

Final Report 2012-2014

Environmental Change and Migration

2. The "**Executive Summary**" concerns the content and results of the research. It should include the following information:

-The research plan (problem statement, general objective, hypotheses, research methods, schedule, etc.);

The debate on whether and how environmental change impairs human security and ultimately forces people to leave their homes and migrate to places more conducive to their wellbeing has experienced a strong revival in the climate change context. The Intergovernmental Panel on Climate Change (IPCC 2014), and academics and policy-makers argue that climate change is likely to cause mass population dislocations (migration) due to extreme weather events, such as stronger and more frequent storms, and floods, as well as longer-term, gradual problems, such as droughts, desertification and rising sea levels. According to some studies 400 to 600 million people living in low elevation coastal areas, such as some islands (e.g. Tuvalu and Maldives) and in major river deltas and estuaries in East and South Asia, would be affected by sea-level rise (Nicholls et al. 2011; MacGranahan et al. 2007). Some existing studies even estimate that these environmental events and processes could force 200 million to 1 billion people to move temporarily or permanently within their own countries or internationally (Laczko and Aghazarm 2009; Myers 2002). These estimates, however, have been heavily criticized that they tend to overestimate the number of 'environmental migrants'¹ because they are usually based on the number of people exposed to increasing risks, and not on the number of people actually expected to migrate; and they do not account for adaptation strategies and different levels of vulnerability to change (Kniveton et al. 2008; see also Gemenne 2011, Piguet et al 2011, Piguet 2010 and Foresight Project 2011).

A rather large body of literature examines particular cases of environmental change and seeks to relate observed dislocations of people to observed environmental events (Gray and Mueller 2012a, b; Doevenspeck 2011; van der Geest 2011; Massey et al. 2010; Mortreux and Barnett 2009; Jäger et al. 2009; Gray 2008; Myers et al. 2008; Henry et al. 2004).² Most of these studies suggest that environmental change *can* induce migration. However, there clearly is room for further research that should address several shortcomings of existing work. First, the large majority of studies examine one particular environmental event such as drought and its effects on migration. By implication existing research therefore does not tell us much about whether and how effects on migration might differ across different types of environmental stressors. The second limitation is that many studies using micro-level data, usually collected through surveys of individuals or households, concentrate on those persons

¹ We use the term "environmental migration" as relating to persons who are displaced primarily for environmental reasons. We prefer the term "environmental migration" over the term "environmental refugees" because the latter term is narrower and refers primarily to situations where people are facing extremely hostile environmental conditions that leave them with no choice but to leave (See Dun and Gemenne (2008) for a discussion on the definition of environmental migration).

² For a much larger review of the existing literature, see: Foresight Migration and Global Environmental Change (2011) <http://www.bis.gov.uk/foresight/migration>.

who have migrated. However, environmental change does not affect all people the same way and individuals do not respond to environmental change in a unified, singular manner (e.g. Black et al., 2011; Raleigh, 2011; Hunter 2005). Hence, studies that overlook those who have not migrated are likely to suffer from selection bias because they do not allow for any conclusions with respect to persons who, despite environmental problems, decided not to migrate. Finally, estimates of future environmental migration flows have failed to adequately acknowledge the effects of individuals' characteristics on migration behavior and have not successfully isolated the environmental influences from the multitude of other factors that influence migration.

In this project we contribute to the environmental migration literature by addressing some of the limitations of existing work. We propose a theoretical argument that systematically links different types of environmental stressors— notably short- vs. long-term environmental events— as well as individual perceptions of the environmental event to decisions of individuals to migrate or stay. At the empirical level we test the plausibility of this argument, using original survey data from Vietnam, Cambodia, Uganda, Nicaragua and Peru, including both individuals who migrated and individuals who decided to stay. We focus on internal migration because there is a strong consensus in the scientific literature that most migration flows associated with environmental factors are internal (Adamo and Izazola 2010). We also implement an agent-based model to simulate the climate-induced migration for alternative future climate scenarios using the newly collected micro-level data to calibrate the model. Unfortunately we have not coded the survey data for all the 5 countries yet and consequently in this report we present empirical results only from the survey in Vietnam.

