Environmental Change, Migration and Conflict: Theoretical Analysis and Empirical Explorations

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Abstract

The Intergovernmental Panel on Climate Change predicts that climate change will induce considerable environmental degradation globally during this century. What are the implications of this prediction for the patterns of population migration and political conflict? Climate change is an evolving environmental phenomenon whose effects are not yet fully manifested. This paper strives to gain insight to this question by exploring the effects of environmental degradation on migration in recent decades, and the effects of this migration on conflict. It is found that environmental degradation plays a role in migration, particularly in less developed countries, and this migration, in turn, can be a factor in international and intrastate political conflict. The paper evaluates the implications of these findings for public policies aimed at preventing environmental migration due to climate change.

The 2001 Intergovernmental Panel on Climate Change (IPCC) predicts that climate change will induce considerable degrees of environmental degradation globally during this century, ceteris paribus (IPCC 2001a, 2001b). What are the implications of this prediction for population migration and political conflict? Climate change is an evolving phenomenon whose effects are not yet fully manifested. This paper strives to gain insight to this question by exploring the effects of environmental degradation on migration in recent decades, and the effect of this migration on conflict.

The theory developed here argues that people can adapt to adverse environmental changes either by defending against them, or by leaving affected areas. The choice between these options depends on the extent of change and the technical capabilities of the society. Developed countries (DCs) are likely to defend against the changes. Less Developed Countries (LDCs) are less able to do so since this effort requires high levels of investment and technological expertise, which they lack. People living in LDCs may have no choice but to migrate from the affected areas. Environmental migration, in turn, increases the likelihood of conflict at its destination due to forces discussed in the next section.[1]

In empirically exploring the implication of this theory, the paper first conducts two case studies, focusing on internal migration in the U.S. during the 1930s, and internal and cross border migration

[1] Kennedy (1993), Homer-Dixon (1994), and Kaplan (1994) highlighted environmental change as a potential source of security concerns. This argument had influence within the Clinton administration (Herman, 1999). The Bush administration seems less interested in this issue, as the US pulling out of the Kyoto Accord in 2001 suggests, but the issue itself has not disappeared (Matthew, 2002).

originating in Bangladesh (East Pakistan before 1971) since the 1950s. Three macro-oriented analyses focusing on global environmental degradation, natural disasters, and environmental migration, respectively, follow the case studies. The empirical findings support the theory of the paper.

If the goal is to prevent environmental migration due to climate change, what are the policy implications of these findings? Since climate change is evolving, answering this question requires prediction. While caution is needed when predicting based on historical data, it is typically assumed that when analyses can explain historical patterns, they provide significant information about the future.

The paper's empirical findings on environmental migration suggest that climate change may intensify migration, particularly in LDCs, and the migration may lead to violence. These conflicts, in turn, may reduce global political stability due to some LDCs having acquired (or trying to acquire) weapons of mass destruction. However, the interconnections between environmental degradation, migration and conflict in the future do not have to be linear or static. In particular, policy responses may mitigate adverse effects *if* they were to identify environmental migration as a problem requiring solution. Thus far, DCs have all but ignored this issue. Assuming that global political stability is important for DCs, it is wise for them to implement policies designed to alleviate expected effects of climate change, particularly those involving considerable environmental migrations in LDCs, sooner rather than later.

This paper is organized as follows. Section 2 presents a theory of environmental migration and conflict. Sections 3-6 explore empirically the implications of the theory. Section 7 considers the effects of climate change on migration. Section 8 summarizes, and discusses implications for public policy.

2. Theoretical Framework

El Hinnawi (1985) introduced the term "environmental refugees" to denote people forced to leave their homes temporarily or permanently due to environmental problems that risk their life or quality of life. Several studies employed this term.[2] Others argued that the usual definition of refugees – people who

[2] See, e.g., Jacobson (1988), Refuge (1992), Myers (1993), Myers and Kent (1995), Lee (2001).

flee across borders due to persecution and war – implies that environmental refugees flee across borders due to environmental factors. Since environmental factors also may promote intrastate movements, and migration may be affected by non-environmental factors, authors suggested denoting people *forced* to leave due to environmental problems as "environmental refugees." The term "environmental migrants" was suggested to denote migration due to environmental and non-environmental factors working together.[3]

This discussion suggests a larger question: what drives migration? We can think about the decision to migrate as the outcome of a cost-benefit analysis. Individuals decide whether to migrate or not by comparing the net benefits (benefit minus cost) from the two alternatives, considering all factors. If the net benefit from migration is larger than from not migrating, individuals migrate. When several destinations are possible, they choose the one that provides the largest net benefit, which could be within – or outside of – their country.

