

Migration Impacts of Climate Change

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Extended abstract for US EPA/DOE Workshop, “Research on Climate Change Impacts and Associated Economic Damages”, January 27-28, 2011, Washington, D.C.

1. Briefly review existing studies of the impacts of climate change on intra- or inter-regional migration, with special attention to any existing quantitative estimates of the effects of changes in temperature, precipitation patterns, or sea level on migration patterns. Which regions are likely to be the most vulnerable to these impacts?

Scholars have long known that environmental conditions, including climatic variability and change, can and do influence human migration (Hugo 1996, Hunter 2005). Contemporary discussions of climate-related migration tend to be framed in terms of “environmental refugees” (a term coined by El-Hinnawi 1986), whereby people are involuntarily displaced in response to environmental conditions or events such as floods, droughts and so forth. A range of climatic events and conditions known from past experience to have stimulated distress migration are expected to increase in terms of frequency and severity in many regions as a result of climate change (Solomon et al 2007, Parry et al 2007) (Table 1). However, distress migration represents only one end of a continuum of possible climate-migration outcomes, the other end being environmental amenity migrants who voluntarily seek better quality environmental conditions (e.g. “snowbird” migration of retirees from northern US to the sunbelt). Many other possibilities exist between the extremes of environmental refugee and amenity-seeker, and in many instances it may be difficult to distinguish environmental influences from political, economic, social, and similar cultural factors that influence migration behavior (Hunter 2005, Massey et al 2010, Suhrke 1994). For example, often overlooked in discussions of climate change-related migration is the potential effect on labor migration patterns, as the impacts of climate change reduce income possibilities in some regions or sectors and open up opportunities in new ones (e.g. economic development in the warming Arctic creating new development and labour migration there (McLeman and Hunter 2010)).

Table 1 Expected impacts of anthropogenic climate change reported by IPCC and potential associations with future population displacements/migrations (adapted from McLeman 2011; McLeman & Hunter 2010)

| Expected biophysical changes (from Solomon et al 2007, Parry et al 2007) | Regions at risk | Possible linkages to migration |
|---|--|--|
| Decreased snow and sea ice cover | Arctic | Economic migrants arriving to take advantage of newly accessible resources |
| Higher average river runoff and water availability; more heavy precipitation events | High latitudes, some wet tropical areas | Flood-related displacements |
| Lower average river runoff and water availability; more | Mid- to low-latitudes and dry tropics; drought-prone | Water scarcity, drought, & decreased crop productivity leading to |

| | | |
|---|---|--|
| droughts in dryland areas | continental areas; areas receiving mountain snowmelt | migration, especially higher rates of rural-urban migration |
| Coastal erosion, extreme storms, sea level rise | Low-lying coastal regions, deltas small island states | Relocation of coastal settlements & infrastructure; salinization of water supplies |

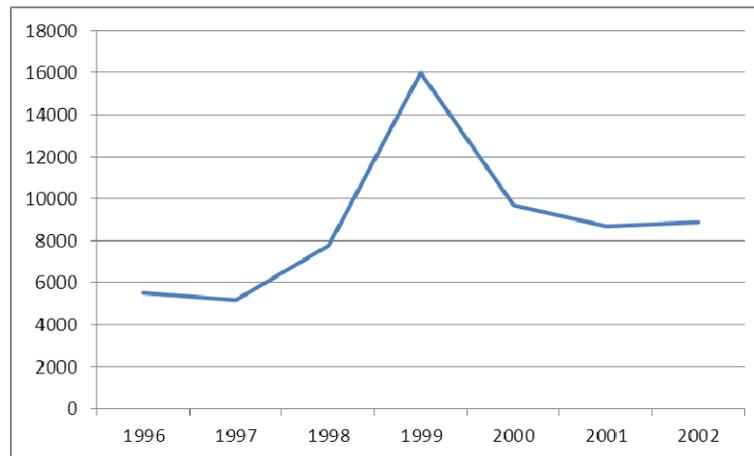
In the scientific community, human responses to the impacts of climate change are typically described in terms of vulnerability, which is in turn seen as being a function of the sensitivity of a given population, region or system to the types of climatic disturbances to which it may be exposed (often simply described as exposure), and the capacity of the population to adapt (Adger 2006, Parry et al 2007). Some types of settlement locations are more exposed to migration-inducing climate events than others, such as low-lying coastal areas and small islands; river valleys and deltas; dryland areas; regions where precipitation is highly seasonal; and, high latitudes and high altitudes (McLeman and Hunter 2010). In this context, migration is a process by which exposed individuals or households may adapt to climatic exposures (McLeman and Smit 2006, Perch-Nielsen et al 2008, Tacoli 2009, Bardsley and Hugo 2010). There are past examples of state-organized population relocations in response to climate-related events (e.g. resettlement after drought in East Africa in the 1980s and in Alberta/Saskatchewan, Canada in the 1930s (Ezra and Kiros 2001, Marchildon et al 2008)). However, most climate-related migration occurs as the result of autonomous responses by households and individuals, and consequently takes on many different shapes and forms. A single climate event may stimulate a variety of possible migration responses, as was seen following Hurricane Katrina (Fussell et al 2010).