Theoretical arguments

In this part of the project we develop a theoretical argument that systematically links environmental change to individuals' migration decision.

Several authors have argued that environmental conditions are part of a complex pattern of causality (e.g. Black et al. 2011; Lonergan 1998; Suhrke 1994). They argue that environmental, economic, social, and political factors are interrelated and need to be examined jointly in order to understand the role environmental factors play in population movements. A very useful option for doing so is to draw on the 'stress-threshold' model (Wolpert 1966).

From the perspective of this model, environmental events, for instance floods and droughts, can act as 'stressors' that bring about 'strains' and motivate individuals to consider migration as a response. That is, when environmental 'stressors' put an individual's wellbeing at risk, decrease her personal income, and/or lower her opportunity for future employment then she is more likely to consider migrating to places with better environmental attributes and better income opportunities. Environmental stress is, obviously, likely to be more paramount in settings where people are more directly dependent on the natural environment for their livelihood.

However, the presence of environmental stressors will, in most cases, not automatically induce migration (the main exception are major environmental hazards that leave local residents with no choice but to leave). Individuals are likely to first try and abate the respective environmental problem and/or adapt to it before they consider migration (e.g. Adger et al. 2007; Roncoli et al. 2001). The reason is that migration is costly in both financial and sociological/psychological terms because individuals tend to develop strong personal bonds over their lives with their home location and its people (Devine-Wright 2013; Lewicka 2011). Consequently, an individual will consider migration only when an environmental event has a major impact on her personal wellbeing and her efforts to adapt to and/or mitigate this

impact are failing (Speare 1974). To what extent this is the case depends on the form and magnitude of the environmental stressor.

The most interesting variation in this respect, in our view, is the difference between *sudden vs. slow-onset* and *short-term vs. long-term* events (see also Renaud et al. 2011). Sudden and short-term (rapid) environmental events, such as floods or storms, can have severe impacts – at least in the short run – on the wellbeing of individuals. Affected individuals may migrate in the aftermath of such natural disasters. However, migration might not be permanent. Individuals are usually tied to a particular location by lifestyle, bonds to other people, culture, social traditions and identity. For these reasons, we expect that they are likely to return once conditions improve and rebuild their lives in a ‘familiar’ setting. The empirical implication of this argument is that *sudden and short-term environmental events have a significant effect on individuals’ decisions to migrate*.

Slow-onset and long-term environmental events, such as droughts, desertification, or sea-level rise are likely to have smaller immediate impacts on the wellbeing of individuals. People can adjust their productive strategies over time when facing such environmental stressors, for example, by investing in irrigation systems, using drought resistant plant and animal varieties, or by diversifying income sources. Moreover, diversification of income sources might be accomplished by having a single-family member migrate. The empirical implication of this argument is that *slow-onset and long-term environmental events are less likely to increase the probability of migration*.

Furthermore we argue that it is not environmental change per se that is important for a person’s decision to migrate but rather individual perceptions of environmental change. Since environmental events are likely to have asymmetric impacts across the affected population, what counts as an environmental problem is relative. That is, individuals within any given population possess a wide and variable range of capacity to adapt to or cope with environmental stresses. The range of adaptive/copying options varies from one individual to the next, depending for example on the work skills, financial assets and other attributes of the individual such as age, sex, health and education. Thus, perceptions of environmental change depend not only on the individual’s exposure to the particular environmental event but also on her adaptive capacity. Consequently, we expect negative perceptions of environmental change to have a significant positive effect on migration because they affect individuals’ relative level of satisfaction with the current location.

Finally, we posit that the effects of environmental change on migration to vary with levels of economic development of the country in which an individual resides as well as the political capacity of the country’s government to effectively address environmental problems. Although individuals may be willing to respond to environmental changes by developing adaptation strategies, their ability to do so critically depends on the availability of the technological and economic resources for developing innovations. Also, adaptation strategies are a function of the political environment, which assists in promoting responses to environmental changes in an effective way.

