

# MIGRATION AS AN ADAPTATION TO CLIMATE CHANGE

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**Abstract.** This article presents a conceptual model to investigate population migration as a possible adaptive response to risks associated with climate change. The model reflects established theories of human migration behaviour, and is based upon the concepts of vulnerability, exposure to risk and adaptive capacity, as developed in the climate change research community. The application of the model is illustrated using the case of 1930s migration patterns in rural Eastern Oklahoma, which took place during a period of repeated crop failures due to drought and flooding.

## 1. Introduction

It is now widely accepted that we are entering a period of unprecedented change in the Earth's climate, caused in large part through human activity, most notably deforestation and the burning of fossil fuels. These changes are expected to be reflected in, among other things, higher average temperatures, widespread changes in precipitation patterns, increased risk of drought over many land areas, rising ocean levels, and more frequent extreme weather events (Houghton et al., 2001).

Among the many potential impacts of climate change for human societies is the possibility of changes in human migration patterns (Glantz and Ausubel, 1988; Döös, 1994; Hugo, 1996; MacKellar et al., 1998; Magadza, 2000; Meze-Hausken, 2000; Hay and Beniston, 2001; Myers, 2002; Barnett, 2003). In the 2001 report of the Intergovernmental Panel on Climate Change (IPCC) on vulnerability, impacts and adaptations, the question of whether such climatic changes could result in changes in human migration patterns was discussed briefly, but no substantive conclusion was expressed (McCarthy et al., 2001). Mention was made of studies showing how human populations have used migration as an adaptive strategy to adverse environmental conditions, and to those that suggest migrations of "environmental refugees" are a possible consequence of land degradation and conflict. Discussions under the United Nations Framework Convention on Climate Change have included the issue of compensation for countries that may be forced to migrate elsewhere, such as small-island states confronted by rising sea levels.

The focus of this paper is on the ways in which changes in environmental conditions can induce or influence migration patterns. While human migration has yet to become the subject of extensive research within the climate change research community, there is a considerable body of scholarship on the migration responses of people to various environmental, social, political and economic conditions. There

is historical evidence to suggest a link between climate and human migration, but this relationship is closely interwoven with other societal processes. Migration should not be considered as a simple or automatic response to a singular risk, climate-related or otherwise. Many factors combine to influence human spatial behaviour, and migration sensitivities and options vary greatly among regions and social groups.

This paper describes a conceptual model developed to investigate the relationship between climate and human migration. In the course of doing so, existing knowledge of the climate-migration relationship is reviewed, climate change vulnerability research and how it has informed the approach is described, and a brief review of theoretical developments in migration scholarship and how these are incorporated into the model is given. We then summarize findings from a study of migration behavior observed in rural Eastern Oklahoma during a period of repeated climate-related crop failures during the 1930s in light of the model.

## **2. Evidence for a Relationship Between Climate and Human Migration Patterns**

The notion that human settlement patterns may respond to climate is not new. Hippocrates and Aristotle believed that characteristics of the natural environment determined the habitability of a region by humans and that the characteristics of people were shaped by attributes of the natural environment in the place in which they lived (Livingstone, 2000).

A significant body of literature indicates that prehistoric human settlement and migration patterns had strong linkages to changes in climatic conditions, both shifts in norms and abrupt changes in conditions (Geel et al., 1996; Dolukhanov, 1997; Gribchenko and Kurenkova, 1997; Huntley, 1999; Yesner, 2001; Tyson et al., 2002). Archaeologist Brian Fagan (2004) suggests a number of examples from prehistory and early civilizations where climate is suspected of playing an influential role in human settlement patterns. In China, where written records have been kept many centuries longer than in most western nations, there exists documented evidence that movements of human populations, particularly nomadic pastoralists, responded closely to changes in climate (Smit and Cai, 1996). Climate was an important factor in the seasonal settlement patterns, in terms of both location and membership, of the Lakota of the North American Plains prior to European settlement (Fixico, 2003).

Examples of climatic influences on human migration patterns can be found in the past century as well. Population growth on the US Great Plains in the early part of the 20th century, including particularly high levels of in-migration, coincided with a period of precipitation and climatic conditions that were especially favourable to agriculture (Lockeretz, 1978). During the 1930s, a period of particularly unfavourable climate for agriculture coincided with severe economic recession and rapid mechanization of farming. That decade witnessed a migration

of approximately 300,000 people out of the US southwest and thousands more displaced within the region (Gregory, 1989).

Research in Africa in recent decades shows that populations in rural areas have adopted strategies to cope with recurring drought that incorporate migration. In Western Sudan, for example, male household members have often migrated to Khartoum in search of wage labour when times of low rainfall hinder agricultural production (Afolayan and Adelekan, 1999). In dryland areas of Ethiopia, migration is undertaken by families during times of drought after other measures, such as reducing food consumption and selling off possessions have been exhausted (Meze-Hausken, 2000). During the large-scale famines of the 1980s, migration was an adaptation taken by a considerable number of households in northern Ethiopia (Ezra, 2001). Showing a relationship somewhat different from that in East Africa, research in Burkina Faso suggests that ongoing environmental changes such as land degradation may have greater influence on migration behavior there than do episodic climate-related events (Henry et al., 2004).

