Chapter 2
Migration and Climate Change: Toward an Integrated Assessment of Sensitivity

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Abstract This chapter sets out a new approach to understanding the relationship between migration and climate change. Based on the understanding that migration is a significant, growing, but also complex phenomenon, this approach seeks to address the sensitivity of existing migration drivers in specific contexts to climate change. In contrast to existing approaches which have sought to generate global-level estimates of the numbers of 'climate migrants', this integrated assessment approach seeks instead to understand how and why existing flows from and to specific locations may change in the future, and provide a practical tool for climate adaptation planning. Examples of the application of this approach are provided for Ghana and Bangladesh.

Keywords Assessment • Integrated • Bangladesh • Ghana • Migration drivers • Sensitivity

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T. Faist and J. Schade (eds.), *Disentangling Migration and Climate Change*,
DOI: 10.1007/978-94-007-6208-4_2,

2.1 Introduction[1]

Future climate change is expected to severely affect people's livelihoods worldwide through the intensification of natural disasters; increased warming and drought affecting agricultural production and access to clean water; rising sea levels making coastal areas uninhabitable and increasing the number of sinking island states; and increased competition over natural resources that may lead to conflict (Martin 2009). Although they will vary regionally, these impacts are predicted to impose significant aggregate costs for society, which are likely to increase over time (Parry et al. 2007; Stern 2007; House of Commons 2008). For example, the total cost of adaptation to climate change was estimated at over US $ 100 billion in the run-up to the Copenhagen Climate Change Conference (Adam 2009).

From a wide array of possible responses to climate change impacts, migration is one response that has received a growing amount of attention from both researchers and policy-makers (Warner et al. 2009; Christian Aid 2007; Action Aid International 2007; Renaud et al. 2007; Stern 2007; Conisbee and Simms 2003). Most of these reports share the underlying assumption that climate-related migration essentially represents either a failure to mitigate climate change, and/or a failure of adaptation, and taken together they have produced some alarming estimates of the total volume of migration that might result from such failures. This issue is also politically and ethically-charged. The effects of climate-related disasters in terms of numbers of people already made homeless fall disproportionately on poor countries in the global South, even though it is the global North that is primarily responsible for anthropogenic climate change (Roberts and Parks 2007). The resulting global injustice is of both ethical and practical policy concern, as climate change negotiators in the global South are increasingly aware of how problematic migration is for states in the global North and newly-industrialising states, to the point that it could play a pivotal role in international environmental negotiations.

Yet migration can also be seen as a valid coping mechanism for increased stresses and shocks that may result from climate change (Laczko and Aghazarm 2009; Tacoli 2009), as well as a range of other factors. Viewing migration as an adaptive response to different combinations of economic, social, political, demographic and environmental 'drivers', it becomes clear that migration may be sensitive to climate change in a variety of ways. Indeed, the impacts of climate change on mobility are mediated through these different drivers with the result that the relationship between migration and climate change becomes highly complex. Complexity also arises from the fact that migration responses to climate change are likely to include moves within countries, as well as international mobility, and may be non-linear, in the sense that migration becomes a learnt behaviour within a population, developing emergent properties as a result.

Bearing in mind this complexity, in this chapter we seek to develop an integrated approach to understanding the nature of climate-migration linkages. We

[1] Reprint of Black et al. (2011). With permission from Pion Ltd, London, www.pion.co.uk.

begin with the principle that migration is already a significant phenomenon in many parts of the world that are likely to be critically affected by climate change, and already takes a variety of forms. Thus, whilst UN estimates of current stocks of international migrants suggest that around 200 million people, or 3 %, of the world's population are living outside their country of origin, the 2009 Human Development Report suggests that at least 740 million people—almost 11 % of the world's population—have migrated within their own countries (UNDP 2009). Simple projection forward of these figures by 40 years would suggest that by 2050 there might be as many as 66 million additional international migrants, and 242 million additional internal migrants, even in the context of no significant climate change, if the proportion of migrants in the population were to stay the same.[2]

Building on the observation that migration is already occurring, is complex, and is almost certainly growing, our approach seeks to analyse the main drivers of existing migration in specific contexts, and then consider the sensitivity of these drivers to climate change. The aim is to develop a tool to assess the likely consequences of climate change on different forms of migration, allowing for the notion that the net effect on migration could be negative rather than positive, and non-linear instead of linear. Although this approach works best at the local and regional, rather than the global, scale this is arguably of greater relevance to adaptation planning than global estimates of numbers that are almost certainly false.

After reviewing evidence from existing empirical case studies into the relationship between different climate stressors and migration, we discuss what have been identified as the 'drivers' of migration in the literature. This is followed by a presentation of the approach of integrated assessment', and its preliminary application to the case studies of Ghana and Bangladesh. We argue that this integrated approach can provide a basis for wider estimation of future flows, although because of data constraints and the complexity of the world system such analysis almost certainly needs to take place first at regional or country-level.

2.2 Past Studies of Migration and the Climate

Given the volume of recent academic and policy publications about the impacts that climate change might have on migration, the number of empirical studies of contemporary manifestations of the influence of climate on migration is surprisingly small. Beyond the historical and archaeological literature, which is not covered here, most studies have been concerned with the effects of drought or changing rainfall patterns on migratory behaviour, but on the whole these do not provide a convincing basis on which to predict migration trends. Thus, one study of south-west Mexico found a correlation between declining rainfall and rising

[2] The UN population division projects an increase of the world population from 6.8 billion in 2009 to over 9 billion by 2050.

migration to the US, since many rural communities depend on rain-fed agriculture (Munshi 2003). A more recent study of the relationship between climate change, crop yields and migration went further, suggesting that Mexican migration to the US might increase by between 1.4 and 6.7 million people by 2080 based on a 10 % decline in crop yields (Feng et al. 2010). However, an alternative analysis of migration and rainfall data for the Mexican states of Zacatecas and Durango, suggests the reverse relationship—in other words, migration to the US decreases as rainfall declines (Kniveton et al. 2008), and at the very least, the analysis of Feng et al. relies on extrapolation of data currently available for only two time periods—1995–2000 and 2000–2005.