The greatest amount of climate-related migration presently occurs at intra-national or intra-regional scales, and this is expected to continue to be the case in coming decades (Adamo and Izazola 2010, Massey et al 2010, Nelson 2010). In developing regions, where economic systems and livelihoods are closely tied to agriculture and natural resources, extreme climatic events and conditions are expected to accelerate already growing levels of rural-to-urban migration (Hunter 2005, McLeman and Hunter 2010). People at the lowest end of the socio-economic spectrum – particularly landless laborers and tenant farmers – are the most mobile and most easily displaced (Massey et al 2010). Landowners, business operators and others at the upper end of the socioeconomic spectrum will also experience economic hardship, but are more likely to resist migration because their household capital is tied to land and other assets that are not transportable (McLeman and Smit 2006). Cyclical intra-regional migration in response to seasonal variability in precipitation and periodic droughts has already long been practiced in Sudano-Saharan Africa and rural South Asia and this is expected to continue and potentially grow (Deshingkar & Start 2003, Hampshire 2002, Mortimore and Adams 2001, Nyong et al 2006).

International movements of people are also expected to increase in response to climate change, particularly along established migration routes and making use of social networks and transnational communities (McLeman and Hunter 2010). This belief is supported by evidence from recent climate-related migration movements, including examples involving the US. For example, Feng et al (2010) have observed that migration from Mexico to the US surges when drought conditions exist in rural Mexico. Hurricane Mitch was followed by a pulse of Honduran migration into neighbouring countries and to the US (Figure 1). Popular media have suggested that anthropogenic climate change has already begun causing migration from small Pacific islands to Australia and New Zealand, but there currently exists no

peer-reviewed research to support this suggestion (Mortreux and Barnett 2009). Case study findings from the EU/UNU-led EACHFOR project on climate and migration,¹ which was completed in 2009, may provide additional insights into international migration prospects under future climate change, but the results have yet to appear in scholarly journals.

Figure 1: *Apprehensions of improperly documented Honduran migrants along southern US border pre- and post-Hurricane Mitch (Oct-Nov 1998)*



Data source: US Department of Homeland Security Office of Immigration Statistics

While there is increasing agreement on the regions and populations most at risk of experiencing climate change-related migration, quantitative forecasts are few and vary considerably. The most widely-cited prediction is one made by British ecologist Norman Myers, who suggested there may be 200 million environmental refugees worldwide by mid- to late century, to be displaced by a variety of environmental changes including climate change and sea level rise (Myers 2002). Similar predictions have been made by CARE International (2009), while the relief organization Christian Aid (2007) suggested as many as one billion people could be displaced from their homes by mid-century from the combination of anthropogenic climate change and other global environmental changes. McGranahan et al (2007) maintain a Low Elevation Coastal Zone database and have used it to estimate that 10% of the world's population (15% of the global urban population) lives within ten metres of sea level, and is potentially exposed to the impacts by sea level rise.