The cost-benefit model faces two threats to validity. First, it assumes that individuals choose whether to migrate or not. However, one may argue that people facing threats to their lives are forced to migrate (Nichiporuk, 2000, Amin, 1974; Peterson, 1958). That said, migration is truly involuntary only if migrants are expelled against their will. Even people whose lives are threatened can choose to remain in affected areas, hoping to get by. Second, the model does not distinguish among intrastate and international movements. Here one may argue that these movements differ because they face different issues – e.g., different costs (Bilsborrow, 2001, UNHCR, 2002). In this paper, however, the issue is what drives migration, not whether the destination is across the border.

So far, the theory did not specify which forces promote migration. Standard migration theory distinguishes between pull, push and network forces.[4] Push forces operate in location A and promote

[3] For this and other criticisms, see, e.g., Suhrke (1993), McGregor (1995), Swain (1996), Hugo (1996), Wood (2001), and USCR (2002b).

[4] See, e.g., Weiner and Teitelbaum (2001) and Martin and Widgren (2002).

migration from A to B. Pull forces operate in location B and attract migration from A to B. Network forces assist in the move. Studies discuss economic and sociopolitical forces. Economic push forces include high unemployment, low wage, high population density, economic decline, and underdevelopment, while sociopolitical push forces include war, persecution, discrimination, and expulsion. Economic pull forces include high wage, attractive jobs, prosperity, and a high level of development, while sociopolitical pull forces include peace, family and cultural unification, and preferential treatment. Economic network forces include informational and financial assistance, while sociopolitical network forces include legal help (e.g., obtain work permits) and illegal help (e.g., smuggling people across borders).[5]

These forces are relevant, but they do not operate in a vacuum. This paper argues that environmental degradation also can promote migration. Some environmental degradation forces are slow-moving; others are faster. Human activity influences some forces; others tend to occur naturally. Natural disasters (e.g., storms) are largely idiosyncratic. Their effects on migration are temporary, fast acting, and localized. Cumulative environmental degradations (e.g., soil erosion) are largely slow-moving and man-made. Their effects are permanent and relatively dispersed. Effects of production accidents (e.g., chemical spills) can advance quickly, but tend to be temporary. Development projects (e.g., artificial lakes) can change the environment; their effects on migration are permanent but localized.

Consider next the possibility of conflict between environmental migrants and the residents at the migrants' destination. This paper conceptualizes conflict broadly to cover a range of interactions, from low intensity to war. Environmental migration can cause conflict through four channels. First, the arrival of migrants can burden the destination's economy and natural resource base, promoting native-migrant competition for economic and natural resources. Economic and resource pressures are expected to rise with the rise in population of migrants and residents, particularly when economic and natural resources

[5] Psychic factors also can also promote migration (e.g., destinations with symbolic heritage).

are scarce at the migration's destination. When pressures are high, people may attempt to secure resources by force, particularly when there are underdeveloped property right institutions.

Second, when environmental migrants and residents belong to different ethnic groups, the arrival of many newcomers over a relatively short period of time may upset a precarious ethnic balance. If migrants have brethren in the destination, residents may considered the combined bloc a threat. Host countries may fear separatism, and migrants may attempt to reunify with their home country, thus promoting aggressive nativist responses. Environmental migration situations involving long-standing ethnic disputes are likely to be more prone to conflict than other situations.

Third, environmental migration provides opportunities to exploit the situation, which generates tension. For example, the migrants' origin country may suspect that the receiving country accepts migrants in order to upset the ethnic balance in the origin country. The receiving government may suspect that migrants wish to destabilize its rule and enable penetration by the origin country. Also, the origin country may resent (actual or perceived) mistreatment of migrants by the receiving country.

Fourth, the conflict could follow existing fault lines. For example, pastoralists and farmers may compete over land. Migrants and residents may compete over jobs. Environmental migration from rural to urban areas–another fault line–presents competing effects. Political entrepreneurs in urban areas may exploit rural migrants' frustration and poverty and mobilize them to challenge the state. Threatened, the state may respond with force. However, urban settings offer migrants more opportunities, which can alleviate pressures and, therefore, reduce the likelihood of conflict.

Conditions of underdevelopment and income disparity will raise the risk of conflict. Developed economies can absorb an influx of migrants into various sectors. Underdeveloped economies – reliant on the environment for survival – are more limited in this regard and are therefore more prone to conflict.

The relative importance of these channels can vary across cases, and the likelihood of conflict is likely to rise as more channels operate simultaneously. These forces can also promote conflict from ordinary migration. What sets environmental migration apart from ordinary migration is its scope and

speed. When migration flows are slow and small, receiving countries can absorb them smoothly. Environmental change can push many people to migrate over a short period of time, particularly when the environment is their livelihood, generating relatively stronger forces leading from migration to conflict.

