details of location and temporal scale, the drivers, filtered by barriers and facilitators, will manifest themselves in different spatial and temporal patterns of migration in different ways, depending on local context.

The factors that drive migration affect both the scale of migration but also whether populations decide not to move location at all. Most of the world's population are not and do not want to be migrants (Hammar et al., 1997). Some parts of the population have low migration rates because they lack the resources – personal and financial – to move (Hatton and Williamson, 2003). Even in the face of exposure to extreme environmental events such as in the aftermath of the Japanese tsunami of 2011, the great proportion of the population usually prefers to stay and rebuild.

2.3. Five drivers of migration

The pentagon in Fig. 2 characterises five groups of drivers of migration. It is the actual or perceived spatial and temporal differences in these five dimensions that influences movement, akin in some respects to Lee's (1966) conceptualisation of the 'push-pull' factors that influence migration. *Economic* drivers include employment opportunities and income differentials between places. *Political* drivers cover not only conflict, security, discrimination and persecution, but also the political drivers of public or corporate policy over, for example, land ownership or enforced relocation. *Demographic* drivers include the size and structure of populations in source areas, together with the prevalence of diseases that affect morbidity and mortality. *Social* drivers include familial or cultural expectations, the search for educational opportunities, and cultural practices over, for example, inheritance or marriage. The *environmental* drivers of migration are exposure to hazard and availability of ecosystem services. The five drivers rarely act in isolation, and the interaction of the five drivers determines the details of movement. The nature of these interactions will influence the scale of movement, and movements at different scales – internal compared to international, for example – will be influenced by different interactions between drivers.

2.3.1. Economic drivers of migration

Economic drivers have direct effects on both internal and international migration. Net income understood as wage differentials and income volatility play key roles in driving migration (Harris and Todaro, 1970; Bauer and Zimmermann, 1998; Stark and Bloom, 1985). If economic growth is rapid then income differentials tend to be the most powerful drivers of migration, as, for example, has been the case with internal migration to mega cities in China, India and, increasingly, in African countries too. Although economic drivers tend to stimulate mobility, it is possible to conceive of circumstances where a sudden economic collapse could trigger short-term reactive displacement.

Government policy can play a key role in stimulating economic development that leads to migration. The creation of Special

Economic Zones in China from 1978 onwards led to rapid urbanisation in areas such as the Pearl and Yangtze River deltas, including the cities of Guangzhou, Dongguan, Foshan, Shenzhen, Shanghai, Changzhou, Hangzhou and Suzhou. In these areas, urban populations are rising from fewer than 10 million people in 1990 to a projected total of more than 65 million by 2025. Similar rural-urban shifts are evident in other Asian mega-deltas such as the Red River and Mekong deltas in Vietnam and the Chao Praya delta in Thailand. Whilst migration to these urban areas can lead to increased income and to improved living standards, there can also be a greater vulnerability to the effects of environmental hazards, including floods, hurricanes and coastal erosion (Seto, 2011).

Income and wage differentials alone, however, cannot explain the specifics of migration. More broadly, migration is not a general process of people moving from poorer to richer places. It is a highly specific process as people move from one relatively poor area to another specific relatively rich area. The scale and direction of movement is linked to the personal circumstances of migrants, such as class, ethnicity, religion, language, education levels and connections with people in planned destinations, mitigated by the intervening effects of migration policies.

2.3.2. Political

Political drivers have a number of direct effects on migration. Most obviously, the breakdown of governance can lead to the emergence of forms of conflict beyond acceptable levels, trigger a decision to move or lead to displacement (Zolberg, 1989; Raleigh, 2011). Local conflict logics mean that movement is often to the next safe place, which may be within a state or across an international border. By 2009, every African state had sent or received political refugees, whilst in the Middle East 2.2 million refugees were recorded (Raleigh, 2011). Various forms of conflict can drive migration. These include inter-state conflict, but it is more likely that conflict within states, such as civil war, communal violence, genocide and politicide drive migration. There is no simple and straightforward relationship between conflict and migration, and no identifiable 'tipping point' in the level or degree of conflict, beyond which migration occurs. Those who are most exposed to conflict may actually lack the resources to move and may remain exposed to high levels of danger in their home towns and villages. Conflict can also interact with other drivers to create conditions where political tensions, poverty, environmental hazard and a relatively young population all contribute to migration and displacement, as has recently been the case in Pakistan (Raleigh, 2011). Political uncertainty, even in the absence of actual conflict, may also be push factors for migration. More positively, perceived political stability may be a pull factor that attracts immigrants, or at least encourages people not to leave.