In 1998, a particularly severe hurricane, Hurricane Mitch, struck Central America. In Honduras, the country hardest-hit, over 5,500 people were killed and more than 1.5 million experienced some significant form of loss (Morris et al., 2002). Wide scale migration within the region and to the United States ensued. The ramifications of this one extreme weather event in terms of international migration continue. In April 2003, the United States Citizenship and Immigration Service announced the extension until 2005 of a protected persons program established to allow persons unable to return to Honduras because of the fallout from Mitch to extend their stays in the US.

This is not an exhaustive list, but it does suggest that changes in human migration patterns can be influenced by changes in climatic conditions. Whether such migration events are responses to the inherent variability of weather or climate or to manifestations of longer period climatic changes is a matter of conjecture. Similarly, isolating the climate "signal" from other stimuli is not always simple. For example, Sen (1999) has shown that famines, such as those of northeastern Africa in recent decades, can be as much the consequence of social, political and economic inequalities that affect access to food, as they are inadequate rainfall or changes in precipitation. Despite the challenges in identifying climate change in causation, it is reasonable to go forward with the assumption that climate change may affect human migration in the future. It is now widely accepted that climate change is not simply manifested in changes in long-term average conditions, but may include changes in extremes or variability, and will be experienced via changes in the frequency, severity, timing and spatial extent of climatic conditions and events such as droughts and floods (Houghton et al., 2001). These are climatic events to which human communities are already vulnerable, and which have been associated with some past migration events. That vulnerabilities such as these and the possible responses will be influenced by the prevailing social, political and economic conditions has been recognized within the climate change research community (Smit and Pilifosova, 2001).

### 3. Vulnerability, Risk, Adaptive Capacity and Migration

One way of approaching the climate-migration relationship is to begin with the concept of vulnerability. Many definitions have been offered to describe human vulnerability to natural conditions (Weichselgartner, 2001; Clark et al., 1998; Cutter, 1996). In most, vulnerability is described in terms of the potential to experience harm or loss from some event or condition, and this potential is related to factors that affect the likelihood of the event or condition occurring and the ability to cope with the event if and when it occurs. In the climate change research community, researchers regularly attempt to account for both human socio-economic processes and biophysical processes when assessing vulnerability to climate change (eg. Fraser et al., 2003; Ikeme, 2003; Leichenko and O'Brien, 2002; Smit and Skinner, 2002; McCarthy et al., 2001; Yohe and Tol, 2002; Bryant et al., 2000; Kelly and Adger, 2000; Schneider et al., 2000; Yohe, 2000; Tol et al., 1998; Smit et al., 1999; Downing et al., 1997; Smithers and Smit, 1997; Easterling et al., 1992).

Such approaches are captured in the following conceptual representation of vulnerability to climate change, modified from Smit and Pilifosova (2003), where:

$$V_{slit} = f(E_{slit}, AC_{slit}) \quad (1)$$

where,  $V$  = vulnerability,  $E$  = exposure,  $AC$  = adaptive capacity,  $s$  = a given system or community,  $l$  = a given location,  $i$  = a given climatic stimulus,  $t$  = a given period of time.

This conceptual model relates to the vulnerabilities of human systems (communities, sectors or regions), and recognizes that vulnerabilities are usually specific to particular types of climatic risk and particular locations and time periods. Vulnerability is dynamic, as it varies over time ( $t$ ) and from place to place ( $l$ ) and system to system ( $s$ ). The two elements of vulnerability ( $V$ ) distinguished in the model are: exposure ( $E$ ), which refers to the probability or incidence of hazardous conditions or events relative to human occupation at a particular location and time (climatic events and system sensitivity have been treated as separate elements elsewhere, McCarthy et al., 2001); and, adaptive capacity ( $AC$ ), which refers to the ability of the system to deal with or cope with the conditions or effects to which it is exposed. An example of exposure in this model would be the likelihood of a community experiencing the effects of droughts of a particular severity, and adaptive capacity would be the ability of that community to deal with the effects of recurring droughts.

The functional relationship between the elements of exposure and adaptive capacity is not specified in the model, but most studies suggest that vulnerability is positively related to exposure ( $E$ ) (that is, increased exposure increases vulnerability), while changes in adaptive capacity ( $AC$ ) have a negative or inverse effect on vulnerability (enhancing adaptive capacity reduces vulnerability, *ceteris paribus* Smit and Pilifosova, 2003).

The elements of exposure and adaptive capacity are not static; as the subscripts imply, they vary according to the properties of biophysical and human social systems in a given geographic location, which change over time. The particular properties of exposure and adaptive capacity at a given place at a given time are in turn the product of historical interactions of human and natural systems. Robards and Alessa (2004) present this model in a slightly different fashion, to place further emphasis on the temporal nature of the relationships in the model, so that it becomes