3. Empirical Research Design

This section develops an empirical research design in order to explore the implications of the theory presented in the previous section. One could conduct empirical research on environmental migration in three ways: (1) Measure individual calculations by interviewing migrants; (2) Collect data over many years and perform statistical analyses; and (3) Employ a case study methodology. Interviewing environmental migrants is typically not feasible, as it is hard to track migrants after the fact, particularly when episodes occurred decades ago. Databases that track details on environmental migrants over time and space are not available. The case study approach is the most viable option, however, it also has limitations. In particular, the exact details obtained from one case may not be applicable to other cases.

Facing these constraints, this paper takes a middle of the road, four-step approach. The first step illustrates the forces of environmental migration by focusing on two specific episodes. Three macro-oriented investigations follow this analysis. One investigation explores the empirics of global environmental change. If there is no global environmental change, environmental migration is a smaller issue. A second probe assesses the effects of natural disasters on population movements across the world's regions. Finally, the paper conducts a meta analysis from a large number of environmental migration episodes. The goal of the meta analysis is not to study episodes in detail, but rather to explore commonalities across them.

Choosing episodes for case studies is necessarily subjective. Recalling our goal to illustrate the forces of environmental migration, this paper focuses on two episodes that provide variation in terms of both the environmental causes of the migrations, and their political consequences. One episode took place in the U.S. during the 1930s, involving internal population movements leading to some violence between migrants and residents in an area of the migration's destination. A second episode has involved

internal and cross-border population movements originating in Bangladesh (East Pakistan before 1971) since the 1950s. These population movements have led to a high level of violence between migrants and residents in the areas of the migrations destinations.

Criteria for choosing cases for the meta analysis of environmental migration may include, for example, the level of economic development in the migrations' origins and destinations, the magnitude of environmental changes promoting the movements, the scopes of the migrations, and the intensity of the conflict between migrants and natives (as was done, for example, in the above choice of cases). Choosing cases in this way, however, means that selection is based on the dependent variable, and the results may not be generalizable. To lessen the effects of this potential problem, the meta analysis conducted here seeks to include all the episodes of environmental migration in the literature reports for recent decades.

The reader may note that the empirical exploration taken here may not tease out all the complexities of environmental migration, and does not speak directly to individual cost-benefit analyses leading to migration. These limitations, however, are not unique to this paper. The typical expectation is not that one paper can encompass everything empirically, particularly when processes are complex. There is room for additional empirical research. Moreover, rational choice models often assume certain preferences, which are often not observed. When the literature uses historical data, as is often the case, it is virtually impossible to measure preferences in retrospect. Therefore, studies focus on observable implications of models, which is the essence of the next three sections.

4. Two Episodes of Environmental Migration

This section illustrates the empirics of environmental migration from two episodes: the U.S. in the 1930, and Bangladesh (East Pakistan before 1971) since the 1950s.

Environmental Migration in the U.S.

In the 1930s, a prolonged drought in the Great Plains region of the U.S. coupled with strong winds to produce large dust and sand storms, eroding soil and reducing the quality of life. There were

other droughts and dust and sand storms on the Great Planes, but the ones of the 1930s were exceptional.[6] Carlson (1935: 333) described the storm of April 14, 1935, which was later dubbed as Black Sunday: "A black or yellow copper-brown cloud pokes its ugly head over the horizon... The impact is like a shovel full of fine sand flung against the face... Cars come to a standstill, for no light in the world can penetrate that swirling murk." Dust became the signature of the region. By 1935, people referred to the Great Plains as the Dust Bowl. By 1938, the storms had damaged 80% of the land in the Great Plains, 40% severely. About 13.5 million acres lost at least 2.5 inches of topsoil, and 10 million acres lost 5 inches.[7]

The drought was an important cause of the calamity, but it was not the only cause. The strong winds blowing in the Great Plains carried the dry topsoil. The generally low vegetation did not suffice to hold the soil in place. Overgrazing further stripped the land. The farmers plowed and tilled the land aggressively, loosening the connection of the topsoil to the ground. During World War I, demand for crops soared, further raising the rate of land utilization. This exhausted the soil's nutrients and, given the prevailing technique, further raised the rate of tilling and plowing. The crops themselves assisted in holding the soil in place. However, when the drought hit, fewer crops grew. Still the farmers continued to till and plow the land intensely. With less and less to hold it down, the topsoil blew in the strong wind.[8]

The land erosion reduced land productivity, cutting down yields. As agricultural outputs fell, many farmers were not able to keep up with loan payments, losing their lands in bank foreclosures. The environmental degradation "resulted in the aimless and desperate migration of thousands of families in search of some means of livelihood." By 1936, a government committee estimated that 165,000 people left the Great Plains. By 1938, 12-20% of the region's population left. A 1941 study finds that 982,000 people left during the 1930s. Recent studies concluded that about 2.5 million left the Great Plains in the

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[6] Other droughts, e.g., Kansas, 1893-94 (Fite, 1966); Montana 1917-21 (Toole,1959).