A rather different picture is provided by findings from studies in Burkina Faso and Mali, where drought in the 1970s and 1980s was associated with decreases in international, long-distance migration (Henry et al. 2004; Findley 1994). These West African studies suggest that food scarcity during drought leads to increased prices, forcing people to spend more money on their basic needs rather than on long-distance migration. They also show, however, that short-distance migration to larger agglomerations increased during drought years, as women and children left in search of work to contribute to household incomes. Similarly, a recent chapter by Barbieri et al. (2010) on internal movement in Brazil estimated relatively small net changes in migration under a range of climate change scenarios, with some scenarios suggesting the possibility of a decrease, rather than an increase in net migration.

Meanwhile a study of migration in El Salvador into responses to adverse agricultural shocks, such as loss of harvest and livestock, found large and positive effects on the household's probability of sending members to the United States when agricultural shocks occurred (Halliday 2006). Yet the same study also found that damage associated with another environmental hazard—earthquakes—was followed by a substantial decrease in net migration to the US. Whilst earthquakes are not a product of climate change, the explanation of this latter relationship—that earthquakes create incentives for households to retain labour at home and disrupt migration financing by depleting savings or restricting access to credit—would appear to be just as applicable to climate change related to sudden events such as floods and hurricanes.

If we turn to an historical example, it is estimated that as many as 2.5 million people were displaced by drought and associated dust storms in the mid-west of the US in the 1930s, with most moving to neighbouring states, but as many as 300,000 moving to California as some of the world's first 'ecomigrants' (Reuveny 2008). Yet here, too, it is important to note that the effects of declining rainfall and drought on migration depended crucially on the socio-economic situation of the people concerned. Such dependence has been demonstrated in relation to the migration decisions of pastoralists in northern Sudan (Haug 2002) and of peasant farmers in northern Ethiopia (Meze-Hausken 2004), where a survey of more than 100 peasant farmers concluded that 'people in marginal regions have developed a great variety of adaptation mechanisms, which strengthen their ability to cope with both, slow climatic changes and extreme climatic events'. In the specific case of the Dust Bowl, there is evidence that longer-distance migration from eastern Oklahoma to California was

dominated by 'young, intact nuclear families with a high level of social capital in the form of pre-existing family connections to California'. Dust Bowl migrants were also more likely to have had no land, or not repaid the mortgage on their land, and to have had agricultural skill sets that were in demand in California at the time. It is also important to note that migration out of the mid-west had already begun before the periods of drought, reflecting over-capitalisation of agriculture in the region and the overall depression of the US economy from 1929 (McLeman 2006). Indeed, far from Dust Bowl migrants being the world's first 'eco-migrants', it could be argued that 'eco-migrancy' is a deeply engrained and traditional response to climatic stress and variability, which goes back well beyond the last century.

There has also been some interest in the phenomenon of migration linked to tropical cyclones and hurricanes, with the consequences of Hurricane Katrina, which hit parts of the US states of Alabama, Mississippi and Louisiana, and destroyed the city of New Orleans in 2005, the most prominent recent example (Gemenne 2009). Several studies of Katrina have highlighted demographic changes as a result of the hurricane, although most have focused on the nature of return migration, and why this has or has not been possible for different groups (Elliott and Pais 2006). One important feature of the displacement associated with Katrina is that initially, at least, as many as 70,000 mainly poorer, black residents of New Orleans were unable to leave (Landry et al. 2007); yet, over time it appears that it is the poorer, black residents who have been least able to return. Similarly, an analysis of the displacement following Hurricane Andrew, which hit parts of Florida in 1994, found that people who lived in the wealthier southern part of the state migrated in much larger numbers than people who lived in the poorer northern part (Smith and McCarty 1996). Whether this was caused by the fact that southern Florida was more severely affected, or by the distribution of wealth in the state, however, is a question left unanswered in the study. The literature on vulnerability and migration points to a complex interplay of factors that influence displacement following natural disasters, including, race/ethnicity, wealth, home ownership, education, age and gender, with evidence for both increased migration and decreased migration for each of these variables in different settings. Part of the difference in how variables such as wealth influence migration decisions in the face of natural disasters can be explained by the timescales over which the migration decision is made. For example wealthier households often make decisions to migrate as considered life choices to move away from disaster prone areas whereas poverty is sometimes related to displacement due to the highly vulnerable physical locations many poor people are forced to live in. Further there is clear evidence that some people actually migrate into disaster prone and affected locations for the economic opportunities they provide (Naik 2009).

Overall, it would seem that empirical studies into the relationship between migration and climate-related and environmental events and are still relatively few, and their results are not conclusive. The studies do show, however, that the assumption that climate-related shocks and stresses lead inevitably to migration in a linear way is not supported by empirical investigation. The relationship is not linear because many other factors play into the nexus between climate factors and migration. It is also not necessarily positive, as several studies found

that international migration decreased as a consequence of environmental stress. Another factor that is implicitly shown in these studies is that migration often pre-existed particular climate-related events as a result of a number of other 'drivers', although these drivers may include environmental factors. It is to these broader migration drivers that we now turn.

2.3 Migration Drivers

There is a large literature on the causes of migration, but also a measure of agreement that the key drivers of migration fall into three categories: (a) factors related to the region or country of origin, including political instability and conflict, lack of economic opportunities, high rates of population growth and lack of access to resources ('push' factors); (b) factors related to the region or country of destination, including the availability of employment and demand for workers, ageing of populations, higher wages, political stability or access to resources ('pull' factors); and (c) intervening factors that facilitate or restrict migration, including ease of transportation, family or social networks, government immigration or emigration policies, economic ties such as trade and investment linkages, or social and cultural exchanges (Arango 2004; Boyle et al. 1998; Portes 1997; Massey et al. 1993; Zolberg 1989).