Government policies to relocate people can also be seen as a political driver of migration, this time primarily focusing on mobility. For example, policies for the creation of growth hubs or new urban developments can act as a pull factor for migration. Similarly, policies for the management of rural land can act as a push, as can specific types of development projects (such as the construction of dams and reservoirs).

2.3.3. Demographic

The effect of demographic factors on migration is most likely to be seen through interaction with other drivers, particularly economic: it is not the presence of large numbers of people in a region *per se* that will trigger outmigration, but rather the presence of large numbers without, for example, access to employment or livelihood opportunities (Plane, 1993). The propensity to migrate is also generally higher amongst younger people, so the demographic characteristics of a source region will influence who moves in response to economic drivers. These demographic characteristics

may be affected not only by birth and death rates, but also the burden of disease and ill-health within a community. Similarly, the demographic characteristics of a receiving area – such as an ageing population – may affect the demand for jobs and employment opportunities, and hence the perceived attractiveness of that area.

2.3.4. Social

The specificity of migration is grounded in the connections that develop between places as a result of histories and cultures of migration. Social drivers of migration include family and cultural expectations, cultural practices regarding inheritance, the need to acquire funds for dowries or bride payments, and the search for educational opportunities. In 2007, approximately 2.8 million students migrated internationally for education purposes, a figure increasing at around 5.5% per year since 1999 (Unesco, 2009). Approximately 600,000 of these went to the United States, and around 420,000 left from China. In some specific cultures, migration is seen as a key part of social and cultural development, as for example in Cape Verde (Åkesson, 2004) or Mexico (Cohen, 2004).

The largest effect of social drivers is on the destination of migrants. 'Gravity models' of migration show the interaction between economic and social drivers by pointing to the importance of both drivers and attractors in migration decisions. In such models, attraction is proportional to population size and inversely proportional to distance (Findlay, 2011). Once established, migration patterns can become consolidated through the dynamics of 'cumulative causation', whereby an initial movement leads to further migration. Migration networks can be formal through the operation of agencies, or more informal through kith and kin networks. Past migration and its direction can therefore be a good predictor of future migration (Massey, 1990). The creation of links between sending places and destinations can open 'transnational spaces' within which remittance flows can potentially contribute to economic development (Vertovec, 2008). New social media and communications technologies have the potential to reduce the social and psychological costs of migration and provide images and representations of destination countries. They also allow connections to be maintained between migrants and their families. Migration can thus provide resources to sustain livelihoods, but social drivers help us to understand how and why opportunities to migrate are not evenly distributed.

2.3.5. Environmental

The environmental characteristics at a place affect both a population's exposure to hazard and the availability of ecosystem services. Ecosystem services are those parts of the environment and ecosystems that are utilised to produce human well-being (Fisher et al., 2009; Millennium Ecosystem Assessment, 2005), through the functions of provisioning (e.g. providing food and water), regulating (e.g. erosion protection) and cultural services (e.g. having emotional or spiritual value).

Rapid-onset extreme environmental events such as floods, tsunamis, landslides, earthquakes, wildfires and volcanic eruptions are well-known triggers of displacement. These displacements tend to be relatively short distance, and are usually within a state. International displacement following an environmental disaster is more significant for small states or islands (such as the Montserrat evacuation – McLeman, 2011), or where events occur in border areas where more than one state is affected. Event-driven displacements are usually short-lived, and people commonly return to the source location once the event has receded, often after only a short time has elapsed.

Demographic and environmental factors affect how and whether displaced peoples return, but are constrained by issues such as political stability. The return of pastoralists to northern

Sudan following the mid 1980s Sahelian drought, for example, was highly skewed, with some displaced people returning at the first opportunity, whilst others were permanently displaced without access to resources (Haug, 2002). Groen and Polivka (2010) show how the rate of return of displaced people to New Orleans following Hurricane Katrina was strongly influenced by age, income and severity of damage, with the old and poor from severely damaged neighbourhoods slowest to return. In more extreme cases, displaced people may never return, because their home and livelihood has been completely destroyed, because of a fear of repeat events, or because new opportunities have arisen in their new location.

There are many historical examples of complete settlement abandonment, and some recent examples. Following the eruption of the Soufriere Hills volcano on Montserrat, for example, the town of Plymouth was abandoned (McLeman, 2011). Some processes of abandonment may be seen as a planned response to a succession of events rather than a single event. For example, the relocation of Pattonsburg, Missouri, after floods in 1993 followed a period of 30–40 floods in the previous 50 years (Greenberg et al., 2007). Such abandonments tend to involve relocation close to the original site.