Research methods

In order to empirically investigate the proposed arguments one needs data for both migrants and non-migrants who originally come from the same area in order to analyze whether environmental stressors influenced migrants’ decision to move to another location. Unfortunately, no data that meet these requirements exist. The only dataset that comes close to this ideal is the EACH FOR project (Laczko & Aghazarm 2009; see also Warner 2011). However, the limited number of observations per country case study makes the EACH FOR data difficult to use in a quantitative analysis and thus not very well suited for our purpose.

Consequently, this project relies on original survey data specifically collected to allow for a quantitative analysis of individual level migration choices.

Overview of the survey: we conducted individual level surveys in five countries, namely Vietnam, Cambodia, Uganda, Nicaragua and Peru, during the period September 2013 to August 2014, using 2 standardized questionnaires for non-migrants and migrants respectively in the local language. Our surveys yielded 3,680 completed questionnaires in total of which half came from migrants. We chose these countries because they provide ideal testing ground for our theoretical argument. Since our theory postulates different reactions to slow-onset/long-term vs. sudden-onset/short-term environmental events, we ideally need countries in which different parts of the country experience these types of environmental stressors such that one can disentangle the effects from the two types of environmental events on migration choices.

Based on information obtained from the EM-DAT/OFDA/CRED International Disaster Database and archive research, we first identified provinces/department in country that are mainly characterized by one particular environmental event, which can be classified either as slow-onset/long-term or sudden-onset/short-term environmental event. Within each chosen department, several communes/villages were randomly chosen using a grid system in which the interviews of the non-migrants took place. Furthermore in each commune, households were again randomly chosen by using a grid system with random starting points, and only one individual in each household was interviewed. In contrast, random sampling of migrants is hardly possible since by definition they do not live in the same commune anymore. Furthermore, in the locations they have migrated to, they are “hidden” since we cannot know whether a specific person has migrated from the relevant areas. Hence we had to rely on snowballing or chain-referral³ to find individuals who came from the exact same locations as the non-migrants but who now live in the nearest major city. Starting points of the snowballing were obtained by asking the non-migrant interviewees whether they knew of any individuals who had left their commune or district after having experienced the same environmental event(s) and did not belong to the same household. In total, we strived for the same number of migrants to match the non-migrants in each district. All interviews were personal interviews consisting of both closed and open-ended questions lasting for about 30-40 minutes. We asked all individuals about their experience with the latest environmental event as well certain important personal information such as age, profession or education levels.

The survey in Vietnam: we first identified four provinces in Vietnam that are mainly characterized by one particular environmental stressor. Then one district in each of the four provinces was randomly chosen for the location of the survey. In particular, the districts of Ba Tri in the province of Ben and Tre Ninh Hai in province of Ninh Thuan experience slow-onset and long-term environmental events in the form of water salinity and droughts respectively. In contrast, the districts of Chau Phu in the province of An Giang and Giao Thuy in the province of Nam Dinh are characterized by short-term environmental events in the form of floods and cyclones respectively. Within the four districts, three communes were again randomly chosen using a grid system in which the interviews of the non-migrants took place. More precisely, in each of the 12 communes (i.e. three communes in four districts) 50 households were randomly chosen by using a grid system with random starting points, and one individual per household was interviewed. Hence 150 non-migrants were interviewed in each of the four districts. Using the snowballing method we identified individuals who came from the exact same locations as the non-migrants but who now live in the nearest major city, in particular Ho-Chi-Minh-City in the case of the three districts of Ba Tri, Chau Phu and Ninh

³ This sampling method is frequently used in sociological studies of such hidden populations (Cohen and Arieli 2011; Laczko & Aghazarm 2009).

Hai, and Hanoi in the case of Giao Thuy. The survey was conducted in September and October 2013 and yielded 1,200 completed questionnaires in total of which 600 came from migrants.