However, whilst there is a degree of agreement that each of these factors is a potential driver of migration, the devil is in the details: each of the particular 'push', 'pull' and enabling factors that may apply in one circumstance may not apply elsewhere, whilst the different factors may interact in different ways. For example, some of the most relevant factors are relational across space—thus classic migration theory posits that people will move from poorer to richer regions or from places where there is 'population pressure on resources' to places where there is not. Yet this does not tell us whether the 'push' of poverty, or the 'pull' of economic opportunity is more important, even though this may be critical in terms of understanding whether and how much climate change will influence economic drivers of migration. Similarly, 'population pressure on resources' is often cited as a reason for people to leave a particular area, yet this may well lead to migration to an urban area where population densities are much higher, but where economic growth has meant a much larger population density can be supported.

In addition to the distinction between 'push', 'pull' and 'intervening' factors, drivers of migration can be categorised into structural and institutional/network influences, and factors operating at the level of individual human agency; in turn, they can also be broadly divided into 'economic', 'political', 'social', 'demographic' and indeed 'environmental', although these categories often overlap. Furthermore the multi-causality of migration has been widely acknowledged (Wood 2001; Boyle et al. 1998; Castles and Miller 1993; Kritz et al. 1992).

Migration patterns are not only complex because of the various types of migration drivers that influence them at different levels but also because they depend on individual characteristics and perceptions and a range of institutional opportunities

and constraints. Factors that drive migration of some people might drive other responses or no response at all of other people in the same or other places. Furthermore, as noted above, migration itself is a complex phenomenon, which involves long and short-distance moves, crossing national borders or not, over timescales that range from a few months to a lifetime, and in circumstances that may be both adaptive and reactive. In particular, there is evidence that migration may accelerate or take on emergent properties in certain situations, as barriers are removed, political or economic conditions deteriorate, or new opportunities emerge.

A particular issue relates to how 'environmental' factors can be considered as drivers of migration alongside other types of drivers. Environmental considerations are included in a number of classic migration frameworks, including those posed by Wolpert (1966), Speare (1974), and DeJong and Fawcett (1981) (see also Hunter 2005). These frameworks have tended to treat the environment as a contextual consideration. Yet, it could be argued that environmental factors directly *cause* some forms of migration; for example, in the Sahel, environmental variability is arguably a direct cause of seasonal migrations of pastoralists and agricultural labourers who are seeking grassland or work respectively. Similarly, vulnerability to, or experience of, extreme climatic events such as floods or tropical storms may also directly drive migration, even in the absence of other drivers. Here, the key question in relation to climate change is less whether climatic variability or climate events will drive migration, and more whether climate change will increase climatic variability or the frequency of extreme events, with the result that future flows are likely to be larger than those currently experienced.

Finally, it is predicted that the consequences of climate change will particularly affect the poorest people as they are more vulnerable and least able to adapt, and as a result they will be rendered even poorer (Parry et al. 2007). Yet, there is also an emerging consensus that it is generally not the poorest people who migrate overseas because international migration is an expensive endeavour that demands resources for the journey and for the crossing of borders (Castles 2000; de Haan 2000; Skeldon 2002). Thus, is it conceivable that climate change might deprive some people from the option of migrating, at least over long distances and internationally, even though it might put pressure at the same time on other people to move. Predicting changes in migratory behaviour caused by climate change is thus difficult and needs a number of factors to be taken into account.

2.4 An Integrated Assessment of Climate Change Related Migration

Within the context of multiple drivers of migration, operating in a variety of situations and at different levels, it is not unreasonable to conclude that assessing the influence of uncertain climate changes is a multifaceted task requiring a multidisciplinary approach. Integrated assessments are one method used within the climate impacts and vulnerability assessment literature to attempt to represent the complex

interactions and feedbacks between multiple drivers and impacts for national and global policy analysis. In particular, integrated assessments try to represent interactions across multiple spatial and temporal scales, processes and activities and may involve mathematical models and/or an integrated process of assessment linking different disciplines and groups of people (McGuffie and Henderson-Sellers 2005).

The previous section showed the complexity of migration decisions and the many factors they depend upon. Yet the impact of climate change on people's livelihoods is also uncertain, for a variety of reasons. An example of the level of uncertainty in understanding the impact of climate change is provided by the wide divergence in predicted change in rainfall over the current century depending on the parameters and assumptions of the climate model used. For example, in the last report of the Intergovernmental Panel on Climate Change (IPCC), over much of the Sahel region of Africa different climate models provided divergent rainfall predictions even in terms of the sign of the change—i.e., whether the Sahel would become wetter or drier over the coming century (Solomon et al. 2007).

Uncertainty in climate change not only arises from model uncertainty, but also from different emission scenarios, as well as from the underlying 'natural' uncertainty related to the chaotic nature of the atmosphere. The IPCC's fourth assessment report sought to limit the range of circumstances within which climate change might occur by referring to a series of specific emissions scenarios (SRES), each of which drew on one of four narrative storylines summarising different demographic, economic and technological drivers of global greenhouse gas and sulphur emissions (Nakicenovic et al. 2000). However, work is already under way on new emissions scenarios that use a completely new methodology, reflecting criticism of the rigid nature of the original SRES scenarios.