2. *Briefly review the models and data used to estimate these impacts. What factors are most important to capture in such models when thinking about the migration impacts of climate change over a long time frame?*

Data for estimating climate change-related migration

Lack of reliable data constitutes a severe and ongoing impediment to reliable forecasting of climate change-related population movements. Data on global-scale population movements are generally coarse in nature, and those pertaining to environmental stimuli are particularly unavailable (Brown 2008). The Population Division of the UN Department of Economic and Social Affairs estimates the

¹ <http://www.each-for.eu>

world's current annual migrant population at slightly more than 200 million (UN DESA 2010); it is not indicated what proportion migrate for environmental reasons. The United Nations High Commission for Refugees (UNHCR) reported an estimated 10.4 million refugees worldwide, and another 15.6 million involuntarily displaced within their own borders at the end of 2009 (the last year for which figures were reported at time of writing)(UNHCR 2010). Because environmental stimuli do not qualify as valid reasons for seeking refugee protection, these statistics do not capture people who are involuntarily displaced for climate-related reasons, and the UNHCR offers no estimates for such categories of people. The UN's International Strategy for Disaster Reduction and the Centre for Research on the Epidemiology of Disasters provide annual estimates of the number of people affected by natural disasters affecting 100 people or more per event, broken down by type of disaster (of which some, but not all, are climatic in nature). These provide crude proxy figures from which to make estimates of involuntary climate change-related migration. It is important to note, however, that not all of those affected by disasters become migrants; many resume their former place of residence as soon as it is safe to do so. Furthermore, many environmentally induced displacements and movements of people are driven by small-scale, frequent or repetitive events that may not show up in disaster reporting (Gutmann and Field 2010).

Modeling of climate change-related migration

Modeling of climate change-related migration is still an emergent area of research. Much of the current work to date can be loosely described as *spatial vulnerability modeling*, having been influenced by techniques developed in natural hazards vulnerability research (e.g. Clark et al 1998, Cutter et al 2000, Wilhelmi and Wilhite 2002). These types of models identify areas or populations vulnerable to particular impacts of climate change by using geographic information systems (GIS) to combine modeled climate data from general circulation models (GCMs) or regional climate models (RCMs) with various types of population, agro-economic and/or resource data (e.g., Byravan et al 2010, Mcgranahan et al 2007, O'Brien et al 2004, Polsky 2004, Vorosmarty et al 2000). From these, assumptions are then made about the potential for population displacement and migration, as was done for example in the CARE International 2009 report cited previously. These models can be extended to identify potential sites of climate change-related conflicts (which would have feedback effects on migration), as is presently being done at the University of Texas-Austin to identify sites of potential climate change-related conflict in Africa² and at Oregon State to identify potential sites of freshwater conflict.³

Migration estimates based on spatial models make an assumption that an increase in exposure to a particular climatic stress stimulates a corresponding increase in migration (Piguet 2010). This assumption is inherently unreliable, because climate-migration rarely unfolds in simple stimulus-response fashion, but is instead heavily moderated by intervening economic, social and cultural variables (McLeman and Smit 2006, Massey et al 2010). For example, McLeman et al (2010) combined regional climate data and census information to create a GIS model of drought-related population change known to have occurred in western Canada in the 1930s. While the model successfully captured spatial associations between population change and drought for that particular decade at regional scales, the model has not yet been able to reproduce drought migration patterns in subsequent decades for the same region. This is because institutional and economic structures changed substantially over subsequent decades, requiring incorporation of additional data and modification of the underlying

² <http://ccaps.strausscenter.org/about>

³ http://www.transboundarywaters.orst.edu/research/case_studies/index.html

assumptions of causality built into the model. Enhancing the predictive capacity of spatial vulnerability models and “ground-truthing” them requires complementary qualitative field research to identify the factors and interactions (macro-level and context-specific) that transform vulnerability to migration.

Identification of vulnerable areas and populations that might experience climate-related migration is not, however, the same as being able to quantify the number of likely migrants. A second type of modeling that may hold promise for climate change migration research is *hazard analysis modeling*, which focuses on capturing the migration behavior of individuals or particular population groups (Barber et al 2000). Somewhat confusingly, the use of the term “hazard” with respect to this modeling method does not relate to environmental hazard stimuli but is simply a generic term denoting any potential lifecycle event (e.g. having a child, changing jobs, migrating, etc) that is contingent upon other variables, one of which could conceivably be changes in climatic or environmental conditions. In general migration research, this type of modeling has been used to understand the timing of migration events in response to particular stimuli (i.e. time-hazard modeling (e.g. Odland and Shumway 1993)) and in identifying potential migration stimuli operating across multiple scales (i.e. multi-level hazard modeling (e.g. Massey & Espinosa 1997)). The types and quantity of data necessary to apply this type of modelling to climate change migration are not widely available at present, although it has been applied in studies of other types of environmental migration, such as the impacts of land degradation on rural migration in Nepal (e.g. Massey et al 2010). A research group at the University of Sussex, England, is currently developing a multi-level hazard method described as *agent-based modelling* to develop forecasts of climate change migration, a method which derives multiple hypotheses about migrant behaviour from known migration data to create computer simulations (Kniveton et al 2008). The researchers have been attempting to apply the method to drought migration in Burkina Faso; results have yet to appear in scientific literature.