$$\frac{dV}{dt} = f\left(E_{(F+L+S)}, \frac{dAC}{dt}\right) \quad (2)$$

In this representation, vulnerability ( $V$ ) is shown to change over time as a result of exposure ( $E$ ) conditions and changes in adaptive capacity ( $AC$ ) over time. The representation of exposure ( $E$ ) in the model is expanded by showing that it varies according to the frequency ( $F$ ), longevity ( $L$ ) and spatial extent ( $S$ ) of the climate-related perturbation. Exposures are not simply the result of biophysical processes. Rather, as shown in the natural hazards literature, extreme events that are the outcome of biophysical processes (such as those that might be exacerbated by climate change) are not hazardous unless humans are exposed to them, such as through human use or occupation of an area where they can occur (Burton et al., 1993). Exposure to natural hazards can therefore be described as a function of the natural systems that give rise to extreme events with human socio-economic processes leading to human presence at or particular human use of a given place at a given time. Burby (2001), for example, suggests that national flood insurance programs actually encourage continued human occupation of floodplains in the United States, and work at cross purposes to any planning measures to reduce the number of people living and working in areas prone to severe flooding. Adaptive capacity ( $AC$ ) can similarly be described functionally, as being a function of societal processes and outcomes (Denton, 2002; Adger, 1999; Handmer et al., 1999) and their effects, among others, on economic resources, human capital, social capital and their distribution (Smit and Pilifisova, 2003). Connected to these is the ability to recognize and assess risks and adaptation needs, and implement suitable options (Frankhauser and Tol, 1997), which in turn may be influenced by availability of information, skills and technologies (Goklany, 1995).

Relationships between changes in climate and changes in human migration patterns can be considered in the context of this representation of vulnerability. Kates (2000) suggests that, especially among poor populations, the lack of capacity to adapt to environmental risks or hazards is interconnected with population displacements. If we assume that climate-stimulated migration is not simply a random or wholesale outpouring of people from an exposed area, migration can be seen as one possible manifestation or outcome of adaptive capacity in light of exposure to some form of climatic stress. In other words, like vulnerability, the potential for climate-related migration can be considered to be a function of exposure and adaptive capacity. This in turn raises a range of questions that merit exploration.

Some might include: How can the factors that influence whether members of a given population may adapt through migration, even temporarily, away from the area of exposure be identified? What conditions lead to migration instead of alternative adaptation options? Are all members in an exposed population likely to have the same disposition or ability to migrate? Under what conditions do migration decisions cease to be made willingly or voluntarily?

Such questions have yet to be investigated in a comprehensive fashion in the climate change research community. As a means of initiating such inquiry, and drawing on past experience, a simple, normative model of how human communities might respond to climatic changes through migration was created. The model is based on the concepts of exposure and adaptive capacity described above. The model was subsequently modified to incorporate theoretical developments in migration research, with emphasis on the role of access to capital in migration behavior. The revised model was then compared with an actual, climate-related migration event, to gauge how well it reflects or captures that event, and to identify further adjustments to be made to the model to enhance its reliability. The following sections describe this process in greater detail.

#### 4. Initial Model of Migration as an Adaptive Response to Climate Change

Figure 1 is a first step in conceptualizing how migration patterns may be influenced by climate change. It is a 'partial' model that focuses on differentiating the adaptive responses of individual households from those of community or higher-level institutions. It begins with the assumption that climate change stimulates some form of change in the environmental and/or socio-economic conditions of a given community ( $x$ ). The question is then posed whether the community's institutions are able to make the necessary adjustments so that the well-being of community members is not especially altered. If community institutions can do so successfully (through measures other than by organizing relocation or resettlement of community members)

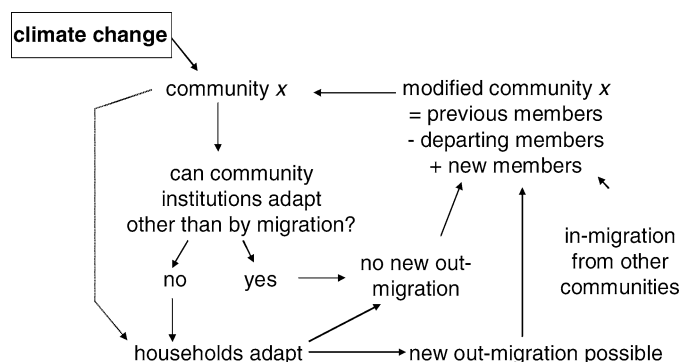


Figure 1. Model of migration in response to climate change.

it is not anticipated that significant changes would occur in migration patterns out of the given community as a consequence of the climate change at that time.

If the community's institutions are unable to cope with the changed environment, individual households remain vulnerable and may be obliged to implement their own adaptive strategies. For some households, migration of one or more members away from the community may be an option. Should household members migrate away from the community, this would alter community membership, which in turn may alter the nature of community institutions. The community in question is not assumed to exist in isolation, and so it may attract migrants from other communities who could not cope with environmental changes there. As a result, the model suggests a feedback cycle in that, as migration patterns begin to change in the given community, community membership and community coping capacity change as well. The dark arrows in the model suggest a progression that community institutions occur before household or individual responses. This is not necessarily the case; it may well be that household adaptive responses are undertaken prior to or at the same time as responses at other levels, and so a dashed arrow bypassing the community institutions is included to suggest alternative progressions.

This model provides only a very basic framework for the climate-migration process. It focuses on how migration decisions are made as private adaptations at the household level, while still acknowledging that such decisions can occur at the public level. There are historical examples where governments have organized, on behalf of their citizens, resettlement of people from areas of environmental risk. For example, in 1984–85 the Ethiopian government resettled tens of thousands from drought-stricken areas (Adugna, 1989). In the case of low-lying small island states in the South Pacific, if sea level rise progresses as expected, migration may sooner or later become the *only* adaptive option (Hay and Beniston, 2001). In such a case we can dispense with the question of *who* might migrate and move directly to analysis of *where* people might migrate, an analysis where the insights of political science would be beneficial.