The availability and stability of, and access to, ecosystem services are the three primary mechanisms by which livelihood and well-being is manifest in particular localities, most starkly in resource-dependent economic systems dominated by agriculture or fisheries. Here a change in ecosystem services directly affects wellbeing and the demand for migration (Adams and Adger, *in press*). Ecosystem service provision can be threatened by rapid onset events, but is more usually affected by slow onset environmental dynamics including droughts and land degradation. Major productivity failures due to drought or degradation may trigger progressive, large-scale, displacement (as for example in July 2011 in the Horn of Africa). Less extreme reductions in productivity may also stimulate short-term mobility by some members of a community, either to other rural areas or to urban areas, where alternative income sources are sought.

Yet such mobility can be seen as part of a response strategy to maintain household wellbeing through livelihood diversification, and is characteristic of populations in many sub-Saharan African dryland environments where variability in climate from year to year is high (e.g. Tacoli, 2011; Henry et al., 2003). For pastoral systems and capture fisheries, variability and instability often increases mobility – with fishing communities and pastoralists migrating temporarily or permanently to secure livelihoods (Findley, 1994; Badjeck et al., 2010). Although rapid-onset events and slow-onset environmental dynamics may trigger displacement and mobility, the specifics of the response, in terms of who goes where and when, is usually determined by the socio-economic context of specific communities (Tacoli, 2011) and, particularly, the patterns of vulnerability generated by this context.

3. The effect of future environmental change

3.1. Environmental change and its effect on environmental drivers

A range of future environmental changes have the potential to influence the drivers of migration, with the most significant and extensive being global climate change, land degradation and the degradation of coastal and marine ecosystems. Each of these types of change is likely to impact migration both directly, as well as indirectly, through impacts on other drivers.

Global climate change driven by increases in the concentration of greenhouse gases in the atmosphere primarily manifests itself in changes to weather patterns at a place and an increase in sea level, due to the thermal expansion of sea water and inputs from melting

land ice. Five dimensions of climate change have a potential effect on the drivers of migration, although these effects will vary between places and there is considerable uncertainty in what may happen at a place.

First, a *rise in sea level* would lead to an increased risk of coastal flooding, together with increased erosion of coastal land and ecosystems and increased salinisation of low-lying agricultural land. Coastal flooding already leads to displacement of affected populations, erosion of ecosystems such as wetlands and mangroves exposes coastlines to greater risk, and increasing salinisation lowers the productivity of agricultural land. Second, a *change in tropical storm and cyclone frequency or intensity* would also alter the risk of coastal flooding and damage. A change in extra-tropical (i.e. mid-latitude) storm frequency or intensity, however, is less likely to be significant for migration because such events have historically generated less displacement than tropical cyclones. Third, *changes in rainfall regimes* lead to changes (increases or decreases) in the risk of river flooding and fire, the availability of water for domestic, municipal, industrial and agricultural uses, and also result in direct changes in crop and pasture productivity, leading in some cases to a change in the frequency of crop and pasture failure. Fourth, *increases in temperature* would increase the frequency of high temperature extremes. Whilst heat-related stress is unlikely to directly drive migration from rural areas, it will affect crop productivity and provisioning ecosystem services. In glaciated mountain areas enhanced melting of glaciers due to higher temperatures can potentially lead to an increased risk of glacial outburst flooding. Higher incidence of extreme heat in urban areas represents a risk that, at the margin, makes those areas less attractive destinations. Finally, *changes in atmospheric chemistry* will combine with changes to rainfall and temperature to affect crop productivity (higher CO₂ concentrations would be good for some, but not all, crops, whilst higher low-level ozone concentrations would be bad for most), and will affect ocean chemistry and hence the productivity of coastal and marine ecosystems.

In addition to climate change, land degradation also has the potential to directly drive migration. Land degradation is the deterioration in the quality of land used for agriculture and the provision of ecosystem services, as represented for example by loss of nutrients, pollution by salinisation or exposure of toxic materials and loss of soil through erosion. This degradation is a result of a combination of agricultural practices, extreme weather events and climate change. According to the Millennium Ecosystem Assessment, between 10 and 20% of drylands suffer from land degradation (Safiel et al., 2005). The primary effect will be on the provision of ecosystem services, and particularly crop and pasture productivity, but a decline in vegetation cover in a catchment can lead to increased risk of flooding.

Similarly, the degradation of coastal and marine ecosystems includes the loss of species and habitats and the removal of protection against coastal storms, triggered not only by agricultural and fisheries practices, but also by encroachment or urban and mineral developments into the coastal zone and interventions and land use changes in catchments upstream. Approximately 35% of global mangroves have been destroyed, along with around 20% of global coral reefs (Agardi et al., 2005). Both land and coastal degradation alter exposure to hazards and the provision of ecosystem services. The primary effects of future degradation of coastal and marine ecosystems will be on regulating and provisioning ecosystem services.