It is beyond the scope of this chapter to reduce the inherent uncertainty in climate modelling, or from this perspective to give a clearer indication of possible migration outcomes. Instead, we illustrate a methodology that seeks to work the other way around—allowing the integration of climate into explanations of future migration. Thus, rather than being based on developing evidence and models of the interaction of a climate driver and consequent migration, this approach attempts to assess the sensitivity to climate change of existing acknowledged drivers and intervening factors affecting migration. The approach is explicitly aimed at countering the standard assumption that all migration associated with climate change will be new. It therefore focuses on existing migration trends, and how these will be affected by climate change.[3]

In the following sections, we apply this approach to two case studies. In each case, we present a brief outline of the major migration flows present in the country

[3] Of course, the possibility remains that genuinely new flows could be generated by climate change, involving groups of people who have not previously migrated and/or new destinations opening up. However, the emergence of these new flows would depend on various factors, such as the availability and attractiveness of new destinations, and the financial, human, and social capital of prospective migrants.

and their key drivers; we then identify likely trends in terms of climate change, before drawing conclusions on the susceptibility of these drivers to climate change. The two case studies are chosen to illustrate, first, slow-onset changes associated with decreased rainfall in dryland areas, and associated droughts (Ghana); and second, the potentially more rapid-onset changes associated with floods linked to sea-level rise and increased frequency and intensity of tropical storms (Bangladesh). This distinction is not intended to imply that droughts have *only* slow-onset effects, or that floods have *only* rapid-onset effects, but nonetheless the division between drought and flood on the one hand, and slow and rapid-onset effects on the other, is useful in terms of both aiding understanding, as well as identifying key policy implications.

2.5 Slow-Onset Climate Forcing: Climate and Migration in Ghana

One of the iconic images of climate change used repeatedly in both research studies and policy reports is that of drought-stricken farmers and pastoralists in the Sahel, where it is generally assumed that rising temperatures and reductions in rainfall over the coming decades will lead to a significant increase in outward migration (Warner et al. 2009). Furthermore, it is feared that climate change might lead to violent conflicts over the ownership of resources, which in turn could cause the displacement of a large number of people (Christian Aid 2007). For example, the United Nations Environment Programme identifies environmental factors as "one of three major causes of displacement in Sudan" (UNEP 2007, p. 104).

In the Sahel, however, there are a number of migration patterns that are already well-established, and which need to be taken into account in any analysis of the likely impact of climate change. Rain (1999) shows that in Niger these annual movements to cities in the dry season have been part of the life of rural populations in the Sahel for generations. In Ghana, both seasonal labour migration and the movement of pastoralists within and from northern Ghana have long reflected differences in the timing of the rainy season (Primavera 2005), and fluctuating work opportunities in commercial agriculture. In the coastal south, there are also historical patterns of seasonal fishing migrations (Marquette et al. 2002). In addition to seasonal migration, there is also substantial longer-term and longer-distance internal migration, involving both rural–urban and rural–rural moves, and lasting from a few years to a lifetime. Again this migration is oriented primarily from north to south, as well as to urban and mining areas, although evidence on whether it is increasing or decreasing, and the degree of return or circularity, is limited. Movements include substantial rural–rural moves of workers seeking employment in plantation agriculture in the centre and south of the country, movement to the gold mining areas in Ashanti, and significant movement of children and young adults from the north to work in commerce and petty trade in the cities of Accra and Kumasi (Anarfi et al. 2003). There has also been a significant volume of return migration to rural areas.

One of the difficulties here is putting a figure on existing rates of migration, as these have not been robustly measured. Urbanisation statistics for Ghana show that its urban population increased by 235 % between 1970 and 2000, whilst its total population increased by 121 % in the same period (Otiso and Owusu 2008, p. 146, using 2005 data from the Ghana Statistical Service). In 2006, more than 10 million people lived in urban areas, which is 44 % of the total Ghanaian population. By 2015, the urban population in Ghana is expected to reach more than 14 million people, increasing the share of the total population to 47.8 % (Otiso and Owusu 2008, p. 145). Yet a recent review of evidence for Francophone countries in the region suggests that urbanisation rates may be declining in many neighbouring countries (Beauchemin 2011), and whilst there may be clear reasons associated with civil conflict in countries such as Côte d'Ivoire, this does give rise to some caution in assuming that continent-wide projections of urban growth provided, for example, by the UN, are likely to be fulfilled.

Looking more broadly, West Africa and the wider Sahelian region also have a long history of migration across national borders, reflecting freedom of movement within the Economic Community of West African States (ECOWAS). Ghana itself was a major destination for migrants until the 1970s, when economic collapse led to return and expulsions of foreign workers, and more recently this migration has built up again, with some 500,000 West African immigrants estimated to work on cocoa farms and in the hotel industry in Ghana (Hernández-Coss and Bun 2007). Meanwhile, between 900,000 and 1.2 million Ghanaians worked in Nigeria in the late 1970s and early 1980s, and again despite mass expulsions in 1983 (Black et al. 2004), there has been a recovery in these flows. Finally, since the 1970s, large numbers of Ghanaians have moved overseas, initially in response to political instability and economic hardship, or to seek educational opportunities, but increasingly to work, to do business abroad or to follow or join family members. The result is that an estimated 960,000 Ghanaians lived outside Ghana in 2005, the majority, about 71 %, in ECOWAS countries (Quartey 2009). In 2006, according to the OECD migration database, about 190,000 Ghanaians lived in OECD countries, a number which constitutes less than 1 % of the Ghanaian population (Quartey 2009). However, the emigration of Ghanaians has enlarged the Ghanaian diaspora especially within Europe, where there are at least 100,000 Ghanaians and in North America, where there are at least 80,000, but also in the Middle East and in Asia (Bump 2006).

2.5.1 Key Migration Drivers in Ghana and Their Susceptibility to Climate Change

A major driver of migration in Ghana is the significant (and growing) inequality in employment and income-generating opportunities, broadly between the north and the south of the country, but also between West Africa and Europe, which has driven a growing number of people to seek to move internationally. In particular,

the relatively strong economic growth in Ghana over the last decade has been very much concentrated in urban and mining areas, and in areas of commercial cultivation of coffee, cocoa and newer export crops such as pineapples. In contrast, significant areas of the north of the country have witnessed little productive investment and a decline in employment opportunities in public service.

