

ABSTRACT

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Since the 1980s, sociological and interdisciplinary research has sought to address a question with significant implications for the study of international migration and global inequalities: how might changing environmental conditions shape human migration patterns? More recently, this broad question has coalesced into more specific inquiries into the relationship between anthropogenic climate change (i.e., global warming) and migration. This study assesses the relationship between environmental factors associated with climate change—droughts, floods, and extreme temperature variations—and national migration rates. While recent research in this area has focused on migration patterns within specific regions, this study investigates the effects of environmental forces on the net migration rates of many countries. Drawing on an analysis of 236 countries and territories between 2005 and 2010, I conclude that at the national level, droughts, floods, and extreme temperature variations do not provoke significant international outmigration. Though environmental forces have been found to serve as push factors in localized studies and those focused on internal migrations, these findings suggest that concerns over mass movements of environmental refugees from the global South to the North are currently exaggerated.

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Climate-Induced Migration: A Cross-National Investigation of the Effects of Climate Change
on International Migration

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INTRODUCTION

While climate change remains a politicized issue in some nations, evidence from climate scientists around the globe is resounding. Due to increased atmospheric concentrations of greenhouse gases, the global surface warming trend over the past 50 years has risen to nearly twice that of the last 100 years (IPCC 2007). In fact, the global mean temperature now exceeds that of the last 11,000 years (Marcott et al. 2013). Such profound atmospheric change alters regional temperature and rainfall patterns, and increases the frequency of extreme weather events like tsunamis and hurricanes (IPCC 2007; Laczko and Aghazarm 2009).

These environmental shifts affect human population movements, resulting in climate-induced migration (Warner et al. 2009). Early work in this area set out to estimate the number of “environmental refugees” that had already been displaced by environmental degradation, with estimates as high as 10 million (Jacobson 1988). Myers (1997) has been a particularly prominent voice in this area of research, estimating the number of “environmental refugees” at as many as 25 million, much higher than previously estimated (see Jacobson 1988). The potential for the displacement of “environmental refugees” is usually framed as a problem for receiving countries (Hartmann 2010), especially with respect to national security (White 2011). Some, however, interpret this “environmental refugee” problem as a humanitarian crisis that demands immediate action, whether that is to address the root causes of climate change or to provide aid for those affected (Christian Aid 2007).

Previous research on climate-induced migration focuses on movement within or out of particular nations, without simultaneously looking across the entire globe (Henry et al.

2003; Massey et al. 2010; Gray and Mueller 2012). Scholars have focused on these more localized dynamics despite concerns that climate change will provoke an influx of poor refugees from the global South into more affluent nations of the global North (Kaplan 1994). Research on international migration tends to focus on the economic and social forces shaping migration, without speaking to the issue of climate change.

This study investigates whether climate change registers as a factor in international migration (in terms of outmigration from countries across the globe). This study assesses the effects of climate change on the net migration rate over the 2005 to 2010 time period. To what extent does environmental change drive international migration, *and* which aspects of climate change in particular influence migration? I begin by discussing existing explanations for international migration, which focus on economic and social forces. Next, I review recent empirical studies of environmental migration, calling attention to the aspects of climate change that will be addressed in the present study: droughts, floods, and extreme temperature variations. Drawing on a sample of 236 countries, I find no detectable effect of droughts, floods, and extreme temperature variations on the rate of outmigration for the nation-state. These findings suggest that concerns over mass movements of environmental refugees from the South to the North may be currently exaggerated. I conclude by discussing the implications of these findings and offering suggestions for future research.