3.2. Indirect effects of environmental change

Environmental change has a clear impact upon the environmental drivers of migration, but also has the potential to affect migration indirectly, both through its influence on the other

drivers, and through its influence on personal characteristics and intervening obstacles. Specifically, changing environmental risks affect economic drivers through effects on agricultural productivity and rural livelihoods, and the locations of industry, employment and settlement, and political drivers through influencing conflict and public policy. Yet it may also influence the cost of moving, and people's ability to move, which are related to levels of wealth and income.

For example, by reducing crop, livestock or fisheries productivity at a place, or damaging assets used in agriculture, environmental change has the potential to reduce household incomes – in the absence of alternative sources of income or the implementation of adaptation strategies. There have, however, been few published assessments of the potential quantitative effects of environmental change on household incomes (see Mendelsohn et al., 2007; Jones and Thornton, 2009; Dougill et al., 2010; Badjeck et al., 2010; Hertel et al., 2010 for examples), and the available evidence suggests strongly that effects will be determined by household economic and social characteristics; the livelihoods of the poorest are most likely to be adversely affected by environmental change (see for example Eriksen et al., 2005; Paavola, 2008; Ahmed et al., 2011). A reduction in income or, more precisely perhaps, a reduction in the reliability of income, may therefore become an economic driver for migration, but may also increasingly limit the ability of individuals and households to migrate. The effects will therefore vary with household characteristics meaning that an environmental change will have a different impact on migration in different parts of a community.

Recent case studies by Feng et al. (2010) and Barbieri et al. (2010) attempt to characterise, using different metrics, the effect of changes in agricultural productivity (Feng et al., 2010) or income (Barbieri et al., 2010) on outmigration. In the case of Feng et al. in particular, the modelled impact on migration from Mexico to the US is substantial. Both of these studies emphasise their partial equilibrium frameworks and the further need to account for the interconnectedness of different drivers of migration. Yet the framework presented in this paper suggests environmental change may have complementary, but also contradictory impacts on different kinds of migration drivers. Moreover, there is a risk of assuming that the economic and political drivers of migration lie largely in source areas, whereas environmental change may be just as influential on drivers of migration – such as the availability of jobs or favourable policy environments – that exist in destination areas.

For example, complex interactions have been seen in recent decades between environmental, economic and political drivers of migration in both Zimbabwe and Afghanistan – two significant sources of international migration in recent decades. Thus droughts in Zimbabwe during the last decade have been less extreme than those in the previous decade, but have been experienced as more problematic by rural populations – and have contributed to food insecurity – as a result of the vulnerability created by economic collapse and political conflict (McGregor et al., 2011). Meanwhile, in Afghanistan, the complex interactions between political conflict, economic collapse (but also the potential economic gain from mineral resources or the illicit trade in opium) and environmental change associated with drought and the drawing down of water resources present a significant risk of population displacement (Smith et al., 2011).

However, whilst environmental change has the potential to affect the political drivers of migration in much the same way as it affects economic drivers – through affecting the occurrence of conflict, for example – there is conflicting evidence on this point. Some studies have examined the relationship between temperature anomalies and conflict, with predictive models suggesting, for example, that environmental change will increase conflict (Burke

et al., 2009). Such results are contested, with Buhaug (2010) finding no evidence to suggest future deviation from the historical downward trend in large scale violent conflict, and ethnographic studies of conflict find less decisive evidence for the direct links between environmental scarcity and the presence of violent conflict. Debate here centres both on the selection of data sets on which analysis has been conducted, but also more broadly on the nature of conflict.

Policies to address environmental change may also affect drivers of migration. These most obviously include environmental, resource management and land use policies, such as policies to curb development in hazard-prone locations, reduce land degradation, enhance conservation, or build infrastructure to provide services. More indirectly, policies to decarbonise the economy have the potential to change the locations of areas of economic growth.

4. Application of the framework

The framework presented can be used in three main ways. First, it can be used for developing hypotheses and framing empirical studies of the effect of environmental change on migration, using a range of anthropological, econometric and modelling approaches. Although there are an increasing number of case studies in the literature (cited above and also in the other papers in this special issue), there remain many gaps in the knowledge base. In particular, very few studies have sought explicitly to understand the effect of environmental change, or indeed environmental drivers, on mobility in the context of the other drivers of decisions. Similarly, there has been little research into the extent to which the interaction between economic, political, social and demographic factors affects who is displaced by an extreme environmental event, where they go and for how long (the study of the effects of Hurricane Katrina cited above (Groen and Polivka, 2010) is an exception).