However, inequality in incomes and access to economic opportunities are not the only factors that have driven recent migration. A significant element of this inequality lies in the fragile natural resource base of much of northern Ghana, and the consequent need for diversification. Traditionally, farmers and pastoralists in northern Ghana have sought to mitigate risk associated with living in the marginal Sahel zone by diversifying their sources of income, and migration has long been one such livelihood strategy. In particular, variability in rainfall encourages patterns of seasonal migration in good years, and distress migration in drought years; the growing variability and uncertainty associated with rainfall patterns have arguably encouraged more anticipatory migration, whilst periods of drought in the north have contributed to undermining other forms of social insurance, leaving migration as a primary strategy to support livelihoods.

Also important are social networks and family ties, as the establishment of a Ghanaian diaspora has created an international social network that enables more Ghanaians to travel abroad. Marriage and other family reasons are also major factors which contribute to migration within Ghana. According to the 1998 Ghana Living Standards Survey, around 60 % of migrants from rural to urban areas moved because of family-related factors, although this includes dependants of those who migrated for economic reasons. Conflict, notably between farmers and pastoralists, has been a feature of northern Ghana in recent years, and though less visible internationally than in some other countries of the region (e.g. Nigeria), it has been a driver of both temporary and more permanent displacement.

In looking at the drivers of migration identified above, the key role of differential employment opportunities is striking, yet it is far from clear that this driver is susceptible to climate change. First, a significant volume of rural–urban migration has been driven by urban employment opportunities created as part of the country's economic 'boom', particularly in the middle belt in the region of the former Ashanti Empire, since the mid-1980s (Anarfi et al. 2003). Furthermore, state policies that valued urban areas and industrial production over rural areas and agriculture also attracted migrants to better-paid urban employment (Otiso and Owusu 2008; Anarfi et al. 2003), although there has also been some return to rural areas, both during periods of economic downturns and for personal reasons. Similarly, movement beyond the country's borders relates to factors such as oil production in Nigeria and Gabon, and growing demand in sectors such as health care and other personal services such as social care and cleaning work in the UK and elsewhere, none of which is particularly related to climate change.

Nonetheless, there are some non-negligible ways in which the identified drivers of migration are susceptible or at least related to climate change. For example, rapid economic growth in Ghana's major cities is underpinned by the need for energy; within Ghana, however, hydroelectric power stations generate 80 %

of total national power production. Detailed predictions are not currently possible here, since as noted above, there remains debate over whether West Africa is likely to see an increase or decrease in rainfall under different emissions scenarios (Arnell 2004). What is clear, however, is that reduced rainfall over the last 40 years has already caused a decline in the lake levels, contributing to power crises and concern within the Government of Ghana about the sustainability of urban development (Kuuzegh 2007).

In addition, there is the potential for climate change to influence the productivity of the commercial agricultural sector in central and southern Ghana, and associated employment opportunities via change and variability in rainfall, temperature and the way in which crops and weeds respond to the carbon dioxide (CO_2) fertilisation effect. For example, cocoa is very sensitive to drought; climate change more broadly could alter the geographical distribution of cocoa pests and pathogens, decrease crop yields, and affect farm income; whilst the magnitude of carbon dioxide fertilisation effect—which arises from increased concentrations of carbon dioxide increasing net primary productivity as plants are able to photosynthesize more and use water more efficiently—varies with different crop types (and weed types) and the supply of water and nutrients. However, each of these physical effects related to climate change may remain a relatively small signal in comparison with other forces determining production and employment in the sector, notably the state of world demand and world market prices for cocoa, as well as state export taxes on cocoa, which have had a consistent and long-term impact on production (Bateman et al. 1990).

Related to this, a rise in sea level can be expected to raise the soil moisture content of sandy and silty soils along the coastline of Ghana. These soils could be at risk of collapse during earthquakes that are prone to occur particularly in the Accra and the west coastal areas, where active geologic faults lie and where unconsolidated sedimentary formations occur (Environmental Protection Agency 2000). Salt water intrusion is also expected as a consequence of a rise in sea level. Increased flood risk in the city of Accra and other coastal cities resulting from higher sea levels and increased intensity of tropical storms could also have an impact on economic activity in these areas, and hence on future employment opportunities.

Finally, and perhaps most obviously, in relation to the fragile natural resource base and need for diversification in northern Ghana, increased temperatures—which appear almost certain—and reduced rainfall—which is widely expected but still cannot be predicted with confidence across the country—would be likely to lead to increased water stress, reduced crop productivity, and an increase in drought risk and food insecurity. This could increase the risk of distress migration during times of acute stress, unless there is substantial anticipatory migration to mitigate this risk.

Table 2.1 draws on the above discussion to summarise the major migration flows within and from Ghana and their susceptibility to climate change. In this analysis, there are arguably two key challenges: first, the assessment of sensitivity, and second, the translation of this sensitivity analysis into quantitative figures.

Table 2.1 Main migration flows in and from Ghana and their susceptibility to climate change

Type of migration	Sending area	Destination	Main drivers	Main climate variables of drivers	Sensitivity to climate change
Seasonal circulation of pastoralists	North	Other areas in the North	Seasonal variation in rangeland productivity; conflict	Short term variations in rain and temperature affect rangeland productivity	High—likely changing patterns
Seasonal moves to commercial agriculture	North	South and centre	Difference in labour demand in agriculture	Short term variability in rainfall and temperature in origin and destination; global changes in rainfall and temperature via impact on global agricultural production	Medium—may increase or decrease
Seasonal labour migration	Mainly North	Cities (Accra, Kumasi)	Need to diversify rural livelihoods	Short term variability in rainfall and temperature at origin	High—likely increase in need to move
Seasonal fishing migration	Coastal South	Along the coast	Presence of fish	Variability and change in oceanic circulation	High—likely decrease if fish stocks depleted
Long-term rural–rural	Mainly North	Agricultural areas in the south and centre	Difference in labour demand, conflict	Patterns of short term variations and long term changes in rainfall and temperature and responses to Co_2 fertilisation effect in sending and receiving regions	Medium—may increase or decrease
Long-term rural–urban	Mainly North	Mining areas (Ashanti), cities (Accra, Kumasi)	Difference in labour demand, family reasons, conflict	Short term variability and long term change in rainfall and temperature and response to CO_2 fertilisation effect in origin regions all affect labour demand	Medium—likely increase in need to move, but masked by change in urban demand
Long-term urban–rural (return)	Cities	Rural areas	Economic downturn in cities, personal motives	Long term changes in rainfall and temperature and response to CO_2 fertilisation effect in rural areas could have marginal impact on personal motives to return to rural areas	Low—possible decrease if north becomes drier