[7] The name "Dust Bowl" was introduced Apr 15, 1935 by Associated Press reporter Robert Geiger (PBS, 2002). See also Worster (1979) and Bonnifield (1979). Data: Hansen and Libecap (2004).

[8] Svobida (1986), Lee et al. (1999), Baumhardt (2001), UNCCD (2001).

1930s due to environmental degradation. Most of these people drifted to adjacent states or counties. Some people traveled far, of which the majority (about 300,000) went to California.[9]

The migrants were often not welcome in the receiving areas. In California, in particular, they became "targets of one ugly slur after another," often referred to as "Okies" (whether or not they came from Oklahoma), "no good bustards," or "ignorant filthy people." Some Californians believed that the Okies are "by God's inscrutable will, inferior men," and will remain so "until, by a stupendous miracle, He gives them equality among His angels... bribe them to be sterilized."[10]

Unable to buy houses in California, many migrants lived in poor camps along roads. Facing competition for jobs and land, local people urged the police to scatter the newcomers. Some Californians beat migrants, burned their shacks, and accused them of supporting Communism. In 1936, the city of Los Angeles sent policemen to stop the migrants at the state borders. Many migrants ended up working in corporate-owned farms, which paid them poorly and forced them to rent high-priced company-owned shacks and buy groceries at high-priced corporate stores. Other migrants left agriculture altogether, setting up residence at poor shanty-towns with names such as Okieville, without electricity and running water. The name Okies persisted for many years, as did the discrimination the migrants faced in California.[11]

Environmental Migration in Bangladesh

Unlike the circumstances in the U.S. case, population pressure played an important role in the case of Bangladesh (East Pakistan before 1971). Having one of the highest fertility rates in the world, the Bangladeshi population has grown quickly, reaching 86 million in 1980 and 131 million in 2000. By the

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[9] Great Plains Committee (1936:8). 1936 data: Great Plains Committee. 1938 data: Webb and Brown (1938). 1941 data: Gillette (1941). Adjacent states: Worster (1979), Deane and Gutmann (2003). 2.5 million: Worster, UNCCD (2001), PBS (2002). 300,000 to CA: Worster.

[10] Slurs, bums: Gregory (1989: 100). God: Worster (1979: 52).

[11] See, e.g., Davenport (1935), Worster (1979), Gregory (1989), PBS (2002). The US government assisted the people of the Great Plains in facing the environmental calamity, as discussed in Section 8.

1990s, population density reached 1000 people per km^2. About 42% of the people lived below poverty, and 85% lived in rural areas. Bangladesh's income per capita has been consistently one of the lowest in the world, and about half of it has come from agriculture. Population pressure played a role in causing land scarcity. Arable land per capita declined from the small level of 0.1 Hectares in 1979, to 0.07 in 1997.[12]

The growing population pressure exhausted much of the scarce land. Unable to make a living, some people moved to steeper hillsides, cleared trees and began farming anew. The farmers exhausted the steeper hillsides faster, since their inferior topography subjected these lands to greater erosion. The country's topography and climate exacerbated the land pressures. About half of Bangladesh is located a few meters above sea level, and about a third is flooded in the rainy season. The floods recharge the land with nutrients, but they also constrain the accessible land, intensifying land scarcity. The country also has been hit often by natural disasters. In 1976-2001, droughts affected 25 million people, floods affected 270 millions of people, and rain and wind storms affected 41 million people.[13]

The Indian Farakka Barrage has made things worse. Completed in 1975, the Barrage diverts water from the Ganges river to its Indian tributary, reducing the flow of water in the Bangladeshi tributary. As a result, salt water intrusion into the Bangladeshi channel intensified, land productivity fell, and river fishery declined. The lower water flow reduced silt conveyance and raised the river-bed, leading to more floods and erosion, adversely affecting about 35 million people.[14]

Since the 1950s, 12 to 17 million Bangladeshis migrated to India (often illegally), moving mostly to the adjacent states of Assam and Tripura. When asked why they moved, they often provide natural

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[12] Fertility: AAAS (2000). Population, income, poverty: WDI (2002, 2001). Rural population: Myers (1995). Arable land: WDR (1999).

[13] One third: Lee (2001). Natural Disasters: CRED (2002). See also Lee (2001), Homer Dixon (HD) (1999; 1994), HD and Percival (1996), Barashi (1991), and Boyce (1990).