Adaptation can occur at multiple levels. The distinction between public and private adaptation shown in Figure 1 has been identified in other analyses of adaptation to climate change (e.g. Smit and Skinner, 2002; McCarthy et al., 2001; Kelly and Adger, 2000; Smit et al., 2000). No priority is assigned to one level over another in the model. The model does not attempt to explain how public adaptation processes function, nor is it intended to; it differentiates scales at which adaptations can occur. There exists a wide body of literature that investigates public adaptation processes, including research that has looked at public adaptation in the specific context of climate change. For example, Handmer et al. (1999) noted that institutional capacity to cope with climate change, especially in industrialized countries, is generally robust at large scales, but that at local levels there exists significant variability in institutional capacity. Adger (2000) examined the capacity of local-level institutions in Vietnam to cope with environmental risks. Bryant et al. (2000) investigated the effects of political processes and institutional arrangements on the capacity of

Canadian farmers to adapt to climatic change and variability, while Leichenko and O'Brien (2002) considered the role that globalization plays in affecting the adaptive capacity of the farming community in southern Africa.

While the model focuses on migration as a private adaptation process, it does not specify whether migration is an adaptive response immediately available to all community members. The use of the term *possible* in the model suggests that not all those who have the option of migrating will do so. To investigate how migration decisions are made and the circumstances under which they occur, incorporation of theoretical explanations of migration behaviour into the model is warranted.

### 5. Theories of Migration Behaviour

This section is not intended to be a comprehensive review or critique of existing theories of migration behaviour, which has been done well elsewhere, by Massey et al. (1993), Boyle et al. (1998), Castles and Miller (1998), Afolayan (2001), Palloni et al. (2001) and other scholars in the field of migration research. Rather, it presents here a broad summary of the theoretical literature as can be related to environmental stimuli to migration.

One general category of migration theories, which have their origins in neo-classical economics, suggests that migration decisions are based on an individual or household need or desire to accumulate economic capital, and migration decisions are typically seen as being based on some form of rational choice. Among the propositions suggested by such theories are that differences in wage rates influence migration decisions, and that labour markets are the primary mechanisms for causing migration movements (Massey et al., 1993). According to this school of thought, individuals make their own estimates of the costs and benefits of migration and act accordingly (Massey et al., 1993; Castles and Miller, 1998).

Stark later expanded on traditional economic theories of migration, suggesting that migration decisions made at the household level can reflect not only the income maximizing behaviour of migrants, but also household attempts to minimize exposure to risk and highlights the role of remittances in achieving this goal (Stark, 1991). This "new" economic theory of migration holds that, by having household members disperse to different places, the household minimizes its exposure to cycles of economic growth and decline in any one place. Findings of this type have been reported by Adger et al. (2002), who found that remittances sent home by out-migrants are indeed an important factor in maintaining the social resilience of coastal communities in Vietnam. Similar practices have been documented as being used by communities in western Sudan (Afolayan and Adelekan, 1999) and northern Ethiopia (Ezra, 2001) as well.

Economic explanations of migration behaviour can incorporate motivations for migration beyond just economic factors, often referred to in terms of 'push and pull' factors (from Lee, 1966). The suggestion is that some forces act to push

people from their place of residence while others exert a magnetic-like force that attract migrants to particular places. Push factors other than economic forces can include demographic growth, low living standards, and political repression, while political freedom and availability of land are some examples of non-economic pull factors (Castles and Miller, 1998).

Curran (2002) notes that push-pull explanations, while common in the literature, leave room for further explanation of why some migrant destinations are selected over others, and why migration occurs out of one community but not another with seemingly similar circumstances. One theoretical direction that offers explanations on such questions considers structural explanations of migration behaviour, and focuses on the broader political, social and economic forces at work in a given community. Such theories argue that people are rarely free to migrate where and when they choose, but that their options are constrained by societal structures. For example, Zolberg (1991) argues that developed countries restrict in-migration in the narrow-self interest of reducing their exposure to deleterious forces of the international market and to ensure domestic security. Developed country economies nonetheless need cheap labour, leading to such phenomena as guest worker programs in Germany and widespread employment of illegal migrants in the USA. Massey et al. (1993) review a range of authors who argue that various aspects of capitalist economies restrict migration decision-making options or, in fact, create pools of mobile laborers that are predisposed to migrate in particular patterns.

Other approaches look at how human social behaviour and cultural dispositions, in addition to economic motives and structural constraints, influence migration. The study of discourse and narratives has given insights, for example, on how popular discussions and strategies aimed at discouraging or lamenting migration by young people out of rural areas in Australia has obscured discussion of the social and economic problems that stimulate such actions (Gabriel, 2002). Historical understanding of life in the American Dust Bowl of the 1930s, a region adjacent to that of the case study discussed later in this article, has been shaped by a number of discourses, described by Lookingbill (2001).

The influence of social behaviour and cultural dispositions on migration has been approached in other ways, involving the study of networks or capital. Migration systems theory, for example, suggests that migration patterns form between two or more places that exchange migrants with one another, generally following economic, cultural, or colonial ties already in existence (Castles and Miller, 1998). Massey and Espinosa (1997) and Palloni et al. (2001) have shown the importance of social capital – intangible benefits accruing to members of a network sharing interpersonal connections with one another – in perpetuating migration movements (see Wall et al., 1998 for a detailed review of social capital, its functions and properties). Faist (1998) examined social capital as a key component in the development of transnational social spaces where not only migrants but also trade in goods and mass communications flow across international boundaries through networks of

people sharing the same social and cultural backgrounds. Curran (2002), building on work done previously by Lutz, places considerable emphasis on the role that social networks play in migration patterns in coastal environments. Cultural attributes can also influence household migration behavior. Drawing upon theories of capital advanced by sociologist Pierre Bourdieu, Bauder (2003), Pettit (1999), and Nee and Sanders (2001), for example, have shown how cultural capital, in addition to social and economic capital, affects migrant destination choices and their ability to integrate into new communities.