(continued)

Table 2.1 (continued)

Type of migration	Sending area	Destination	Main drivers	Main climate variables of drivers	Sensitivity to climate change
Intra-regional (ECOWAS)	Mainly south	Historically Nigeria, Côte d'Ivoire	Difference in labour demand	Pattern of variability and change in rainfall, temperature and response to CO_2 fertilisation effect could affect labour demand	Low—may increase or decrease
International (to Europe/North America)	Better off households	Mainly UK, USA but also other European countries	Difference in labour demand, diaspora	International changes in rainfall, temperature and sea level rise	Low—may increase or decrease

Source authors

Here, we choose to categorise sensitivity as 'high' if the migration flow is driven primarily by an environmental factor that is likely to change in magnitude as a result of a change in temperature or precipitation; 'medium' if environmental factors play a part in driving migration alongside other factors; and 'low' if environmental factors are only marginal as drivers of migration. We stop short of quantification, however, as the quality of existing data on which to base estimates of change is simply too poor.

As Table 2.1 shows, it is not unreasonable to conclude that international Ghanaian migration, within and outside Africa, is likely to be relatively unaffected by climate change. Still, there is certainly scope for a significant impact on movements that are internal to the country. Changes to precipitation and temperature patterns in the northern savannah are likely to increase the need for seasonal circular migration of pastoralists, as well as the volume of temporary and permanent migrants from the rural north to the agglomerations in the centre and the south of the country. However, rural–rural migration in the north and seasonal labour migration to agricultural regions might either increase or decrease, depending on how the sending and the receiving areas will be affected under future climate change scenarios.

2.6 Rapid-Onset Climate Forcing: Climate Change and Migration in Bangladesh

If migration of farmers and pastoralists in the Sahel is iconic of climate change in Africa, the displacement of populations due to flooding plays a similar role for Asia. In the case of Bangladesh, estimates of existing 'environmental migration' have been high, and predictions for the future dire, with Myers and Kent (1995) suggesting 26 million people will become displaced as a result of floods and storms alone by 2050, which equals almost 11 % of the total projected population for the country.

As in the Sahel, however, there are existing migration flows in Bangladesh that have a variety of drivers, not all of which are clearly related to climate stressors. For example, internal migration is important and increasing. For the majority of families, labour migration to local urban areas or to the capital is the most important source of household income, whilst beyond specific source areas such as Sylhet, Comilla, Chittagong and Dhaka, only relatively few better off families can afford international migration. Case studies reveal that seasonal migration to both rural and urban areas provides vital income sources for the rural poor during periods of low local employment opportunity: almost two-fifths of rural households in the Districts of Faridpur and Rajbari send adult members to nearby towns, whilst in the north-west of the country 19 % of households across all wealth groups migrate in the lean agricultural season, rising to 25 % for chronically poor households (Afsar and Baker 1999; cited in Afsar 2003). In some villages, more than 80 % of incomes might come from outside the village, with temporary labour migration becoming increasingly common (Toufique 2002; cited in Afsar 2003).

Long-term migration is dominated by rural–urban flows, largely to the centres of Dhaka and Chittagong. One study attributes nearly two-thirds of internal migration to rural–urban flows, compared to just 10 % for rural–rural migration (Rahman et al. 1996, cited in Afsar 2003). Another has concluded that net migration to urban areas increased dramatically from 1.2 to 16.4 per thousand between 1984 and 1998, compared to an increase from 1.5 to 4 per thousand of rural–rural migration during the same period (Afsar 2003). Economic migrants are typically young, poor and male, although this has changed significantly with the recent increase in demand for female labour in the ready-made garment factories of Dhaka and other metropolitan areas. Most poor migrants live in slums and squatter settlements, which have been growing at 4 % per year and account for 86 % of the urban population (UN-HABITAT 2007). Such areas lack security and basic amenities and are located in ecologically vulnerable areas such as flood plains. As a result they are amongst the first and largest urban casualties of climate shocks (Barkat and Akhter 2003).

Bangladesh is also a major labour-sending country, with international migration playing a considerable role in both livelihoods and the national economy, accounting for some US $ 10.9 billion in 2009.[4]Most long-term or permanent emigration is to the UK or US, with some 500,000 Bangladeshis estimated to reside in each country (Siddiqui 2003). Short-term contract migration to the Middle East and South-East Asia has grown considerably since the mid-1970s (aided by the emergence of private recruiting agencies in the 1980s), and is now the dominant form of international migration. More than three million Bangladeshis have migrated overseas for employment during this period, with an annual average of around 226,000 leaving from 1991 to 2002 (Siddiqui 2003). Since 2000, however, substantial increases in the cost of migration and growing competition from other countries have recently led to a small decline. Such migrants are mostly male, and semi-skilled or unskilled, reflecting significant restrictions on the unskilled migration of women (Siddiqui 2003).

Nonetheless, it is also evident that forced migration associated with climatic processes does occur, and is significant. More than one million people are estimated to lose their homesteads or land to river erosion each year (RMMRU 2007). Case studies suggest that displaced people initially try to relocate themselves within the village, or in neighbouring villages, reflecting the fact that the annual cycle of flooding both erodes land, and may slowly create new areas for potential settlement as a result of siltation. But whilst river bank erosion may occur overnight, sedimentation is a considerably longer process and may not necessarily occur in the same location. Local population pressures therefore rise and some of those displaced gradually move to urban areas when no other income options are available (Hossain et al. 2003). However, it was found that those people who own some land, or can rely on supportive kin or richer patrons, benefit more from migration than the poorest people in a region.