[14] Swain (1996), Lee (2001), Rahman (1984).

disasters, land scarcity and degradation and poverty as reasons. About 2 million moved to India's West Bengal from the Kulna region in Bangladesh, which was hard-hit by the Farakka Barrage. About 400,000-600,000 people moved internally to the Chitagong Hill Tracts (CHT).[15] Other factors also promoted the migration. Unequal land distribution intensified the land scarcity. Inheritance norms led to division of lands among family members, resulting in plots that were too small to support a living. The relatively higher standard of living and lower population density in India attracted the Bangladeshis. Bengalis saw the region as greater Bengal, ignoring borders. Finally, the Bangladeshi government called on the Bengalis to move to CHT, seeking to "Bengalize" the largely non-Bengali region.[16]

The Bengali migrants altered the economy, land distribution and political power balance in the receiving areas. In Assam, the non Bengali natives have long resented the Bengali newcomers, which we can trace back to the colonial era when the British installed Bengalis as regional officials. India's Congress party supported the migration, seeking to limit the native's power. The Assamese accused the new comers of stealing their lands. Native-migrant violence erupted in the early 1980s. The Indian government offered to deport illegal migrants arriving after 1971, but the Assamese rejected the offer. They demanded to exclude the migrants from the 1983 elections, and boycotted the vote. As the violence intensified, thousands were killed on both sides, including 1700 Bengalis killed during a five-hour rampage in 1983.[17]

Unlike in the state of Assam, in the state of Tripura the original, primarily Buddhist or Christian people became the minority due to the Bengali migration. By 1981, they consisted of only about one third

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[15] 12-17 million migrants: HD (1999), Suhrke (1997), Hazarika (1993). 2 million: Swain (1996). 400,000-600,000: Lee (2001), Hassan (1991). About 1-2 million moved due to the 1971 war (HD). Environmental reasons: Lee, HD, Swain.

[16] HD (1999, 1994), HD and Percival (1996), Abbott (1991), Boyce (1987). On the other factors promoting migration to CHT, see Lee (2001), Hassan (1991).

[17] HD (1994), Suhrke (1997; 2001), and Weiner (1983) provide an overview. Casualties: 1700, Kalbag (1983), Swain (1996), HD (1999); pre 1983, 3000, Swain (1996); 1983, 3000-5000, Suhrke, (1997); early 1980s, 4000-5000, HD and Percivel (1996), Hassan (1991).

of the total population, down from about 90% in 1947. Resentful and increasingly competitive with Bengali migrants over land and resources, the native people turned to violence, which raged from 1980 to 1988. The Indian government tried to calm the local outrage in the 1990s by returning land to Tripuris owners, and by tightening the controls over migration. However, the migration and the violence continued, albeit at a lower intensity.[18]

The CHT region has been home to about one percent of the Bangladeshi population. Before 1964, the Pakistani government followed the British in prohibiting Bengali migration to the predominantly non-Muslim CHT.[19] As the Bengali migration intensified after 1971, the local tribesmen demanded to renew the pre-1964 prohibition on Bengali migration. However, in 1975 the Bangladeshi government refused to do so. The natives turned to anti-migration violence. The Bangladeshi government sent an army to the region, armed the settlers, and forced many tribesmen to move to army-controlled villages. The violence escalated in the 1980s, killing about 3000 rebels, civilians and soldiers in 1980-1991. In 1992, the Bangladeshi army apparently killed 1000-2000 civilians, in response to the killing of Bengalis, which the government denies. In late 1997, the government and the rebels signed a cease fire agreement, but the situation in CHT remained volatile and tense.[20]

Synthesis

The environmental migrations in the U.S. and Bangladesh share several elements, all of which support the theory of this paper. In both cases, the migrants depended on the environment for livelihood, and there was substantial environmental degradation. When the environmental conditions deteriorated, many lost their source of livelihood, and their quality of life declined significantly. They leaved their

[18] See Hazarika (1993), HD (1994), HD and Percival (1996).

[19] See Lee (2001), Shelley (1992), and Trimm (1991).

[20] Insurgency: Mey (1984) Lee (2001: 44). Dead: 3000, Lee (2001); 1000, Shelley (1992). 1992 violence and crease fire: Lee (2001), UNHCR (1992). Recent turmoil: UNHCR (2003).

homes in search of better life and a more hospitable environment. In both cases, the migrants were not welcome in the receiving areas; their arrival led to violence between migrants and residents.

There are also differences. In the U.S., the migrants and residents were of the same nationality and, by in large, ethnicity and religion, which helps to explains why the resident-migrant violence in California, while substantial, was not militarized. In Bangladesh, the migrants and residents have been of different ethnicity, religion, and, in most cases, nationality. In some cases, relations were tense before the migration. All of these forces played a role in the militarized violence in receiving area.

5. The Empirics of Global Environment Change

The previous section illustrates the role of environmental degradation in internal and cross border migration and conflict between migrants and residents. What are the global implications of these forces? Are the forces observed in the American and Bangladeshi episodes relevant for migration in other regions? To answer these questions, we first need to investigate the empirics of global environmental change.