THEORIZING INTERNATIONAL MIGRATION

Scholars across disciplines have investigated an array of structural influences on international migration patterns. While some migration theories emphasize economic factors

provoking outmigration, others point to the role of household decision-making processes, social networks, or political factors (Brown and Bean 2005). This section outlines several dominant approaches to international migration, highlighting the various factors that have been found to impact population flows across national borders. These perspectives shed light on the economic and social forces that influence the net migration rate, which is the dependent variable to be analyzed in this study.¹

Neoclassical Economic Theory

Traditional theories have in large part regarded migration as an economically-induced phenomenon. The neoclassical economic approach, for instance, emphasizes the role of the migrant as a rational, decision-making and opportunity-seeking worker. On the macro level, differences in supply and demand for labor contribute to wage differentials between countries (Harris and Todaro 1970). These differences channel low earning workers into areas offering higher wages, thus shaping migratory flows. The structure of the global economy is of chief importance for the decision to migrate. At the micro level, wage differentials between countries spur cost-benefit analysis on the part of these rational decision-making workers (Borjas 1989). If the costs of migrating—including transportation, rent, and the various costs of settling in a new country—are lower than the benefits of increased wages, migration occurs. If the costs outweigh the benefits, the individual does not migrate. Here, migration is largely a consequence of the labor market and is dependent upon the economic capital of the individual.

¹ To address the effects of climate change on international migration, a macrostructural approach is taken in this paper, highlighting larger, global structures more than the agency of migrants. While this is the strategic choice taken here, it does not mean that other processes are not happening at the same time and at different levels of analysis.

A variant of this theoretical approach to explaining migration is human capital theory (Becker [1964] 1993), which highlights the returns on investment in education for migrants. Potential migrants are, again, rational decision-making economic actors, who may decide to invest in education and then migrate to receive a higher return on these educational investments in the form of higher wages (Chiswick 1999). Since the 1970's, much attention has been given to the "brain drain," whereby highly-educated individuals from less-developed countries move to developed nations to pursue careers, effectively stripping less-developed countries of the most highly-skilled in their labor force. Recently, scholars have turned towards a more optimistic view highlighting "brain gain" when economic development pulls emigrants back to their countries of origin (de Haas 2012; Findlay 2002). This neoclassical economic perspective emphasizes the agency of migrants. While larger economic forces shape their decisions, in the end, the rational individual has the free will to make migration decisions.

Sociological Critiques

While the neoclassical economic approach explains the economic forces that are determinants of international migration, sociologists also offer insights into a wider array of contributing factors. The new economics of labor migration (NELM) approach spearheaded by Stark and Bloom (1985) shifts the unit of analysis in studies of migration decision-making from the individual to the household. Households may send at least one family member as a migrant in order to manage risks associated with a variety of market failures, like those of the insurance and capital markets in less-developed countries that leave people exposed to livelihood instability. Migration of family members may serve as self-insurance for

households in less-developed countries to mitigate risk (Massey et al. 1993). Through remittances, migrants also provide the household with access to capital not otherwise available through loans (Massey and Espinosa 1997). Therefore, migration serves as a diversification strategy, where remittances from one member can supplement the total household income. Additionally, the NELM perspective considers the role of inequality in migration decisions. Households make migration decisions not only according to absolute levels of income, but also by considering their economic status in comparison to other households within their communities. Those households that are *relatively* deprived may still choose to send members abroad even when they experience absolute income gains (Stark and Boom 1985). On a wider scale, communities may experience overall gains in income, but if those at the lowest end of the income distribution do not benefit from those gains, out-migration may still increase (Massey et al. 1993). These contributions of the NELM perspective serve as important critiques of the neoclassical economic frame, adding new insights to the appropriate unit of analysis. One issue that is not adequately explained, however, is the persistence of migration streams once they are started.

International migration streams continue once they have been established. Immigrant social networks play a crucial role in sustaining migratory flows, contributing to what has been referred to as cumulative causation (Massey 1990). The social capital approach (Portes 1998) highlights the influence of social networks on migration decisions. The conversion of social contacts into social capital can help in offsetting the costs of migration and in producing favorable labor market outcomes (Palloni et al. 2001). Social networks also provide entrepreneurial resources, protection from hostile environments, and financial and

social remittances to the home country (Gold 2005). From this perspective, individuals with contacts located in the United States and other receiving countries are more likely to migrate, because they already have resources to draw on once they arrive at their destination. This would especially be the case for someone who has already migrated at least once and then returned to their sending country, because they would have established contacts in the receiving country that make migration easier. Migration is therefore self-perpetuating; once a flow of migrants is established, it will become easier for more migrants to follow. Furthermore, social networks impact return migration. Networks in destination countries draw migrants back, while social capital at their place of residence negatively impacts return migration (Haug 2008).