Second, the framework can be used to inform the development of policy options and assist in their evaluation. The framework emphasises that migration in response to environmental drivers now and in the future – whether mobility or displacement – is a complex function of a range of drivers, and policies to address the causes and consequences of migration need to take this into account. The effects of policies to improve rural livelihoods, for example, will likely have different impacts on mobility in different parts of a community, and perhaps over different time horizons. Policies to reduce mobility may have the undesired effect of increasing vulnerability to loss or displacement in future extreme events.

Third, the framework can be used to develop scenarios characterising feasible potential future migration flows and patterns, either for planning purposes or for the evaluation of policy interventions. The effects of environmental change on the characteristics of future migration will depend not only on the environmental change itself, but also on how the other drivers of migration change over time. It is of course not possible to predict how these drivers will change, and arguably these are inherently less predictable than environmental changes. For a given set of assumed emissions, for example, it is possible not only to use simulation models to estimate future environmental changes, but also to assess uncertainty to model form and parameterisation. Such an approach that starts with an assumed trajectory of population change is not feasible for the other drivers. Assessments of future impacts and policies therefore typically use scenarios describing feasible changes, and because there is an infinite range of feasible futures are usually based on a series of coherent narrative storylines.

In order to span as wide a range of futures as possible, these narratives should be defined along a series of dimensions which represent the main determinants of future sensitivities and vulnerabilities. The IPCC SRES scenarios, for example (IPCC, 2000), were characterised along two dimensions likely to most influence emissions, leading to four different worlds. Hallegatte et al. (2011) proposed a characterisation of narratives along three axes representing what they saw as the three key dimensions defining the vulnerability of human systems to environmental change, producing eight different worlds.

Scenarios for the assessment of future environmental influences on migration, and the evaluation of policy options, can similarly be constructed from the non-environmental drivers of migration incorporated in the framework presented here. In practice, it is not feasible to define narratives along four dimensions; nor is it clear that the four dimensions outlined here – economic, political, demographic and social – act in similar ways or with similar strength to deliver migration outcomes.

Yet amongst these various drivers, two stand out and are crucial to scenario building: the economic drivers of migration, specifically the evolution of the world economy, driving the opportunities for migration, both nationally and internationally, and the political drivers of migration, specifically how they impact on the local governance of social and economic circumstances, and of migration. This suggests it might be helpful to contrast scenarios with high and low global economic growth, and with connected and inclusive governance compared to divisive and exclusive governance. The result is four scenarios in the space of growth and governance (Fig. 3); within each, narratives of social and



Fig. 3. Global environmental migration scenarios.

demographic conditions influence the specifics of migration flows and patterns.

5. Conclusions

The new analytical framework presented in this paper seeks to focus attention away from the idea that environmental change directly causes migration, towards an understanding of the broader drivers of migration, and how these are susceptible in different and inter-linked ways to environmental change. The framework focuses on drivers, conceptualised in a somewhat 'macro' sense, but we realise individual and institutional factors represent important filters as to whether people actually move or not in any specific case.

Thus importantly the presence of drivers of migration does not necessarily mean that migration will take place. Rather, migration is the result of a decision – albeit one that may be forced – in response to these drivers, and this decision is influenced partly by personal and family characteristics, and partly by barriers or facilitating mechanisms that may be in place. Key personal characteristics which influence decisions to move include age, sex, educational level, wealth, marital status, attachment to place, and attitudes and preferences (such as degree of risk aversion). Decisions are frequently made in a family context, so the characteristics of the family unit, and power relationships within it, are also important; the relative effects of personal and household characteristics vary between members of a community (Gubhaju and de Jong, 2009). Barriers or obstacles to movement include the cost of moving, access to the means of moving, and the presence of legal or administrative barriers and constraints. On the other hand, features such as the existence of a transportation network, the presence of recruitment agencies or traffickers, social networks and diasporic links may influence who moves, to where and for how long.

These personal and family characteristics, barriers and facilitators, however, are largely independent of environmental conditions – with the possible significant exception of the extent to which attachment to place is influenced by local environmental characteristics. They will also be largely independent of environmental change, except to the extent that changing environmental conditions change legal or political barriers. However, the effects of environmental change on migration will be mediated through personal and family characteristics, and the barriers and facilitators of movement.

Notwithstanding this caveat, we argue that this new framework has the potential to help us move beyond the impasse in current debates over environmental change and migration (see Castles, 2011). In particular, the analysis we present here highlights the mechanisms by which the well-established routines and contexts of migration are affected by environmental change. This analysis is important, not only to increase the explanatory power of the underlying theories, but also to influence current debates at the interface of global environmental governance.