A broad reading of the migration scholarship suggests that a range of economic, social and cultural processes play roles in shaping migration behavior. An analysis of household access to capital, in its economic, social and cultural forms, is consequently a promising means of capturing and incorporating such theories in the conceptual model of the climate-migration relationship introduced in Figure 1. Analysis of capital endowments can bridge the household decision-making processes and the broader socio-economic processes and constraints that influence migration behavior during periods of climate-related hardship. This is because the distribution of the various forms of capital among members of a community is reflective of the broader structures of society at any given point in time (Bourdieu, 1986). In addition, capital takes time to accumulate and tends to persist (Bourdieu, 1986), so incorporating it into a process model of climate-related migration helps identify the climatic “signal” or exposure: climatic events or changes that stimulate migration responses might be detected by sudden shifts in household capital endowments.

## 6. Modification of Conceptual Model to Incorporate Capital

Figure 2 shows the climate change-migration model after being modified to incorporate capital endowments as a means of distinguishing different potential adaptive responses.

The influence of household capital endowments on adaptation is given a lens shape in the revised model, symbolizing their potential to distinguish those who migrate as an adaptive response to climate change from those who do not. A similar lens could also be situated at the community level, to suggest that adaptation at levels higher than the household can also be influenced by community endowments of capital. Alternatively, capital could be represented in a more dynamic fashion than simply a lens, to show how it is not static. Here we keep the model as simple as possible, and focus on individual household responses to climate change.

The first model (Figure 1) has been modified to reflect migration theory in other ways. Migration is no longer portrayed simply as a binary phenomenon; rather, multiple possible outcomes exist, with capital endowments being influential. For the sake of simplicity, the migration outcomes are kept to a small number of possibilities. For example, two households in the same community exposed

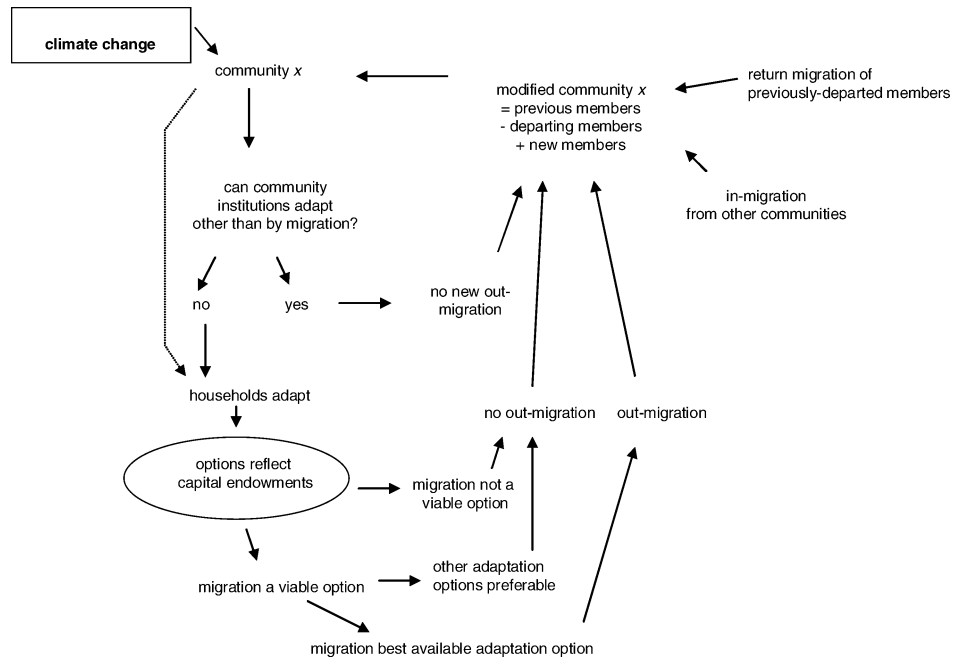


Figure 2. Model of migration in response to climate change, reflecting household capital.

to adverse climatic conditions might enjoy similarly rich endowments of social capital, such as good relations with extended family elsewhere, but one might own economic capital in the form of land while the other does not. In such a case, the land-owning household may have the option of migrating elsewhere, but might be less inclined or have less need to do so than the other. These different possible outcomes are illustrated in the model by the different paths that follow from the capital endowment lens.

The possibility of return migration to community  $x$  of former residents has also been added. Since no time parameters are specified in this model, this acknowledges that both environmental conditions and capital endowments are dynamic, and that combinations that lead to out-migration at one point in time can change, and migrants could return. Indeed, a temporary migration away from the exposed area could be a particularly effective form of adaptation in some cases; in others, migration away from the affected community could be indefinite.