Operationalization of variables: The dependent variable measures a person's decision to migrate. It takes on the value 1 for those individuals who migrated and the value 0 for those who did not. For our two main independent variables covering environmental stressors, sudden and short-term environmental versus slow-onset and long-term environmental events, we relied on a question asking respondents to describe the main weather event(s) they had experienced during the past five years in their present location in the case of the non-migrants and in their previous location in the case of migrants. Respondents could choose between several weather events such as heavy rain/storm/flood or drought/desertification/salinity but could also list any other weather event that was not listed or were able to state that no weather events have occurred lately. If individuals mentioned that they experienced heavy rain, flood, hail, storm, cyclone, typhoon, and/or landslide/ mudslide, we coded this due to the short-term nature of the event as sudden and short-term environmental stressor. In contrast, we coded any mentioning of salinity, drought or desertification as slow-onset and long-term environmental stressor. In addition, we incorporate several control variables in our model that are typical in the study of individual level migration choices, such as a respondent's gender and age, whether another family member has migrated (a proxy for migration networks). Information for all of the variables comes from the survey.

Furthermore to control whether economic problems drove the migrants' decision rather than environmental stressors, we rely on respondents' self-assessment as to whether economic reasons influenced their decision to migrate or not. In particular, all migrants were asked about their reasons to migrate and they could choose between many categories (e.g. social, political, environmental, or economic reasons). For all respondents who stated that economic reasons contributed to their decision to migrate, we coded the variable "*economic reason*" as 1 and for all other respondents as 0. Since we could not ask the non-migrants the same question, we asked them whether they have ever thought about migrating from their location and if so, which were the reasons for doing so. For those respondents who stated that they thought about migrating because of economic reasons, the variable "*economic reason*" takes the value of 1 and for all other respondents 0. However, since this self-assessment might be problematic as individuals might want to over- or understate the relevance of certain factors due to personal reasons (e.g. non-migrants might not want to admit that economically they are not doing well), we use three other variables as additional proxies for the economic reasons of migration. The first one is the interviewers' classification of the respondent's economic household status based on a predetermined household status scale. Second, we rely on a respondent's profession to proxy his economic wellbeing. As our final variable to control for the economic reasons of migration, we include a respondent's level of education.

Econometric procedure: Since our dependent variable is binary we use logistic regression models to analyze how environmental variables relate to a respondent's decision to migrate.

Computational model: In order to estimate future environmental migration flows we use a computational Agent-Based Model. Using the logistic regression models from the econometric analysis (see above) we first estimated individuals' migration decision as a function of multiple predictors including environmental events. We then incorporated four different potential future climatic scenarios to simulate their effects on the migration dynamics.

In particular, to model the impact of future climatic change on the migration intention, we first had to define an extreme environmental event as well as its future frequency. A heavy precipitation event was defined by applying a percentile-based threshold index, reporting the number of days on which the daily precipitation exceeds the 99th percentile (r99p) of the reference period 1961-1990. For a drought, the number of days without rain (r1mm) in a year

was chosen. For both kinds of events, the differentiation between extreme and non-extreme years is based on historic data. As the current and former location of the questionnaire participants is known, site-specific thresholds (in this case the 66th percentile of the period 1961-2010) were identified. While years with larger values than the threshold indicate extreme years, the ones showing smaller values are considered as not extreme.

To calculate these thresholds and to get information about the projected future frequencies we use the dataset from Sillman et al. (2013a, 2013b) which is based on state-of-the-art global climate models developed by the Coupled Model Intercomparison Project Phase 5 (CMIP5). Sillman et al. calculated historic and future yearly extreme indices according to the definitions of the Expert Team on Climate Change Detection and Indices (ETCCDI). The global data set has a spatial resolution of 2.5°, includes the time period of 1861 – 2100 and is available for several global climate models. In this study the ensemble means of all climate models for four different emission scenarios representing an increase in the radiative forcing of +2.6 (rcp2.6), +4.5 (rcp4.5), +6.0 (rcp6.0), and +8.5 (rcp8.5) W/m² compared to pre-industrial levels of green house gases are used (http://climexp.knmi.nl/selectfield_cmip5_annual.cgi).