Migration policy—of both receiving and sending countries—also plays a crucial role in international migration (Cornelius and Rosenblum 2005). Historically, temporary worker policies have made it possible for great numbers of migrants and subsequently their families, to establish themselves in host countries. In the mid-twentieth century, programs like the bracero program in the United States and the German guest worker system recruited foreign labor with formalized conditions for migrants (Castles and Miller 2009). Since the 1970s, highly developed countries have largely sought to control migration flows, particularly irregular migration, by developing restrictive immigration policies (with migration within the EU as the major exception). Especially after the events of 9/11, international migration came to be seen as an issue of national security (Adamson 2006). While the results of immigration policies are not always those intended, such policies are always significant, as they define the

rights of migrants, classifying them according to legal status (Cornelius and Rosenblum 2005).

MIGRATION & THE ENVIRONMENT

While the perspectives above focus on voluntary migration, a third area of research focuses on involuntary migration, including forced migration, refugee flows, and asylum seekers (Black 2001). This area of research is particularly relevant to the study of climate-induced migration as environmental change is seen as a push factor that spurs largely involuntary migration. Forced migration may be caused by different types of political unrest, including war, terrorism, ethnic conflicts, and oppressive state regimes (Richmond 1988). The UN definition of refugee includes those who have been “forced to flee his or her country because of persecution, war, or violence. A refugee has a well-founded fear of persecution for reasons of race, religion, nationality, political opinion or membership in a particular social group” (UNHCR N.d.). Those displaced by environmental change and disasters, as well as internally-displaced persons, while not included in the official UN definition of refugees, must also be considered in terms of types of forced migrants.

Throughout human history, migration has been a key response to changing environmental conditions, with examples ranging from the Mayan civilization collapse of 750-950 A.D. to the U.S.’s Dust Bowl of the 1930s (Orlove 2005). Scholars have developed several typologies for categorizing such environmentally-induced migration, distinguishing between the types of environmental push factors (Bates 2002). These push factors may consist of slow-onset degradation, as in desertification in former maize-growing areas of

Mexico (Eakin 2006), or quickly-arising natural disasters, like earthquakes and hurricanes (Carvajal and Medvalho Pereira 2009). Development projects and technological disasters also contribute to migration. Displacement can occur due to public works projects like the building of the Three Gorges Dam in China (Heming, Waley, and Rees 2002) or technological disasters like oil spills and dam failures (Erikson 1978). From here, environmental migration can be further parsed into temporary and permanent and short- and long-distance movements depending on the duration of the migration and the distance travelled (Bates 2002).

One major concern of climate scientists is the increasing frequency of natural disasters in a warming planet (IPCC 2007). Evidence suggests that natural disasters like floods and droughts increase outmigration from developing countries and influence migration patterns within countries. In Guatemala, for example, natural disasters and environmental degradation were cited by 10 percent of surveyed households as principal push factors of outmigration, sending migrants from southern Guatemala to the forest frontier in the northern region of the country (López-Carr 2012). In Mozambique, internal population flows are directly related to water (EACH-FOR 2008). Severe floods push the largely agrarian population out of flood plains. Ironically, these migrants are often resettled via government programs in drought-prone areas where they then struggle to find access to water for their crops. In Niger, drought also serves as a push factor of both internal migration and international outmigration (Afifi 2011). In areas plagued by drought, crop production is no longer possible. Men are often forced to emigrate from their area of origin to find alternative sources of livelihoods, while women, children, and the elderly stay in place. As droughts

have become more frequent over the past decades, the time men are away has also increased. Perch-Nielsen and colleagues (2008) also explore floods and sea level rise as two mechanisms of environmental migration. In their model, both mechanisms are theorized as contributing to internal migration by way of damages to infrastructure, housing, crops, and livestock. A recent longitudinal study of population movement in Bangladesh found that flooding has a moderate positive effect on population mobility both within and between districts of the country, though crop failures that were unassociated with flooding do have a stronger effect (Gray and Mueller 2012). These findings highlight the significance of both natural disasters themselves and the concomitant disruption of agricultural productivity.