[4] See www.bangladesh-bank.org.

Climate shocks can exert a heavy toll on lives and livelihoods. Floods in 1988 and 1998 in Bangladesh, for example, left 45 million and 30 million homeless respectively, and an estimated combined death toll of 3,000–7,600 (Rayhan 2008, p. 2). Evidence for the impact of rapid-onset disasters on population displacement is mixed. Heavy monsoonal rains in 2007 affected more than 10 million people in 39 of the country's 64 districts, driving a reported 3,000 migrants a day to Dhaka due to inadequate relief and lack of incomes (IRIN 2007). However, where aid has been effectively distributed and food markets supported (e.g. the 2004 tornado and the 1998 floods), out-migration has been minimal (Paul 2005).

2.6.1 Key Migration Drivers in Bangladesh and Their Susceptibility to Climate Change

A major economic driver of migration in Bangladesh is the differential availability of employment opportunities. It is estimated that one-third of the total working-age population of Bangladesh is either unemployed or underemployed, of whom 80 % live in rural areas. International migration has helped to keep the unemployment rate virtually unchanged since the 1980s, although the growth rate of the labour force is almost twice that of the population growth (Siddiqui 2003). The economic pull of urban areas, where non-agricultural incomes grew six times faster than agricultural incomes between 1988 and 1995, is a complementary driver (Afsar and Baker, cited in Afsar 2003). Urban incomes are also more secure. Case studies suggest that, even in slums, employment is commonly found within days of arrival in the city, and provide key remittances back home (Afsar 2003; Barkat and Akhter 2003). Limited employment is not confined exclusively to rural areas: lack of year-round employment has been one of the major reasons for out-migration by adult members in almost two-fifths of the households in small and medium towns (Afsar and Baker 1999).

Alongside economic drivers, there are also a number of social and political drivers of migration in and from Bangladesh. For example, although perhaps not precisely termed a 'driver' of migration, flows of migrants abroad are also significantly steered by family and social networks. In the case of migration from Bangladesh to the UK, colonial era migration flows have been reinforced in particular by the search for marriage partners amongst UK-based Bangladeshis; in the case of the Gulf, movement has depended on employment opportunities generated either through kin networks, or through networks of recruitment agents.

Political security is also often cited as a driver of overseas long-term or permanent migration, as well as being a primary motivation for cross-border migration into India, where some 15 million are estimated to be living illegally (Shamshad 2008), although this figure is highly contested and does not have any empirical basis. Between October and December 2002, for example, an estimated 5,000–20,000 Bangladeshi Hindu and other minorities fled to India to escape violence following the national election which brought a pro-Muslim party to power.

According to an estimate by the West Bengal Border Police Department, about 1,000 people cross the border each day and enter West Bengal, although it is unknown how many stay or return after temporary employment (Datta 2004).

As in Ghana, it is clear that in Bangladesh there is also migration directly related to environmental stress, in this case associated primarily with extreme climatic events—floods—rather than specifically with climatic variability. Thus, Hunter (2005) reports on the work of Zaman (1991), who found in a survey in the mid-1980s that two-thirds of households had been directly displaced by riverbank erosion, with the mean number of displacements during an adult's lifetime being seven. Yet some 88 % of affected households had moved no more than two miles from their original residence, motivated by the strength of local family ties, and a belief that in due course they would be able to reclaim their previous residences and farm land.

Climate change is likely to have a detrimental impact on almost all rural production systems, which, combined with a growing population, may dramatically reduce both productivity of and access to, natural resources. Thus, local access to common resources on which the rural poor depend (e.g. fisheries, forests and river bank cultivation) is likely to decline as a result of increased riverbank erosion, driving further out-migration of the rural poor. Adaptive responses (e.g. development of shrimp farming in response to increasing salinity) currently tend to benefit outside (i.e., urban) investors, whilst local populations are increasingly forced to abandon land and migrate to the city.

In addition, increased volatility of agricultural productivity is likely to widen real and perceived rural–urban differences in income opportunities and access to services. In the drought-prone north west, where rainfall is almost half the national average (1,240 mm/year), the period 1978–1990 has already witnessed trends of increasing temperature (0.05 °C/year) and a decline in the length of the monsoon (Rahman and Alam 2003). Rice, the nation's principal crop, is particularly sensitive to higher temperatures, and in the absence of long-term changes to cropping patterns, may lead to declines in rural incomes. Relatively small deficiencies in the 2006 monsoonal rainfall, for example, generated rice losses of 25–30 % (Rahman et al. 2007). Whilst major investment over the last 2 decades in some regions (e.g. rainfed Barind) has succeeded in raising agricultural productivity, most of these efforts will be challenged by predicted increasing drought in the north-west (Rahman et al. 2007). One can thus expect accelerated rural–urban flows and increased international migration (for those able to access such markets) as urban centres become increasingly over-burdened and competition for employment increasingly scarce.

Once again, putting these elements of susceptibility of migration drivers to climate change together (see Table 2.2), it is not unreasonable to expect that the bulk of any additional migration is likely to take place within Bangladesh, rather than overseas. However, two key factors here that are different to Ghana are, first, the extent of economic inequality between Bangladesh and its neighbour India, in a context where social and cultural ties between East and West Bengal are arguably stronger than those across the West African region, and, second, the extent

Table 2.2 Main migration flows in and from Bangladesh and their susceptibility to climate change