First, detailed assessment of migration processes and change using this framework would highlight that future environmental change will have an incremental impact on migration flows. It will not cause, but will rather amplify (or in some cases alter) existing demographic trends of migration to urban areas. The global urbanisation trend will continue over the incoming decades and the key policy challenge is the sustainability of these growing urban centres, whether or not the population are swelled by additional migrants pushed from rural areas by resource scarcity.

The second important contribution of the analysis here is to move the debate from identification of migration as a problematic outcome of global environmental change, towards an assessment of mobility as a key element for managing

environmental and other risks. The analysis provides a sound basis to discuss the normative and emotive issues of the human rights dimensions of migration – both the rights of people to reside free from harm and the necessity to migrate, through to the rights of migrants moving away from their homes to new cities or countries. The use of migration-specific scenarios also provides a vehicle for thinking about migration futures in different, but equally plausible ways.

Finally, whilst the focus here is on how environmental change might influence a wide range of drivers of migration into the future, it is important to note that the framework could be adapted to encompass any other form of change to any one of the drivers identified as being significant in influencing the quantity and direction of migration. Thus it should be possible, for example, to think conceptually of the influence of future political, economic, social or demographic change through charting both its direct effect, and its indirect effect on the range of other drivers of migration identified here. However, operationalising this task remains for other authors.

Acknowledgements

This conceptual framework was developed as part of the UK Government Office for Science Foresight project on Migration and Global Environmental Change, by the project Lead Expert Group. The Group acknowledge the contributions and comments of the Foresight project team – Stephen Bennett, Sarah Hudson and Esther Horner – and Professor Sandy Thomas and Mr Derek Flynn, Head and Deputy Head respectively of Foresight. The views expressed are those of the authors, and not of the UK government. The authors thank Hallie Eakin, who acted as external Guest Editor for this paper for the journal, and the two anonymous reviewers for their helpful comments.

References

- Abrar, C., Azad, S.N., 2004. Coping with Displacement. Riverbank Erosion in North-West Bangladesh. RDRS Bangladesh and North Bengal Institute, Dhaka.
- Adams, H., Adger, W.N., 2012. Changing places: migration and adaptation to climate change. In: O'Brien, K., Sygna, L., Wolf, J. (Eds.), *The Changing Environment for Human Security: New Agendas for Research, Policy, and Action*. Earthscan, London, in press.
- Affi, T., Jäger, J. (Eds.), 2010. *Environment Forced Migration and Social Vulnerability*. Springer, Berlin.
- Ahmed, S.A., Diefenbaugh, N.S., Hertel, T.W., Lobell, D.B., Ramankutty, N., Rios, A.R., Rowhani, P., 2011. Climate volatility and vulnerability in Tanzania. *Global Environmental Change* 21, 46–55.
- Åkesson, L., 2004. Making a life: meanings of migration in Cape Verde. PhD thesis, Department of Anthropology, University of Gothenberg, Sweden.
- Agardi, T., Alder, J., Dayton, P., Curran, S., Kitchingman, A., Wilson, M., Catenazzi, A., Restrepo, J., Birkeland, C., Blaber, S., Saifullah, S., Branch, G., Boersma, D., Nixon, S., Dugan, P., Davidson, N., Vorosmarty, C., 2005. Coastal systems. In: Hassan, R.M., Scholes, R., Ash, N. (Eds.), *Millennium Ecosystem Assessment: Ecosystems and Human Well-being: Current State and Trends*, vol. 1. Island Press, Washington, DC, pp. 513–549.
- Asian Development Bank, ADB, 2011. *Climate Change and Migration in Asia and the Pacific*. Asian Development Bank, Manila.
- Badjeck, M.-C., Allison, E.H., Halls, A.S., Dulvy, N.K., 2010. Impacts of climate variability and change on fishery-based livelihoods. *Marine Policy* 34, 375–383.
- Bakewell, O., 2011. Some reflections on structure and agency in migration theory. *Journal of Ethnic and Migration Studies* 36 (10), 1689–1708.
- Barbieri, A.F., Domingues, E., et al., 2010. Climate change and population migration in Brazil's Northeast: scenarios for 2025–2050. *Population and Environment* 31 (5), 344–370.
- Bauer, T., Zimmermann, K.F., 1998. Causes of international migration: a survey. In: Gorter, C., Nijkamp, P., Poot, J. (Eds.), *Crossing Borders: Regional and Urban Perspectives on International Migration*. Ashgate, Aldershot, pp. 95–127.
- Black, R., Kniveton, D., et al., 2011. Migration and climate change: towards an integrated assessment of sensitivity. *Environment and Planning A* 43, 431–450.
- Boyd, M., 1989. Family and personal networks in international migration: recent developments and new agendas. *International Migration Review* 23 (3), 638–670.
- Buhaug, H., 2010. Climate not to blame for African civil wars. *Proceedings of the National Academy of Sciences of the United States of America* 107 (38), 16477–16482.