As such, climate scientists also draw attention to the impacts of climate change on agricultural and food production. Climatic change, and extreme temperature variations in particular, have the potential to drastically disrupt agricultural production. For instance, one study of Mexican migration to the United States found that climate-driven declines in crop yields in Mexico are significantly associated with increased migration to the United States (Feng, Krueger, and Oppenheimer 2010). Furthermore, the authors estimate the potential increases in emigration that could result from continued declines in crop yields associated with patterns of climate change: a 10 percent decline in crop yields was predicted to lead an additional two percent of the population to emigrate. In sub-Saharan Africa, a decline in rainfall in the late twentieth century has also disrupted agricultural production and pushed migrants from rural to urban areas, altering patterns of urbanization (Barrios, Bertinelli, Strobl 2006). Economists Lilleør and den Broek (2011) argue that climate change affects migration by way of economic drivers, including income. Furthermore, the perceptions that

potential migrants hold also shape decisions to migrate. In a study by Adams and Adger (2013) in Peru, survey results suggest that a loss of ecosystem services decreases attachment to place, potentially leading more residents to migrate to other areas in Peru. Things like climate, a lack of pollution, and the aesthetic value of the natural environment are pull factors that kept the residents in the study in place. Therefore, whether or not people perceive their environment as having less utility or they believe they are imminently threatened by climate change—whether they actually are or not—factors into migration decisions.

Taken together, these studies shed light on the complex economic, social, and political factors implicated in climate-induced migration. However, since they are focused on migration within particular regions, they share a common weakness in their inability to fully account for global transformations—both social and environmental. The debate over “environmental refugees” necessitates research that utilizes a macrostructural approach with a global scope (following Amankwaa 1995; Sanderson and Kentor 2008; 2009; Sanderson 2010). The environmental emphasis of this study fills out the macrostructural perspective by addressing the question of climate-induced migration in a cross-national analysis.

This study also adds to the sociological research by bringing environmental factors into the study of international migration. One key problem is that much of the previous work on international migration suffers from the “Human Exemptionalist Paradigm” (from Catton and Dunlap 1978). Like much of social science, it often disregards environmental factors that influence social phenomenon, as if humans are exempt from environmental forces. A “New Ecological Paradigm,” they argue, is needed to address the influence of economic, social, political, *and* environmental factors that are far-reaching and global in scale. This model

stresses an orientation to the material, biophysical world in which social processes occur. This realist perspective has been prominent in environmental sociology since its conception (Dunlap, Buttel, Dickens, Gijswijt 2002; Goldman and Schurman 2000) and is essential for addressing the concerns over climate-induced migration.

Drawing on this synthesis and the debate over climate-induced migration, I test the effects of environmental variables on net migration rates. Much of the theory and empirical studies discussed above focus on the reasons why people leave their countries of origin. Similarly, in the context of the debate over “environmental refugees,” the main interest in this study is emigration from areas affected by changing climatic conditions, which is a part of the overall net migration. Therefore, in this analysis, I am interested in determining if environmental variables have negative effects on the net migration rate, signaling increased emigration (i.e., more “environmental refugees” being displaced). I test the following hypotheses:

H1: As the percentage of the population affected by floods increases, there will be more emigration (as signaled by a numerical decrease in the net migration rate variable itself).

H2: As the percentage of the population affected by drought increases, there will be more emigration.

H3: As the percentage of the population affected by extreme temperature variation, there will be more emigration.

DATA AND METHODS

In order to test these hypotheses, I constructed a dataset of 236 countries and territories with available data collected by the United Nations (ISO N.d.). Data were drawn mainly from the United Nations World Population Prospects, the World Bank World Development Indicators, and the Centre for Research on Epidemiology of Disasters' Emergency Events (EM-DAT) database, whose disaster data is compiled from a number of sources, including UN agencies, non-governmental organizations, and insurance companies. While the data are not longitudinal—which is one limitation of the analysis—they are time-ordered to meet the temporal order assumption of causality. The initial sample included 239 countries and territories included in the UN World Population Prospects data, but three outliers (United Arab Emirates, Qatar, and Peru) identified using the blocked adaptive computationally efficient outlier nominators (BACON) algorithm proposed by Billor, Hadi, and Velleman (2000) were removed from the analysis. See Table 1 for a list of variables, descriptive statistics, and data sources.