Type of migration	Sending area	Destination	Main drivers	Main climate variables of drivers	Sensitivity to climate change
Localised displacement	All affected regions	Cities (Dhaka)	Flood risk, monsoon	Variability and long term change in sea level tropical storms, oceanic-atmosphere circulation, rain intensity and distribution	High—but depends largely on other factors, e.g., food aid
Localised displacement	River communities	Often inside own or in neighbouring communities, sometimes urban areas	River erosion	Changes in ice and snow melt in upper catchment and rainfall changes in other parts of catchment	High—but in some cases people move back to land after event
Seasonal moves to urban areas	Rural areas	Nearby cities, capital	Need to diversify livelihoods, often main source of income	Same as for localised displacement	Medium—decline of productivity possible, risk of saturation of cities
Long-term rural–urban	Rural areas	Mainly Dhaka and Chittagong	Difference in labour demand, security of employment	Same as for localised displacement	Low—as climate-related effect outweighed by other factors
Cross-border migration	All country, also rural areas	India	Economic differences, political security, social and cultural ties (East–West Bengal)	Same as for localised displacement and also for destination location	Medium—consequence of saturation of cities in Bangladesh
International	Better off households	Gulf and regional centres in SE Asia	Difference in labour demand, recruitment, political security	Same as for localised displacement and also for destination location	Medium—consequence of saturation of cities in Bangladesh
International	Better off households	Europe (mainly UK) and US	Difference in labour demand, networks, marriage, political security	Same as for localised displacement and also for destination location	Medium—consequence of saturation of cities in Bangladesh

Source authors

to which destinations within Bangladesh—especially the capital Dhaka—are themselves vulnerable to future climate change. As a result of the former, it is likely that a significant proportion of any growth in migration that might result from rural impoverishment associated with the negative impacts of climate change could be seen in international migration to India: indeed, such cross-border migration is already arguably the largest bilateral migration flow in the world, larger even than flows from Mexico to the United States. In relation to the latter, it is difficult to estimate the extent to which urban overcrowding in Dhaka and the surrounding region will lead to onward (international) migration, not least because a significant proportion of international migration comes direct from rural areas such as the district of Sylhet (Joarder and Hasanuzzaman 2008). There is also scope for investment in improved urban infrastructure in Dhaka such that significantly larger flows of rural–urban migrants could be absorbed, at least in principle.

2.7 Conclusion

As it is currently formulated, the approach that we have outlined in this chapter does not seek to provide a clear estimate of the number of people who are likely to migrate as a result of climate change, or the direction(s) that such migration will take. However, it does serve as a heuristic device to think about the relationship between the various different drivers of different kinds of migration, and the way that migration might affect these drivers—and therefore also migration itself—into the future. As such, it provides a note of caution in relation to predictions of future migration at a global level. At the same time, we would argue that such an approach also crucially provides a basis for a more detailed assessment of particular case study contexts to directly test the sensitivity of specific drivers to anticipated climate change impacts. Such an assessment is likely to require detailed field verification to ensure that drivers are properly understood, and climate change impacts on these drivers correctly specified.

Such detailed verification could take a number of forms. One way forward is to develop a model of human adaptation in response to likely climate change, building in migration as one of a number of adaptive or reactive responses, and allowing for ‘interaction’ effects between actors that could lead to acceleration (or deceleration) of migration reflecting ‘learned behaviour’. This ‘agent-based modelling’ approach has been developed elsewhere, and we will not dwell on it here (Kniveton et al. 2008). However, other options can also be envisaged; one of the more powerful of these is likely to be a process of scenario building, in which changing influences on the macro- and meso-level drivers of migration are built up through expert and ground-level participatory analysis to build a small number of ‘likely’ future scenarios based on different climate change inputs.

In relation to this latter approach in particular, it is important to note that in addition to understanding migration drivers, there is also a significant gap in the understanding of the likely trends of climate change that will influence these drivers, requiring input from natural as well as social scientists. For example, most existing scenarios of likely future change in the Sahel region are premised on the assumption that there will be a significant decrease in rainfall, but as noted above, this is not a robust prediction, and inter-annual variability of rainfall in recent years provides support for scenarios that could involve both rises and falls in rainfall. Indeed, perhaps the only robust prediction that is currently available in relation to Sahelian rainfall is its likely continued geographic variability, such that even in the face of relatively extreme drought, some areas are significantly more affected than others. Similarly, in the Ganges–Brahmaputra delta, there remains significant debate about the nature of future flooding hazard, associated with uncertainty about the future contribution of snowmelt in the Himalaya region to floods downstream (Mirza 2002; Shaman et al. 2005).

Of course, such uncertainty cuts both ways: it is entirely feasible that climate change could be more extreme than 'mainstream' scenarios currently envisage. For example, less likely climate changes include a global temperature rise of more than 3°, the potential that climate change could introduce new pathogens that affect either animals or humans, the risk of ocean acidification, and the potential for large-scale geo-engineering by major powers such as the US or China, to increase rainfall in their own dry lands, but with potentially significant consequences elsewhere. An integrated approach to modelling climate change-migration interactions could seek to reflect some or all of these 'hard-to-imagine' climate scenarios—particularly in the context that multiple-degree temperature rises are increasingly seen as more likely by the scientific community.

Another issue relates to the concern of this chapter with understanding climate-migration linkages at a variety of spatial and temporal scales. It is important to provide a corrective to mainstream policy thinking that migration is by definition international and/or long-term or permanent, even if internal migration is usually less politically and ethnically charged and requires more national than international policy responses. In addition, the Ghana and Bangladesh examples above both point to how whether future migration is internal or international may have as much to do with the shifting ways in which borders are constructed and enacted—i.e., whether they are permeable or selectively restrictive—as it does to specific climate changes.

Our final point relates to the policy relevance of such a study. In many respects, what is important for policy-makers is less the number of likely migrants, and more the question of where migrants might go in the future, compared to where they go at present, and what the key 'tipping points' might be that are associated with a significant rise (or fall) in migration to a particular destination. The integrated assessment approach provides the basic building block for such analysis, and as such, holds significant potential within the field of policy-making aimed at adaptation to climate change.

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http://www.springer.com/978-94-007-6207-7

Disentangling Migration and Climate Change
Methodologies, Political Discourses and Human Rights
Faist, Th.; Schade, J. (Eds.)
2013, XIX, 259 p., Hardcover
ISBN: 978-94-007-6207-7