- The results obtained from the survey in Vietnam and an analysis of them;

a. Our econometric results suggest that sudden and short-term environmental weather events such as floods or typhoons significantly increase the likelihood that an individual opts for migration. This finding supports the idea that short-term environmental events have severe impacts on the wellbeing of individuals and affected individuals therefore migrate to other regions. In contrast, slow-onset and long-term environmental events do either not influence or significantly reduce the likelihood of migration. The finding is consistent with the argument set forth in the previous section of the paper, where we claim that people are unlikely to migrate in response to longer-term environmental stressors, such as droughts and water/land salinity, since adaptation and mitigation should be the preferred options.

b. The ABM results show that for all four emission scenarios the extreme precipitation projections will significantly ($p=0.05$) increase in the period 2010 – 2100. However, there are differences in the intensity of that increase. While for the most pessimistic (in terms of radiative forcing) scenario rcp8.5 an increase of about 100 days is expected, the most optimistic scenario rcp2.0 projects only an increase of about 20 days. In contrast to that the projections of days without any precipitation tend to decrease, with two scenarios (rcp6.0, rcp8.5) showing a weak significant ($p=0.05$) negative trend according to the Mann-Kendall test. Additionally, here the differences among the emission scenarios are much smaller compared to the projections of extreme precipitation events.

Consequently the computation results indicate that the average proportion of migration among the agents will increase in the future mainly due to the decrease of the mitigating drought events and the simultaneous increase of heavy precipitation events which tends to exacerbate the migration intention. From 2040 onwards the most severe scenario rcp8.5 reaches an upper boundary with a migration probability slightly above 0.6, as in this scenario hardly any drought events and almost constant precipitation events are projected. The other- less severe- climatic scenarios show a less pronounced behavior.

-A summary indicating whether the results obtained correspond to those expected at the beginning of the research;

The results derived from our work so far largely corroborate our theoretical expectations (see above).

- Information regarding the practical application of results;

In a world increasingly likely to be subject to severe climate change, the gaps in our knowledge about the consequences of climate change for migration are daunting. More importantly, the potential for “conventional wisdom” to be established based on spreading of hearsay and unfounded claims, is clearly evident and potentially detrimental to appropriate policy action. The formulation of appropriate policies by the international community aiming at dealing with environmental migration requires knowledge of the relative contribution of environmental change to migration. We believe that our research findings entail important policy implications for policymakers interested in knowing how to best cope with the effects of environmental change on migration. The results of this research project can contribute to generating the scientific information on which policymakers can base their decisions (see also below).

- Questions that merit further exploration (scientific, practical, methodological) or that have risen as a result of the research;

While our empirical results provide some support for the environmental change–migration nexus, further research is required before we can move towards closure of the debate. Given that the obvious limitation of our empirical findings is that they are limited to one country, namely Vietnam, future research will have to focus on larger-scale primary data collection to compare several different countries. Furthermore, future research should examine which economic, political or institutional factors may best support and complement individual mitigation and adaptation strategies. Finally future research into the temporal dimension is also needed to determine the “threshold” by which environmental migration sets in when facing long-term environmental change.

- Practical and policy recommendations that follow from the results obtained;

In view of our results for the environmental change–migration relationship, one policy implication of our findings is that a more differentiated perspective on the issue of environmental migration is urgently needed. It remains possible that abrupt and extreme climatic changes could force people to migrate permanently from some areas of the world, particularly from low-lying coastal areas in some developing countries. However, if the past provides any insights into what may happen in the future, our results that depending on the type of environmental event people might prefer adaptation over migration. This finding appears to apply especially to slow-onset, longer-term environmental events. The main implication is, therefore, that spectacular “climate refugee” scenarios (Laczko and Aghazarm 2009; Myers 1997, 2002) are probably exaggerated, and that financial and technical support for adaptation to environmental changes resulting from climate change or other causes is the most productive policy-option.

- Information regarding past and expected publications and other activities (articles, books, conferences, workshops, etc.).

Publications

Working papers:

1. Koubi, Vally, Gabriele Spilker, Lena Schaffer and Thomas Bernauer (2014) "Environmental Stressors and Migration: Evidence from Vietnam" (under review at Global Environmental Change). Attached to this report.

2. Koubi, Vally, Sebastian Stoll, Tobias Siegfried and Lukas Beck. "An Agent- Based Model of Climate Induced Migration from Vietnam," work in progress.