Dependent Variable

The dependent variable—the net migration rate—is the average annual net number of migrants per 1,000 people between 2005 and 2010 as reported in the UN World Population Prospects data. This rate is calculated as the number of immigrants minus the number of emigrants over the 2005-2010 time period, divided by the person-years lived by the population of the receiving country over that period. Positive values correspond with more

people entering the country than leaving, and negative values correspond with more people leaving the country than entering.²

Independent Variables

To test the impact of climate change, three variables drawn from the EM-DAT database of natural disasters are introduced to the analysis: the percentage of the population affected by *drought*, *floods*, and *extreme temperature* variations. The EM-DAT database provides the number of people affected by various types of disasters, meaning those people requiring immediate assistance for basic survival needs such as food, water, shelter, sanitation, and immediate medical assistance. The number of affected people also includes cases of infectious disease that the population is usually free from. The number of those affected for each disaster has then been divided by the country population in 2005. While the database also provides the total number of natural disasters that occurred in a country over a specific time period, utilizing the percentage of the population affected by each type of disaster provides a more accurate measure of the actual impact of each disaster. Of course, some disasters have wider impacts than others, affecting many more people, and these independent variables take that discrepancy into account. Also, using the percentage of the population as opposed to the total number of those effected allows for comparison of the effects across both large and small nations. Climate scientists suggest that these extreme weather events (droughts, floods, and extreme temperature variations) will become more frequent and severe if the prognoses of climate change are accurate (IPCC 2007). Thus, by

² Though the net migration rate hides internal migrations and does not allow me to distinguish between the total number of immigrants and emigrants, it is the most recent data available.

including the percentage of the population affected by these three aspects of climatic change, the study points to the central aspects of climate change that are expected to become even more critical in the future.

The following variables are used to account for factors that are commonly found in the literature to affect international migration. From the neoclassical economic perspective, the level of economic development influences migration (Massey 1988), and I include *Gross National Income per capita* in 2004 (measured at Purchasing Power Parity) to control for the level of economic development. I use GNI per capita as opposed to GDP to compare living standards across countries. *Age composition* is included to account for the “young adult selectivity bias” (Williamson 1988) in which younger individuals are more likely to migrate. This variable indicates the percentage of the population ages 15 to 24 in 2005. *Education* is included to account for the level of human capital of each nation’s population, which, as a variant of the neoclassical economic perspective, has been found to affect migration rates (Findlay 2002). I capture this variable with secondary school enrollment per capita in 2004. *Armed conflict* is included to account for political stability, which has been shown to influence population movements (Lindley 2010), both voluntary and involuntary. This is a dummy variable indicating whether the nation was involved in at least one armed conflict from 2000-2005 (=1). Ideally, I would have liked to account for existing social ties to other countries and cumulative causation of migration streams. However, the cross-sectional nature of this analysis limits my ability to assess the effects of historical migration flows on current net migration rates. Since the sample size is relatively small, including lagged versions of the independent variables would run the risk of overfitting the model and potentially producing

spurious results. The literature reviewed above also shows how migration policy affects migration flows, though operationalizing such a complex concept is difficult. Though I leave policy out of the current models, future research should assess the historical legacy and current effects of migration policies on international migration. The current analysis is therefore limited in its ability to assess the effects of these factors, though future research, especially analyzing longitudinal data, could improve upon this weakness.