This section focuses on some of the most salient changes: the availabilities of arable land and fresh water, and the scope of land degradation, deforestation, and natural disasters. Arable land is used for pasture, crops such as wheat, and various gardens. Since it includes most of the world's agricultural-land, arable land per capita indicates food availability. Fresh water is a life-sustaining resource; contaminated sources threaten societies with water-born diseases. Land degradation reduces land productivity, arable land availability, harvest size and farm income, and diminishes water supply due to runoff, erosion, sedimentation, and flooding (Bot et al., 2000; Vital Signs, 2002). Deforestation reduces the availability of fresh water, as about 40% of the world's population depends on water absorbed by mountain-range forests, as well as destroys protective vegetation, promotes flooding, and intensifies land erosion and desertification (HDR, 1998). Natural disasters can damage or destroy infrastructures, and injure or kill

people. As discussed in Section 6, scientists expect that climate change will amplify many f these issues.[21]

In 1998, arable land per capita was 1.95 hectares in Oceania, 0.75 in North America, 0.42 in Europe, 0.35 in Latin America and the Caribbean, 0.27 in Africa, and 0.18 in Asia (AAAS, 2000). Sub-regions with particularly limited arable land per capita included East Asia (0.10), South Asia (0.16), the Middle East and North Africa (0.20) and Sub-Saharan Africa (0.24) (WDI, 2002).

In 2000, 1.1 billion people lacked access to safe water. Of these, 693 million were in Asia, 300 million were in Africa, and 78 million were in Latin America (Vital Signs, 2001). In relative terms, in the 1990s, 46% of the people in Sub-Saharan Africa, 29% in Southeast Asia and the Pacific, 32% in East Asia, 22% in Latin America, 18% in South Asia, and 17% in Arab states lacked access to safe water (HDR, 2000). Using a related measure, in 2000, 34% of the rural population in East Asia, 38% in Latin America, and 59% in Sub-Saharan Africa did not have access to improved water sources (e.g., household connections) (WDI, 2002).

Land degradation is measured in four levels: light (reduced productivity), moderate (greatly reduced productivity), severe (largely destroyed, non reclaimable at farm level), and very severe (fully destroyed, non reclaimable) (FAO, 2000). In the 1990s, the percentage of severely and very severely degraded land in Europe was 48%, North Africa and the Near East 34%, Asia and Pacific 29%, South and Central America 27%, Sub-Saharan Africa 25%, North Asia 21%, and North America 16%.

During 1980-1990, South America deforested 60.3 million hectares, Africa 48.9 million, Asia 45 million, and Central America 3.7 million; Europe reforested 3.8 million hectares. The average annual change in forest area was -0.8% in Africa, -0.75% in Asia, -0.7% in South America, -0.4% in Central America, and 0.27% in Europe (World Resources, 1999).[22] During 1990-2000, the data are similar: Africa

[21] Production accidents and development projects are not necessarily related to climate change and therefore are not discussed here.

[22] For 1980, data for Asia and Europe are from FAO (1997); data from North America and Oceania are not available.

deforested 52.6 million hectares, South America 37.1 million, Central America 3.3 million, Asia 3.6 million, and Oceania 3.7 million hectares (FAO, 2001).[23] The US and Canada reforested 3.9 million hectares, and Europe 8.8 million. The average annual percent change in forest area was -0.8% in Africa, -0.4% in South America, -0.1% in Asia, -0.2% in Oceania, 0.1%, in Europe and 0.8% in the US and Canada.

We compile the number of natural disasters from the CRED (2002) database. During 1975-2001, Africa had 254 droughts, Asia 117, Latin America 66, Oceania 22, Europe 22, and North America 12. Africa experienced 43 famines, Asia 16, Europe 2, Latin America 1, and Oceania and North America none.[24] The largest number of floods occurred in Asia (737), followed by Latin America with 355, Africa with 312, Europe with 237, North America with 97, and Oceania with 70. Asia had 726 windstorms (e.g., typhoons, cyclones, hurricanes, tornados), North America 307, Europe 220, Latin America 218, Oceania 161, and Africa 105.

Logically, regions whose livelihood depends on agriculture are more likely to experience the adverse effects of environmental degradation, ceteris paribus.[25] People in these regions are therefore more likely than others to migrate when facing environmental problems. Thus, it is essential to consider the economic importance of agricultural activity. The shares of labor force employed in agriculture in 2000 were 58% in Africa, 51% in Asia, 24% in Central America, 18% in Oceania, 14% in South America, 8.6% in Europe, and 6% in North America. In Sub-Saharan Africa and South Asia the agricultural employment shares were highest: 66% and 58.5%, respectively (FAO, 2002). In 1999, the share of agriculture in GDP was 2.4% in high-income countries, 9.4% in medium-income countries, and 23.1% in low-income countries (HDR, 2000). In 2001, the shares were 25% in South Asia, 17% in Sub-Saharan

[23] Reforestation in China and Japan drove the decline in Asia's deforestation in 1990-2000 relative to 1980-1990; without these two countries, Asia was deforested by 21.7 million hectares.