Drawing on questions posed in the survey questionnaires regarding the short- and long-term effects of the environmental event(s) the respondents had experienced on their well being and

the efforts/actions they exerted in order to deal with these effects, we are presently working towards developing indices of individual vulnerability and adaptive capacity to climatic event(s) in order to better proxy individual perceptions to climatic changes, making hence the predictions of the computational model more realistic and accurate.

3. Koubi, Vally, Gabriele Spilker and Tobias Böhmelt. "The role of environmental change on migration decisions," work in progress.

In this paper we use the newly collected micro-level data from all 5 countries to empirically examine our proposed theoretical argument, that is, individual decisions to migrate are link to a) the type of the environmental stressor– notably short- vs. long-term environmental event–; b) individual perceptions of the environmental event, which depend on the capacity of the individual to cope with/adapt to the environmental problem; and c) the level of economic development of the country in which an individual resides and the political capacity of the country's government to effectively address and mitigate environmental problems.

Conference presentations:

1. "Environmental degradation and migration," (V. Koubi, G. Spilker, L. Schaffer and T. Bernauer)
 - Annual Meeting of the International Studies Association, San Francisco, CA, USA, 4-7 April 2013.
 - Annual Meeting of the American Political Science Association (APSA), Chicago, IL, USA, 28 August-1 September 2013.
2. "An Agent- Based Model of Climate Induced Migration from Vietnam," " (V. Koubi, S. Stoll, T. Siegfried and L. Beck)
 - Annual Meeting of the European Political Science Association (EPSA), Edinburg, UK, June 2014.

References

- Adamo, S. and Izazola, H. (2010) Human migration and the environment. *Population and Environment* 32: 105-108.
- Adger, W.N., Agrawala, S. and Mirza, M.Q. (2007) Assessment of adaptation, practices, options, constraints and capacity. In M. Parry (Ed) *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: IPCC / Cambridge University Press.
- Black, R., Adger, W. N., Arnell, N. W, Dercon, S., Geddes, A., and Thomas, D. S.G. (2011) The effect of environmental change on human migration. *Global environmental Change* 21, S3-S11.
- Cohen, N. and Tamar Arieli (2011) Field research in conflict environments: Methodological challenges and snowballing sampling. *Journal of Peace Research* 48(4): 423-435.
- Devine-Wright, P. (2011) Think global, act local? The relevance of place attachments and place identities in a climate changed world. *Global Environmental Change* 23 (1), 61–69.
- Doevenspeck, M. (2011) The thin line between choice and flight: Environment and migration in rural Benin. *International Migration* 49 (S1), e50-e68.
- Dun, O. and Gemenne, F. (2008) Defining environmental migration. *Forced Migration Review* 31: 10-11.
- EACH-FOR (Environmental Change and Forced Migration Scenarios).
<http://www.each-for.eu>
- EM-DAT: The OFDA/CRED International Disaster Database. Université Catholique de Louvain, Brussels (Belgium), www.emdat.be
- Foresight Migration and Global Environmental Change, 2011. Final Project Report. The Government Office for Science, London.
- Gemenne, F. (2011) Why the numbers don't add up: A review of estimates and predictions of people displaced by environmental changes. *Global Environmental Change* 21, S41-S49.
- Gray, C.L. (2008) Environment, land and rural outmigration in the southern Ecuadorian Andes. *World Development* 37 (2), 457–468.
- Gray, C. and Mueller, V. (2012a) Natural disasters and population mobility in Bangladesh. *Proceedings of the National Academy of Sciences* 109 (16): 6000-6005.
- Gray, C. and Mueller, V. (2012b) Droughts and population mobility in rural Ethiopia. *World Development* 40(1): 134-145.
- Henry, S., Schoumaker, B. and Beauchemin, C. (2004) The impact of rainfall on the first out-migration: A multi-level event-history analysis in Burkina Faso. *Population & Environment* 5 (5), 423-460.
- Hunter, L.M. (2005) Migration and environmental hazards. *Population and Environment* 26 (4), 273-302.
- IPCC Fifth Assessment Report (AR5). (2014). *Climate Change 2014: Synthesis Report*.
http://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_LONGERREPORT.pdf
- Jäger, J., J, Frühmann, S. Grünberger and A. Vag (2009). Environmental change and forced migration scenarios project synthesis report. Deliverable D.3.4 for the European Commission.
http://www.each-for.eu/documents/EACH-FOR_Synthesis_Report_090515.pdf
- Kniveton, D., Schmidt-Verkerk, K., Smith, C., Black R. (2008) Climate change and migration: Improving methodologies to estimate flows. *Migration Research Series No. 33*. International Organization for Migration.
- Laczko, F. and Aghazarm, C. (Eds) (2009) *Migration, Environment and Climate Change: Assessing the Evidence*. Geneva, CH: International Organization for Migration (IOM).
- Lewicka, M. (2011) On the variety of people's relationship with places. *Environment and*