Analytic Technique

To test the effects of climate-related environmental variables on the rate of net migration, I employ ordinary least squares (OLS) regression.³ The current literature on environmental migration points to the complex interplay between social and environmental factors shaping both international and internal migration patterns. In Black et al.'s (2011) comprehensive conceptual model of migration, environmental change is one of several macro-level factors that influence migration, alongside political, social, and economic factors. Ideally, it would be helpful to test the entirety of the model, which includes micro-level individual characteristics like age, sex, and education, connecting macro- and micro-level determinants of migration into one model. However, such a complex model is difficult to empirically test. Missing data is also a common problem in this type of research. I filled in missing data using multivariate imputation by chained equations (Allison 2001). The conclusions drawn from the regression results are similar whether using listwise deletion or imputation (see Additional Analyses).

³ To assess concerns about collinearity, I computed variance inflation factors, which ranged from 1.01 to 2.58, suggesting multicollinearity is not a problem in the model.

RESULTS

Net migration rates range from -23.13 to 55.03, with a mean of 0.30. Notably, these migration rates are most highly correlated with GNI per capita, suggesting a strong connection between economic development and international migration (see Table 2). The correlation is positive, which is as expected considering more affluent countries tend to be overall receiving countries while poorer nations produce more emigrants. Cambodia has the highest percentage of the population affected by floods (49%), and though this data spans the time period of 2005 to 2010, this high impact is representative of current severe flooding trends as well (OCHA 2013). Other countries highly affected by floods include Mozambique and Bangladesh (at 27% and 30% respectively), which, as discussed previously, have both garnered attention from migration scholars (EACH-FOR 2008; Gray and Mueller 2012). The countries most highly affected by drought are primarily African nations including Kenya, Malawi, and Niger with percentages affected as high as 80%, 61%, and 50%, respectively. Significantly, these are also some of the poorest nations in terms of GNI per capita. The nation most highly affected by extreme temperature variations is Peru, though it is not included in the analysis because it is such an outlier at 14% of the population affected (with Afghanistan coming in second at less than one percent of the population affected). Extreme temperature variations in Peru continue to affect tens of thousands; in September 2013 a state of emergency was called in 10 regions of the country as a cold snap and snowstorms caused severe damage to property, livestock, and crops (Vidal 2013).

Table 3 presents the results of the OLS regression predicting net migration. In Model 2, I test Hypothesis 1 (flood increases). Floods do not have a statistically significant effect

on the net migration rate, net the effects of the other variables in the model. While empirical findings at the local level suggest that floods are a significant driver of migration (Gray and Mueller 2012; EACH-FOR 2008), these findings do not hold in terms of international migration at the global level. This suggests that floods do not significantly influence the net migration rate and Hypothesis 1 is not supported.

In Model 3, I test Hypothesis 2 (drought increases). Again, net of the other variables in the model, droughts do not have a statistically significant effect on the net migration rate. In Model 4, I test Hypothesis 3 (extreme temperature variation). The percentage of the population affected by extreme temperature variations is not statistically significantly related to net migration.

Finally, Model 5 includes all of the independent variables of interest. Still in this model, none of the climate-related variables—floods droughts, or extreme temperature variations—have a statistically significant effect on the net migration rate. Since the aim of this analysis was to determine to what extent climate change effects international migration, the findings reveal that at least these three independent variables do not have statistically significant effects on the net migration rate from 2005-2010.

Notably, the findings offer support for none of the three hypotheses about the effect of climate-related variables on net migration rate. While concerns about the effect of climate change on international migration have warranted much attention in the civil and political spheres (Brown 2008; Warner 2011; Zetter 2011), this analysis raises some doubts about a direct relationship between droughts, floods, and extreme temperature variations and international migration. Beginning with Model 1, I present a simple baseline model

predicting the net migration rate with the following variables: GNI per capita, age composition, education, and armed conflict. Three of the four variables are significant predictors of net migration in all of the models. These variables include GNI per capita, age composition, and education. In contrast, armed conflict does not have a statistically significant effect in any of the five models. This could be due to the way the variable is operationalized as a dummy variable. One limitation of this operationalization is that it only provides information on whether or not a country was involved in an armed conflict, as opposed to the magnitude or severity of the armed conflict. This is an area where future research can improve upon these models.