## 7. Illustrative Case: Migration Patterns in Rural Eastern Oklahoma, 1930s

To assess this model against actual climate-related migration processes, to see if migration can be characterized in the context of adaptive capacity, and to find whether household migration behavior is indeed reflected in their capital endowments, a



Figure 3. Migrant source and destination areas in case study.

case study was sought where climatic events or conditions have been identified as stimuli was sought. The goal was to identify and examine the processes that occurred in this case, and to relate them to the model. The case study deals with migration patterns that emerged in rural Eastern Oklahoma in the 1930s during a period of unusually harsh climatic conditions. A particular focus was on the comparison of migration behavior and capital endowments of people who migrated to California with those who remained in the region (Figure 3).

One reason for selecting this case study is the sheer wealth of information available. Documentary sources include reports of US government agencies and Oklahoma's agricultural experiment station completed during the 1930s and 1940s; transcripts from US congressional hearings on interstate migration held in 1940; contemporary and post-event scholarly research; published oral histories and autobiographies; and, migrant camp administrative records. This was supplemented with information gathered in interviews conducted in 2004 in Sequoyah County, Oklahoma, and Kern County, California with people who had firsthand knowledge of the migration patterns that emerged out of Eastern Oklahoma during the 1930s. Interviewees included people who migrated from Oklahoma to California during this period as well as people who remained in Oklahoma; that is, migrants and non-migrants.

In the second half of the 1930s, approximately 300,000 people migrated out of Oklahoma, one-third of whom joined a large-scale regional migration to California that became known colloquially as the Dust Bowl migration (McWilliams, 1942; Stein, 1973; Hale, 1982; Gregory, 1989). Two sub-groups were identified by Gregory (1989) among Oklahoman migrants to California: those who originated in rural areas of Oklahoma and tended to settle in rural parts of California, and those who originated in or around urban areas in Oklahoma and tended to settle in urban areas in California. The highest levels of out-migration occurred from counties where cotton and corn were main crops, a region concentrated in the eastern half of the state.

In addition to interstate migration, a considerable degree of intrastate migration was also occurring during this period. In the first half of the 1930s, many people lost their employment in urban centers and in areas of oil production and mining when the US economy contracted with the onset of the Depression. Many of these sought to take up subsistence farming in Eastern Oklahoma, where large numbers of small farms were available for rent. This movement was joined by displaced farmers from semi-arid western Oklahoma, where a prolonged drought was already under way by 1933, and who were also seeking subsistence farms to rent. At that time, tenant farms typically represented less than one-half of farms in the western parts of the state, but between one-half and three-quarters of farms in eastern counties (Southern, 1939).

It is widely agreed upon in scholarly studies (e.g. McWilliams, 1942; Stein, 1973; Worster, 1979; Gregory, 1989), in reports from the time of the migration (e.g. Mayo, 1940; Duncan, 1943; McMillan, 1943a, b) and in the information provided to officials in California by arriving migrants (Holzschuh, 1939) that adverse climatic conditions played an influential role in stimulating migration out of the region during this period. There was also a range of other social, political, and economic changes occurring during this same period, including mechanization of agriculture, severe economic recession and corresponding implementation of new social programs under the New Deal, and a number of scholars have provided insights into how these helped influence migration patterns in Oklahoma (e.g. McDean, 1978; Bonnifeld, 1979; Worster, 1986; Gregory, 1989). However, the climate “signal” in migration out of rural Eastern Oklahoma was clearly evident in the almost complete and widespread failure of the principal cash crop, cotton, due to drought in 1934 and 1936 and to flooding in 1935 (USDA Weather Bureau, 1934, 1936). Such failures had a noticeable influence on migration patterns in the exposed area.

In Oklahoma’s eastern cotton belt, such as in a fairly typical county like Sequoyah County, tenant farms were generally 160 acres or smaller in size, sometimes much smaller. Most tenants had a form of crop-share arrangement with their landlord: the landlord typically received one-quarter of the cotton harvest and one-third of the corn harvest, assuming the tenants had their own draft animals and equipment. Tenants who provided little more than their labour received a smaller proportion of the harvest. Because of the influx of farm-seekers from other parts of the state, landlords were able to charge prospective tenants cash rent, often referred to as “privilege money”, on top of crop-share arrangements (Southern, 1939). Most tenancy agreements were oral and made on an annual basis. Tenants had no legal right to remain on their farms once the crop year was finished, regardless of how long they had been on a particular farm. Landlords could legally evict a tenant farmer with three days’ notice (Coleman and Hockley, 1940). A tenant farm family’s ability to remain in their place of residence from one year to the next was highly contingent upon their ability to bring in a successful harvest. Consequently, turnover of tenant farms was brisk even when climatic conditions were not especially difficult.

The cotton crop failures from 1934–1936 had two key impacts on the rural population of eastern Oklahoma. First, cotton was the principal source of generating wealth, and with its failure, money became scarce and barter became the principal form of economic transaction. Second, many tenant farm families, who formed the largest group among the rural population, were obliged to change their place of residence. The migration patterns that emerged during this period were reflected in the capital endowments of rural households.

Information drawn from multiple sources showed that particular patterns of capital endowments were exhibited by those households that migrated to California. Social capital, in the form of pre-existing family or community contacts in California, was highly common among interstate migrants. By the early 1930s, there already existed a community of 60,000 Oklahomans in California (Gregory, 1989). This network provided a flow of information about employment opportunities in California, assisted new arrivals in finding accommodation and employment, and helped the migrant community cope with a host population that would have preferred that they leave California at the completion of harvest, as had previous migrant worker groups from Mexico and the Philippines.