- Burke, M.B., Miguel, E., et al., 2009. Warming increases the risk of civil war in Africa. *Proceedings of the National Academy of Sciences of the United States of America* 106 (49), 20670–20674.
- Carr, E., 2005. Placing the environment in migration: environment, economy and power in Ghana's Central region. *Environment and Planning A* 37, 925–946.
- Castles, S., 2011. Understanding global migration: a social transformation perspective. *Journal of Ethnic and Migration Studies* 36 (10), 1565–1586.
- Cohen, J.H., 2004. *The Culture of Migration in Southern Mexico*. University of Texas Press, Austin, TX.
- de Haas, H., 2011. The internal dynamics of migration processes: a theoretical inquiry. *Journal of Ethnic and Migration Studies* 36 (10), 1587–1617.
- Dougill, A.J., Fraser, E.D.G., et al., 2010. Anticipating vulnerability to climate change in dryland pastoral systems: using dynamic systems models for the Kalahari. *Ecology and Society* 15 (2).
- Eriksen, S., Brown, K., Kelly, P.M., 2005. The dynamics of vulnerability: locating coping strategies in Kenya and Tanzania. *Geographical Journal* 171, 287–305.
- Feng, S.Z., Krueger, A.B., Oppenheimer, M., 2010. Linkages among climate change, crop yields and Mexico-US cross-border migration. *Proceedings of the National Academy of Sciences of the United States of America* 107 (32), 14257–14262.
- Findley, S.E., 1994. Does drought increase migration? Study of migration from Mali during the 1983–1985 drought. *International Migration Review* 28 (3), 539–553.
- Findlay, A., 2011. Migrant destinations in an era of global environmental change. *Global Environmental Change* 21, S50–S58.
- Fisher, B., Turner, R.K., Morling, P., 2009. Defining and classifying ecosystems services for decision-making. *Ecological Economics* 68, 643–653.
- Gemene, F., 2011. Why the numbers don't add up. A review of estimates and predictions of people displaced by environmental change. *Global Environmental Change* 21, S41–S49.
- Gray, C.L., 2009. Environment, land, and rural out-migration in the Southern Ecuadorian Andes. *World Development* 37 (2), 457–468.
- Greenberg, M.R., Lahr, M., Mantell, N., 2007. Understanding the economic costs and benefits of catastrophes and their aftermath: a review and suggestions for the U.S. Federal Government. *Risk Analysis* 27 (1), 83–96.
- Groen, J.A., Polivka, A.E., 2010. Going home after Hurricane Katrina: determinants of return migration and changes in affected areas. *Demography* 47 (4), 821–844.
- Gubhaju, B., de Jong, G.F., 2009. Individual versus household migration decision rules: gender and marital status differences in intentions to migrate in South Africa. *International Migration* 47 (1), 31–61.
- Hallegatte, S., Przyluski, V., Vogt-Schilb, A., 2011. Building world narratives for climate change impact, adaptation and vulnerability analyses. *Nature Climate Change* 1, 151–155, doi:10.1038/nclimate1135.
- Hammar, T., Brochmann, G., et al., 1997. *International Migration, Immobility and Development*. Berg, New York.
- Harris, J., Todaro, M.P., 1970. Migration, unemployment and development: a two-sector analysis. *American Economic Review* 60, 126–142.
- Hartmann, B., 2010. Rethinking climate refugees and climate conflict: rhetoric, reality and the politics of policy discourse. *Journal of International Development* 22 (2), 233–246.
- Hatton, T.J., Williamson, J.G., 2003. What fundamentals drive world migration. Discussion Paper. 2003/2, WIDER, Helsinki.
- Haug, R., 2002. Forced migration, process of return and livelihood construction among pastoralists in northern Sudan. *Disasters* 26, 70–84.
- Henry, S., Boyle, P., Lambin, E.F., 2003. Modelling inter-provincial migration in Burkina Faso, West Africa: the role of socio-economic and environmental factors. *Applied Geography* 21 (2–3), 115–136.
- Hertel, T.W., Burke, M.B., Lobell, D.B., 2010. The poverty implications of climate-induced crop yield changes by 2030. *Global Environmental Change* 20, 577–585.
- IPCC, 2000. *Special Report on Emissions Scenarios*. Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge.
- Jones, P.G., Thornton, P.K., 2009. Croppers to livestock keepers: livelihood transitions to 2050 in Africa due to climate change. *Environmental Science and Policy* 12 (4), 427–437.