Additional Analyses

To ensure the robustness of my results, I performed several additional analyses. First, I explored an alternate way to operationalize the climate-related independent variables. Instead of using the percentage of the population affected by each environmental factor, I used the number of occurrences of the natural disaster. This data is also drawn from the EM-DAT database. These alternate environmental variables measure the total number of droughts, floods, and extreme temperature variations occurring in each country from 2000 to 2005. Running the analyses again, using the new variables that represent the number of occurrences of floods, droughts, and extreme temperature variations, the results are similar and the conclusions drawn are identical (see Table 4 for results). None of these alternate climate variables have a statistically significant effect on net migration rates. Operationalizing the independent variables in this alternative way does not drastically change the analysis.

Second, I compare the original results obtained using multiple imputation with an additional analysis using listwise deletion to deal with missing data (see Table 5). This decreased the sample size to 140 countries and territories. However, the results were the same—the percentage of the population affected by droughts, floods, and extreme temperature variations do not have statistically significant effects on the net migration rate in the new model. This provides evidence that either way of dealing with missing data lends itself to similar conclusions.

DISCUSSION AND CONCLUSION

There has been much conjecture about the effects of climate change, and particularly its impact on international migration patterns. Some have argued that there will be large numbers of “climate refugees” from the global South, turning to affluent Northern nations for refuge. This is a critical debate as the world begins to face the effects of climate change and one that sociological research can shed much light on. Theories of international migration have brought to light many factors that influence migration at different levels of analysis. To evaluate the debate on “climate refugees,” this study looks to the large-scale, structural factors that influence migration. Additionally, it integrates environmental variables in the theoretical framework and analysis. This study reveals no discernable effects of climate-related variables—droughts, floods, and extreme temperature variations—on net migration rates.

Although these results suggest that droughts, floods, and extreme temperature variations, controlling for additional factors, do not shape international migration on a global

scale, this is not to say that environmental factors do not matter in the migration process. At this point, climate migration may be a primarily internal phenomenon, occurring within borders. In their study of outmigration from Nepal, Massey et al. (2010) find that environmental change has a stronger effect on short-distance migration—out of neighborhoods—rather than long-distance migration out of the Chitwin Valley region. Even within regions, there is variation in the distance of migration. If the climate change-related variables in this study do not serve as significant push factors, leading people to emigrate in numbers substantial enough to change their country's population, there still could be environmental migration happening at the local and regional levels, which is an area for future research. Furthermore, we know that a great deal of migration is not permanent. The dependent variable here is a net migration rate over a five year period. As a result of this operationalization, it does not allow us to get a sense of the magnitude of more temporary migration patterns. People can leave, recover, and return to affected areas in less than five years. In fact, temporary migration is an important area for further research. It may be possible to find common ground between the investigation of environmental migration and recent work focused on transnationalism, as attention is given to more temporary migration and transnational networks. Environmental sociology has much to offer this area of research, and addressing these issues can demonstrate its value to the larger discipline of sociology.

These results raise questions about the concerns over large numbers of climate refugees inundating the global North—though not about the existence of climate change itself (see IPCC 2007). The null findings of this study provide evidence challenging the idea that climate change is pushing large numbers of migrants across international borders. This

does not mean that this will never occur, just that the effects are not discernable at this point in time. The idea of massive movements of climate refugees may nevertheless be promoted—either as part of anti-immigrant sentiments or—more likely by environmentalists who may present the climate-migration nexus as a crisis and an impetus to address the causes of climate change immediately. Anti-immigrant and pro-environmental sentiments are not necessarily mutually exclusive, as environmentalists have also argued that securing borders is a strategy aimed at preserving the environment of receiving nations (Salazar and Hewitt 2001).

Future research is needed to follow up on these findings at a later point in time, especially as more recent environmental and immigration data become available. The effects of climate change-related environmental variables on international migration will need to be monitored into the future as the relationship may change. Another area of future research that will add to our knowledge of this issue is the framing of the climate refugee debate itself. It is necessary to understand the multiple interests and perspectives involved. Though the results of this study find no discernable effect of climate change on international migration at this time, this issue will continue to be of great importance as the world faces the effects of climate change in the years to come.