3. Characterize the uncertainty / robustness / level of confidence in these estimates, on average globally and by region.

There is a great deal of convergence in the research in terms of global and regional scale identification of areas and populations potentially at risk of experiencing population displacements and distress migration due to climate change. This situation will likely improve in the short run due to improvements in the availability of regional climate model data. Reliable local and sub-regional identification of potential climate change-related distress migration hotspots is not yet widely available and requires more research.

Existing estimates of future climate change migration numbers are inherently speculative and often anecdotal, and are consequently viewed with considerable scepticism by many scholars (Massey et al 2010, McLeman and Hunter 2010). This is to be expected given the limited availability and quality of regional climatic and population data and our weak understanding of the process linkages between climatic stimulus, migration outcome and intervening socio-economic and cultural processes. Most climate change-related migration is expected to occur within regions and borders, and is likely to include not only distress migrants but large numbers of voluntary migrants as well.

No global monitoring program presently exists for capturing environmentally-related population movements across international borders or internal movements. For particular regions and sub-regions, researchers have developed detailed datasets that include linked environmental information and population and migration data over particular time periods, with Burkina Faso, Nepal, and Amazonian Brazil being just some examples (Kniveton et al 2008, Massey et al 2010, Parry et al 2010). These disparate datasets are not necessarily linkable to create larger scale models, may not cover similar time

periods and may not be maintained on an ongoing basis. In summary, reliable forecasts of climate change migration numbers (as opposed to populations at risk) are many years off.

4. *What are the most important gaps or uncertainties in our knowledge regarding the migration impacts of climate change? What research in this area would be most useful in the near term?*

One important area for additional research is in enhancing our understanding of the underlying connections between climatic stimuli, intervening socio-economic factors and migration decision-making outcomes. Evidence from known climate-related migration events shows that migration responses to climatic stimuli are highly variable within and across populations (McLeman and Hunter 2010). Not all households exposed to a given climate event adapt through migration, and not all those who might migrate do so (McLeman and Smit 2006). Understanding the underlying forces responsible for differential migration responses is important for translating spatial vulnerability models into reliable forecasting models. Massey et al (2010) have suggested that migrants may act on the perception of an impending environmental risk rather than waiting for the actual occurrence of the environmental risk itself; if so, this is an area that is greatly understudied. Social networks and social capital are also believed to be significant influences on climate-related migration and therefore warrant further research attention (Gilbert and McLeman 2010, Massey et al 2010). The potential effects of climate change on intraregional and international labor migration patterns is virtually unexplored and warrants close attention, particularly given recent empirical findings regarding the influence of climatic conditions on labor migration within the Himalayan region and between Mexico and the US (Banerjee 2010, Feng et al 2010).

A second area of uncertainty, and one where US and international policymakers have an opportunity to play an important role, is in the creation of a protocol and mechanisms for generating global statistics on internal and international migration undertaken for environmental reasons. As indicated above, existing datasets relating to refugees and disaster displacements provide only rough and unreliable proxies for measuring the effects of climate and other environmental events and conditions on migration. A global environmental migration monitoring initiative would in principle be a relatively straightforward undertaking, requiring a simple protocol that might be enacted through an existing international agreement such as the UN Framework Convention on Climate Change. A range of existing international institutions, including various UN agencies and the International Organization for Migration, have the potential wherewithal for collecting and maintaining such statistics and would require modest incremental resources to do so. Such an initiative would be a particularly useful step forward in transforming discussion of climate change migration from informed speculation to evidence-based policy-planning.

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