Oklahomans who migrated to California's southern San Joaquin valley found their cultural capital to be in demand. As in Eastern Oklahoma, cotton was a key crop in the San Joaquin and required large inputs of manual labor, and draft animals were still in wide use. In 1930, immigration restrictions had been placed on California's traditional supply of Mexican agricultural workers and employers were quick to fill the labour shortfall with Oklahoman migrants. Local wages, though high in comparison with Oklahoma, were low by local standards, and necessitated that entire families work in the fields in order to remain in California. Consequently it was not common to find elderly people or people physically unable to perform field work among Oklahoman migrants to the southern San Joaquin.

Few Oklahomans who migrated to rural California brought with them significant amounts of economic capital. The vast majority had been tenant farmers or agricultural laborers back in Oklahoma, and so financed their trip to California through the sale of their draft animals, farming equipment and personal possessions. Most owned an automobile or had access to one. Though poor in comparison with established Californians, they were generally not entirely destitute when they arrived in California. Those that left Oklahoma with insufficient funds for the trip stopped in states along the route where they performed agricultural work to raise additional funds for the journey.

Such capital endowments differ in two particularly important ways from people who did not migrate out of Oklahoma. The first is the geographic expanse of their social networks. Those who remained in rural Eastern Oklahoma throughout the 1930s often had strong local social networks. Extended families would often share residences, and mobilized to help one-another perform laborious tasks. With the disappearance of cash from the rural economy, barter became a principal form of economic transaction in the rural community. Being perceived as having good

standing within the community not only facilitated one's ability to barter, but also helped one obtain short-term credit from local merchants at a time when credit from financial institutions was prohibitively expensive or simply unavailable. Hiring for federally-funded infrastructure projects under the Works Progress Administration (WPA) was administered locally, and obtaining such employment often required having personal connections with the administrators. Such manifestations and uses of social capital are consistent with theories advanced by Coleman (1988) and Putnam (1995).

The second key distinction between California migrants and those who remained in the community relates to economic capital in the form of land. Ownership of land in Eastern Oklahoma in the 1930s conferred three distinct advantages. First, assuming they were not deeply in debt, land owners, unlike tenant farmers, did not risk of losing their place of residence following a crop failure. Second, the influx of tenant farm-seekers from other parts of the state increased the local demand for farms, and enabled landowners to charge supplemental cash rents or "privilege money" on top of the usual crop-share arrangements. Third, the federal government had by this point begun offering subsidies to farmers who reduced their acreage of crops like cotton, in an attempt to bolster low commodity prices. This allowed landowners the option of evicting their tenants and receiving compensation from the government, and had the additional effect of reducing the available supply of tenant farms.

The types of cultural capital that migrants found to be in demand in rural California – experience in working with cotton and other crops, the ability to handle draft animals – were fairly common in Oklahoma and neighboring states, and hence there was a difference in its relative value between the two regions. This differential alone does not, however, appear to explain the migration to California without the influence of the roles of the other forms of capital. The relative youth and vigour of migrants distinguishes them as a group from the general population left behind, but again, it is in concert with the other forms of capital that its role in the migration becomes pronounced.

Not all landless residents of rural Eastern Oklahoma who were displaced from their residences had social networks extending to other states, and not all had even the modest economic means of the California migrants. Considerable movements of people occurred within the region, and one of the more visible manifestations of this displacement was the congregation of large numbers of destitute people in shack settlements on the outskirts of urban centers, along railways, highways and rivers, and in remote parts of the countryside during the 1930s.

It should be noted that, although there was a high representation of people from Eastern Oklahoma among the broader population of people who migrated to rural California during the 1930s (see Holzschuh, 1939), some eastern Oklahoma counties like Sequoyah County actually experienced a small net increase in population during that decade. Some of this is attributable to cyclical or return migration (Mayo, 1940) and birth rates, and the influx of tenant farm-seekers from other parts of the state also appears to have been a significant contributor.

## 8. Discussion

The migration patterns that were observed in the case study are generally consistent with the central elements of the climate change-migration model (Figure 2). The capital endowments of migrant households displayed particular patterns, and these differed from capital endowments of non-migrant households. This provides an example of the model's suggestion that capital endowments can distinguish migration outcomes.

As noted previously, the climate-migration model comes out of the more general conceptualization of vulnerability being a function of exposure and adaptive capacity, and migration being one potential adaptive outcome. This case provides evidence of migration as a type of adaptive response to climate-related exposures. It also highlights that the adaptive response is not always the outcome of a selection process over which the household has control. For many households in rural Oklahoma, the decision as to whether they would remain in their place of residence at the end of a failed harvest was controlled by the landlord and not by the household itself. In such cases, the adaptation decision was not whether or not to migrate, but where to migrate to, given the household's available options. For the model to better reflect this possibility, a fourth path should be added from the capital-endowments lens, showing that some households may have no option but to migrate (Figure 4).

The case study suggests that particular types of exposure influence the potential for migration, and that particular characteristics of adaptive capacity differentiate migrants from non-migrants. This version of the model simply acknowledges "climate change", and clearly this needs more specificity in any application. It is important, therefore, to identify the key factors influencing exposure and adaptive capacity so that the role of capital in the model does not become a "black-box". For example, the vulnerability of rural Eastern Oklahoman households in the 1930s to being displaced as a result of exposure to climatic conditions was a function of such factors as the occurrence of crop failure as a consequence of drought and/or flooding (i.e. exposure) and the nature of their land use and tenure, the nature, extent and location of their social connections, and the health, well-being and ingenuity of family members (i.e. factors influencing adaptive capacity). This identification of exposure and adaptive capacity guides the analysis of the possible migration outcomes within the model.