[24] The famines in Europe occurred in Albania and Macedonia.

[25] I define agriculture broadly to also include ranching and pastoralism.

Africa, and 2% in Western Europe (WDI, 2002).

6. The Empirics of Environmental Migration

The previous section shows that in recent decades, Asia, Africa, and Latin America have had more environmental degradation than Europe and North America. We also see that countries in Asia, Africa and Latin America – mostly LDCs – depend more on the environment for livelihood than countries in North America and Europe – mostly DCs. This section explores implications of these findings for migration throughout the world. We will first evaluate the effect of natural disasters, and then conduct a meta analysis from a large of number environmental migration episodes.

Natural Disasters

Panel A of Table 1 presents numbers of people affected by droughts, famines, floods and windstorms during 1975-2001, compiled from the CRED (2002) database. CRED defines "affected by a disaster" as people needing immediate assistance with food, shelter, water, or medical help, and people left homeless." Some of these people may decide to migrate, particularly when disasters are frequent and intense. **[Insert Table 1]**

Droughts affected 1.096 billion people in Asia, followed by Africa (221.9 million), Latin America (47.89 million), Oceania (8.65 million), Europe (6 mil.) and North America (30 thousand). Famines affected 49.9 million in Africa, followed by Asia (7.5 million), Europe (3.21 million), and Latin America (1 million); in Oceania or North America there were no famines. Floods affected 2.12 billion in Asia, followed by Latin America (40.41 million), Africa (28.93 million), Europe (7.73 million), North America (830 thousand), and Oceania (498 thousand). Windstorms affected 415.95 million in Asia, followed by Latin America (21.96 million), Africa (9.1 million), Europe (7.57 million), Oceania (5.55 million) and North America (2.64 million).

On average, a drought affected 9.36 million people in Asia, followed by Africa (870 thousand), Latin America (720 thousand), Oceania (390 thousand), Europe (270 thousand), and North America (2.5

thousan).[26] In Africa, a famine affected 1.16 million people on average, Europe 1.6 million, Latin America 1 million, and Asia 470 thousand.[27] On average, a flood affected 2.88 million people in Asia, 110 thousand in Latin America, 93 thousand in Africa, 32 thousand in Europe, 8.5 thousand in North America, and 7 thousand in Oceania. A windstorm affected 570 thousand people in Asia on average, 100 thousand in Latin America, 87 thousand in Africa, 34 thousand in Europe or Oceania, and 8.6 thousand in North America.

We can gain insight as to the magnitude of migration due to these disasters by further utilizing the CRED (2002) database. During 1975-2001, the number of internally displaced people due to these disasters was 9.45 million in Asia, 4.67 million in Africa, 870 thousand in Latin America, 21 thousand in Europe, and 13 hundred in North America. These numbers may underestimate the full impact since they do not include individuals crossing borders.

In sum, the largest numbers of people that hydro-meteorological disasters affect are found in Asia, Africa and Latin America, which reflects the pattern of dependence on the environment for livelihood.[28]

Meta-Analysis

Table 2 assembles data on 38 episodes of environmental migration. This set includes all the episodes for which I found information (see the Appendix). The meta-analysis explores patterns across cases. For each episode, Table 2 lists the origin and destination of migration; time period; environmental and non-environmental push factors; number of migrants; and the nature of conflict in the migration's

[26] For example, the number of people affected per drought in Africa is 870 thousand (221.9 million from Panel A of Table 1 divided by 254 droughts from 1975 to 2001, reported above).

[27] The numbers of people a famine affects on average in Europe and in Latin America need to be interpreted with caution, as there were only two famines in Europe and one famine in Latin America.

[28] It may also reflect higher population density, more intense disasters, fewer defenses, and weaker infrastructure, the relative importance of which deserves more research.

destination. Several sources per episode are used in order to increase confidence in the data. Sources generally agree, but in some instances the numbers of migrants varies. I use the highest number reported to provide an upper boundary. **[Insert Table 2]**

In Table 2, 36 episodes occurred in LDCs and 2 in DCs. Across regions, 15 episodes occurred in Africa, 12 in Asia, 8 in Latin America, 2 in North America, and 1 in the Russian Arctic. This distribution reflects the global distributions of environmental change and dependence on the environment for livelihood (Section 4). Thus, regions that exhibit more environmental degradation and depend more on the environment for livelihood also experience more environmental migration.