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APPENDICES

Appendix A

Table 1: Descriptive Statistics and Data Sources

Variable	Mean	Std. Dev.	Min	Max	Date	Data Source
Net Migration Rate	0.30	7.53	-23.13	55.03	2005-2010	UN World Population Prospects
GNI Per Capita	10954.08	10756.81	0.00	56720.00	2004	World Bank World Development Indicators
Age Composition	18.16	3.11	10.32	26.22	2005	World Bank World Development Indicators
Education	74.95	25.21	8.94	149.84	2004 ^a	World Bank World Development Indicators
Armed Conflict	0.10	0.30	0.00	1.00	2004	UCDP/PRIO Armed Conflict Dataset
Floods	0.02	0.06	0.00	0.49	2000-2005	EM-DAT
Droughts	0.05	0.12	0.00	0.88	2000-2005	EM-DAT
Extreme Temperature	0.00	0.00	0.00	0.01	2000-2005	EM-DAT

^a Note that the percentage of the population enrolled in secondary education can be greater than 100 due to the inclusion of over-aged and under-aged students because of early or late school entrance and grade repetition.

Table 2: Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Net Migration Rate (1)	1.00							
GNI Per Capita (2)	0.52	1.00						
Age Composition (3)	-0.25	-0.73	1.00					
Education (4)	0.21	0.66	-0.61	1.00				
Armed Conflict (5)	-0.05	-0.15	0.15	-0.26	1.00			
Floods (6)	-0.13	-0.22	0.18	-0.28	0.10	1.00		
Droughts (7)	-0.08	-0.26	0.35	-0.41	0.09	0.24	1.00	
Extreme Temperature (8)	-0.10	-0.05	-0.02	-0.06	0.02	0.00	0.02	1.00

Table 3: OLS Regression Predicting Net Migration Rate

	Model 1	Model 2	Model 3	Model 4	Model 5
<i>Climate Change</i>					
Floods		-7.42 (7.37)			-7.24 (7.45)
Droughts			-1.57 (3.65)		-0.99 (3.69)
Extreme Temperatures				-413.23 (327.19)	-416.47 (327.88)
<i>Controls</i>					
GNI Per Capita	0.00*** (0.00)	0.00*** 0.00	0.00*** 0.00	0.00*** 0.00	0.00*** 0.00
Age Composition	0.58** (0.20)	0.58** (0.20)	0.60** (0.20)	0.56** (0.20)	0.56** (0.20)
Education	-0.06* (0.02)	-0.06** (0.02)	-0.06* (0.02)	-0.06* (0.02)	-0.06** (0.02)
Armed Conflict	-0.26 (1.41)	-0.22 (1.41)	-0.26 (1.41)	-0.25 (1.41)	-0.21 (1.41)
Constant	-12.28** (4.57)	-11.79* (4.60)	-12.30** (4.58)	-11.55* (4.60)	-11.07* (4.64)
<i>N</i>	236	236	236	236	236
<i>R</i> ²	0.33	0.34	0.33	0.34	0.34

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4: OLS Regression Predicting Net Migration Rate with Alternative Independent Variables

	(A)
GNI Per Capita	0.57** (0.20)
Age Composition	0.00*** (0.00)
Education	-0.06* (0.02)
Armed Conflict	-0.34 (1.64)
Number of Floods	0.04 (0.10)
Number of Droughts	-0.11 (0.49)
Number of Extreme Temp	-0.16 (0.40)
Constant	-12.04* (4.76)
<i>N</i>	236
<i>R</i> ²	0.33

Standard errors in parentheses
 * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5: OLS Regression Predicting Net Migration Rate Using Listwise Deletion

	(B)
GNI Per Capita	0.00*** (0.00)
Age Composition	1.41*** (0.35)
Education	-0.10* (0.04)
Armed Conflict	-0.60 (2.52)
Floods	0.00 (0.00)
Droughts	0.00 (0.00)
Extreme Temperatures	0.00 (0.00)
Constant	-28.78*** (8.10)
<i>N</i>	140
<i>R</i> ²	0.47

Standard errors in parentheses
 * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$