The model presented here is clearly a work in process, and there are clearly opportunities for development. For example, it describes climate-related migration out of a given community, but does not suggest the destination(s) of the resulting migration; these must be inferred from capital endowments, particularly social capital. This works so long as social networks are easily identifiable and so long as people's actual behavior holds true to social network migration theory. The model also does not describe the factors that lead migrants to come to, or to return to, the exposed community. As well, it does not address how people's perceptions of

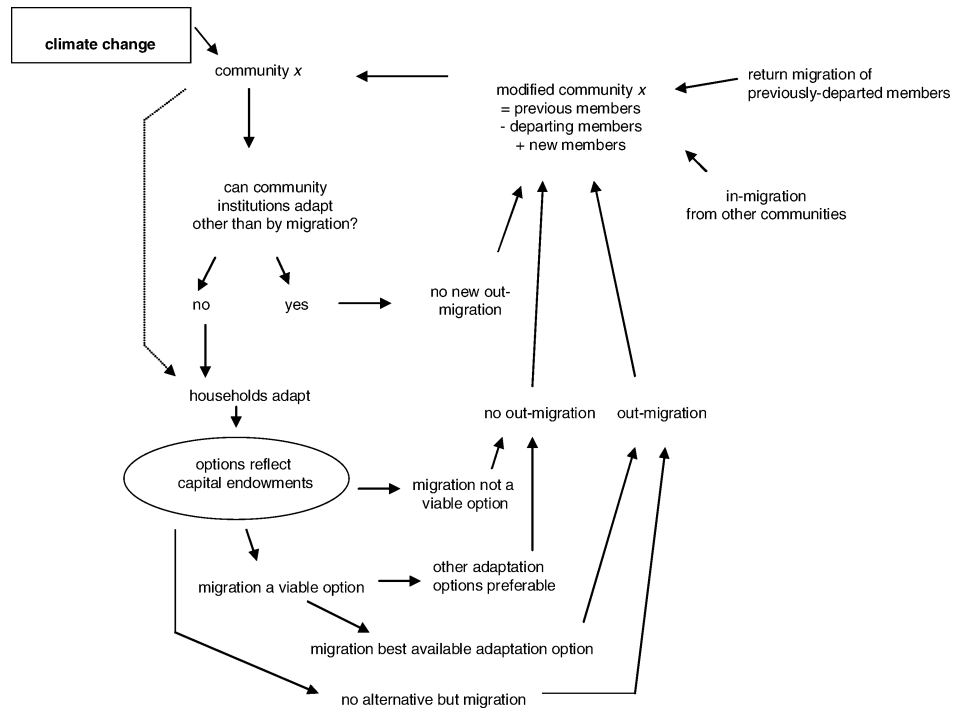


Figure 4. Model of migration in response to climate change, modified after case study.

environmental changes and the associated risks affect their adaptive decisions, factors which can be as influential as the actual realization of the risk itself (Kunreuther and Slovic, 1996; Slovic et al., 2000).

The utility of this model can not be assessed with a single historical case study. Jamieson (1988) and Glantz (1991) have identified a number of limitations of research by analogy, many of which are relevant here. For example, the same climatic stimuli occurring in the same place but at a different point in time can lead to considerably different outcomes. For example, later droughts in Oklahoma did not lead to a similar degree of out-migration as the 1930s (Warrick, 1980). This does not imply that the model's ability to reflect the migration events of the 1930s was merely a happy coincidence, but emphasizes that the nature of communities and their adaptive capacity is dynamic. Migration still occurs out of places like Sequoyah County to this day, but the nature of migration, the mobility of the population and the forces and drivers that influence migration are different. This relates back to the importance of using analytical approaches, such as the use of here of an approach based on differential access to capital, that are as dynamic as migration itself. However, to have greater confidence in the analytical and conceptual approaches introduced here, particularly before employing them in an anticipatory sense to describe potential future climate change-migration, it would be beneficial to assess

them in investigations of other known climate-related migration events in a variety of different places and time periods.

This work also shows the need to be cautious of sweeping predictions that future climate change will be accompanied by widespread international migrations of impoverished people. The potential exists, but this case study suggests there is not necessarily a direct relationship between the level of exposure to climatic risks and the likelihood of migration in response. It is important to consider the adaptive capacity of the exposed populations in question and, with particular respect to the question of migration, consider the broader societal processes and contexts in which exposed populations are situated.

## 9. Conclusion

There are few empirical examinations of the relationship between environmental change and human migration (Henry et al., 2004). This is especially so in the case of climate change research. The approach introduced in this paper considers the non-physical factors that influence migration decisions during periods of climate-related stress. It attempts to bridge the theoretical advances in migration and climate change scholarship. The model presented here is a tool that directs attention to the factors influencing vulnerability, and facilitates additional empirical research into human migration responses to climatic stimuli. This approach has in common many elements used by climate change researchers who begin with identification of the vulnerability of populations to existing environmental and socio-economic processes of change and then assess how well such populations could adapt to new conditions imposed by climatic change. With further refinement, the research introduced here may eventually be used with a variety of methodologies to not simply describe past climate-related migrations, but as a potential means of anticipating future climate change-migration relationships.

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