- Lee, E.S., 1966. A theory of migration. *Demography* 3 (1), 47–57.
- Massey, D., 1990. Social structure, household strategies and the cumulative causation of migration. *Population Index* 56 (1), 3–26.
- Massey, D., Arango, J., et al., 1998. *Worlds in Motion: Understanding Migration at the End of the Millennium*. Clarendon Press, Oxford.
- Massey, D.S., Axinn, W.G., et al., 2010. Environmental change and out-migration: evidence from Nepal? *Population and Environment* 32 (2–3), 109–136.
- McGregor, J., Marazzi, L., Mpofu, B., 2011. Conflict, migration and the environment: the case of Zimbabwe. The Government Office for Science, London Available online at: <http://www.bis.gov.uk/foresight/migration>.
- McLeman, R., 2011. Settlement abandonment in the context of global environmental change. *Global Environmental Change* 21, S108–S120.
- McLeman, R., Smit, B., 2006. Migration as an adaptation to climate change. *Climatic Change* 76, 31–53.
- Mendelsohn, R.A., Kurukulasuriya, B.P., Dinar, A., 2007. Climate and rural income. *Climatic Change* 81, 101–118.
- Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.
- Myers, N., 2002. Environmental refugees: a growing phenomenon of the 21st century. *Philosophical Transactions of the Royal Society, London - B* 357 (1420), 609–613.
- Paavola, J., 2008. Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. *Environmental Science and Policy* 11 (7), 642–654.
- Perch-Nielsen, S.L., Bättig, M.B., Imboden, D., 2008. Exploring the link between climate change and migration. *Climatic Change* 91, 375–393.
- Piguet, E., 2010. Linking climate change, environmental degradation and migration: a methodological overview. *Wiley Interdisciplinary Reviews: Climate Change* 1, 517–524.
- Piguet, E., Pecoud, A., De Guchteneire, P. (Eds.), 2011. *Migration and Climate Change*. Cambridge University Press, Cambridge.
- Plane, D., 1993. Demographic influences on migration. *Regional Studies* 27 (4), 375–383.
- Portes, A., De Wind, J., 2007. Rethinking Migration: New Theoretical and Empirical Perspectives. Berghahn, Oxford.
- Raleigh, C., 2011. The search for safety: the effects of conflict, poverty and ecological influences on migration in the developing world. *Global Environmental Change* 21, S82–S93.
- Renaud, F.G., Dun, O., Warner, K., Bogardi, J., 2011. A decision framework for environmentally-induced migration. *International Migration* 49, e5–e29.
- Safiel, U., Adeel, Z., Niemeijer, D., Puigdefabregas, J., White, R., Lal, R., Winslow, M., Ziedler, J., Prince, S., Archer, E., King, C., 2005. Dryland systems. In: Hassan, R.M., Scholes, R., Ash, N. (Eds.), *Millennium Ecosystem Assessment: Ecosystems and Human Well-being: Current State and Trends*, vol. 1. Island Press, Washington, DC, pp. 623–662.
- Seto, K., 2011. Non-environmental drivers of migration to cities in Asian and African mega-deltas. *Global Environmental Change* 21, S94–S107.
- Smith, M., Bastin, G., Chewings, V., 2011. Environment and non-environmental drivers of migration from global drylands. The Government Office for Science, London Available online at: <http://www.bis.gov.uk/foresight/migration>.
- Stark, O., Bloom, D.E., 1985. The new economics of labor migration. *The American Economic Review* 75 (2), 173–178.
- Stern, N., 2007. *The Economics of Climate Change*. The Stern Review. Cambridge University Press, Cambridge.
- Tacoli, C., 2011. Not Only Climate Change: Mobility, Vulnerability and Socio-economic Transformations in Environmentally-fragile Areas of Bolivia, Senegal and Tanzania. International Institute for Environment and Development, London. In: <http://pubs.iied.org/10590IIED.html>.
- Unesco, 2009. *Global Education Digest 2009*. Comparing Education Statistics Across the World. Unesco Institute of Statistics, Montreal, Canada.
- Vertovec, S., 2008. *Transnationalism*. Routledge, London.
- Warner, K., Hamza, M., et al., 2010. Climate change, environmental degradation and migration. *Natural Hazards* 55 (3), 689–715.
- Zelman, J., 2011. 50 Million Environmental Refugees by 2020. Experts Predict. *Huffington Post* 22 January 2011 at http://www.huffingtonpost.com/2011/02/22/environmental-refugees-50_n_826488.html.
- Zolberg, A.R., 1989. The next waves: migration theory for a changing world. *International Migration Review* 23 (3), 403–430.