- Behavior* 43 (5), 676–709.
- Loneragan, S. (1998) The role of environmental degradation and population displacement. *Environmental Change and Security Report* 4, 5-15.
- MacGranahan, G., Balk, D. and Anderson, B. (2007) The rising tide: Assessing the risks of climate change and human settlements in low elevation coastal zones. *Environment and Urbanization* 19 (17), 17–37.
- Massey, D.S., Axinn, W. and Ghimire, D. (2010) Environmental change and out-migration: Evidence from Nepal. *Population and Environment* 32 (1), 109–136.
- Mortreux, C. and Barnett, J. (2009) Climate change, migration and adaptation in Funafuti, Tuvalu. *Global Environmental Change* 19 (1), 105-112.
- Myers, N. (2002) Environmental refugees: a growing phenomenon of the 21st century. *Philosophical Transactions of the Royal Society* 357 (1420), 609-613.
- Myers, N. (1997) Environmental Refugees. *Population & Environment* 19 (2), 167-182.
- Myers, C.A., Slack, T. and Singelmann, J. (2008) Social vulnerability and migration in the wake of disaster: the case of Hurricanes Katrina and Rita. *Population & Environment* 29 (6), 271-291.
- Piguat, E. (2010) Linking climate change, environmental degradation, and migration: a methodological overview. *Wiley Interdisciplinary Reviews: Climate Change* 1 (4), 517–524.
- Piguat, E., Pécoud, A., and de Guchteneire, P. (2011) *Migration and Climate Change*. Cambridge University Press.
- Raleigh, C.A. (2011) The search for safety: the effects of conflict, poverty and ecological influences on migration in the developing world. *Global Environmental Change* 21, S82–S93.
- Renaud, F. G., Dun, O., Warner, C., and Bogardi, J. (2011) A decision framework for environmentally induced migration. *International Migration* 49(1): e3-e29.
- Roncoli, C., Ingram, K. and Kirshen, P. (2001) The costs and risks of coping with drought: livelihood impacts and farmers' responses in Burkina Faso. *Climate Research* 19: 119–32.
- Sillmann, J., V. V. Kharin, F. W. Zwiers, X. Zhang, and D. Bronaugh (2013a) Climate extremes indices in the CMIP5 multi-model ensemble. Part 1: Model evaluation in the present climate. *Journal of Geophysical Research* 118(4): 1716-1733.
- Sillmann, J., V. V. Kharin, F. W. Zwiers, X. Zhang, and D. Bronaugh (2013b) Climate extremes indices in the CMIP5 multi-model ensemble. Part 2: Future projections. *Journal of Geophysical Research* 118(6): 2473-2493.
- Speare, A. Jr. (1974) Residential satisfaction as an intervening variable in residential mobility. *Demography* 11 (2), 173–188.
- Suhrke, A. (1994) Environmental degradation and population flows. *Journal of International Affairs* 47: 473-496.
- Warner, C. (2011) Environmental change and migration: methodological considerations from ground-breaking global survey. *Population & Environment* 33(1): 3–27.
- Wolpert, J. (1966) Migration as an adjustment to environmental stress. *Journal of Social Issues* 22 (4), 92–102.
- Van der Geest, K. (2011) North-South Migration in Ghana-What role for the environment. *International Migration* 49 (s1), e69-e94.