Some of the 38 cases in Table 2 involve multiple factors. Environmental migration is associated with land degradation in 27 cases, drought in 19, deforestation in 17, water scarcity in 15, floods in 9, storms in 7, and famine in 5 cases. These factors operate against a background of underdevelopment, poverty, high population density and growth rate, and inequality. In the typical scenario, governments of LDCs do not have financial resources to encourage people to stay in place and defend against declining environmental conditions. By the time international relief organizations provide aid, many people are already on the move. Turning to political factors, conflict in the origin of the migration was present in 11 episodes. The role of government policymaking was a factor in six episodes, promoting one region at the expense of another, or offering incentives to migrants. Repression and persecution were present in four episodes. These findings support the theoretical framework of this paper.

Consider next the issue of crossing borders, and the number of migrants. Nineteen of the thirty eight cases involve intrastate movements. In 6 cases, migrants crossed borders; 13 cases involved internal and cross-border movements. These support our theory: environmental migration can involve either internal or cross-border movements. The highest number of migrants occurred in Bangladesh (East Pakistan before 1971) (12-17 million), the Sahel region of Africa (10 million), followed by Brazil (8 million), Philippines (4.3 million), Sudan (3.5-4 million), Somalia (2.8 million), and the U.S. (2.5 million).

Table 2 indicates that factors associated with migrant-resident conflict in the area of the migration's destination include ethnic tensions, tensions over use of land, income and wealth inequality, resource scarcity, and migration across rural areas. All of these factors support the theoretical framework. However, as noted in section 3, environmental migration does not necessarily promote conflict. Furthermore, out of the 19 cases that did not experience conflict in the receiving area, 10 cases involved migration from rural to urban centers. This suggests that the urban factor probably was not the most important factor in these cases.

In sum, environmental migration occurs primarily in LDCs. The environment is not the only push factor, but it plays a defining role in this migration. Environmental migration can lead to conflict between migrants and residents of the receiving area, particularly in the presence of poverty, resource scarcity, dependence on the environment for livelihood, and existing tensions between migrants and residents.

7. Climate Change

Scholars predict that climate change will induce considerable environmental degradation during this century. This section outlines the basics of climate change and evaluates implications for migration.

In the 20th century, there have been systematic patterns of climate change (IPCC, 2001a). For example, the frequency and duration of warm periods rose, glaciers retreated, and the sea-level rose approximately 20 centimeters. Since the 1950s, average global temperature has risen about 0.1^{0}C per decade, winter snow covers have declined approximately 10%, summer Northern sea ice coverage fell 15%, Northern ice thickness fell 40%, and the frequency and intensity of droughts and storms have increased. The IPCC attributes most of these changes to carbon emissions from fossil fuel burning.

Forecasts of future climate change differ in assumptions, including the type of energy used, population growth, economic growth, policy coordination, preferences for sustainable development, and technological progress (IPCC, 2001b). However, all forecasts predict considerable global environmental degradation, including a rise in sea-level, inundation of coastal areas, more intense and frequent extreme weather events, changes in temperatures and precipitation, declining fresh water resources, and falling

soil productivity. The previous section suggests that these forces play a role in migration.

To gain insight on the magnitude of migration due to climate change, I focus on sea-level rise – the most direct channel leading from climate change to migration. Evaluating the effect of other changes would require associating patterns of expected degradations with data on dependence on the environment for livelihood, population density, water use, and vulnerability to disasters. This very large task will have to wait for future research. However, it should be noted that if these forces are strong, they would likely increase the magnitude of migration relative to the numbers discussed here.

Table 3 presents predicted effects of a one meter rise in sea-level, assuming no adaptation measures are taken.[29] In Asia, more than 117 million people are exposed to inundation, in Europe 13.5 million, in Africa 12 million, in Latin America 760 thousand, and in Pacific islands 300 thousand. Bangladesh may loose 21% of its land, Vietnam 12%, the Netherlands 5.9%, Germany 3.9%, Senegal 3.1%, Japan 2.4%, Malaysia 2.1%, and Guyana 1.1%. Several islands in the Pacific may be completely submerged. **[Insert Table 3]**

Moreover, approximately one billion people live at sea level or a few meters above. Sixteen of the world's nineteen largest cities (population above 10 million) are located on coastlines. Twelve of these sixteen cities are in LDCs. The implications are daunting. For example, assuming no adaptation, a one meter sea-level rise will displace about 4 million in Alexandria (Egypt), 3 million in Lagos (Nigeria), and 6 million in Shanghai (China) (WDR, 2002; WR, 1999; IPCC, 2001c).

Facing climate change people have several options; they can build defenses, do nothing and accept a decline in quality of life, or leave affected areas. Naturally, it is harder to defend against extreme change than to moderate change. Adaptive capacity is another factor. For example, adapting to sea-level

[29] Cases 1-6 are from IPCC (2001b); case 7 from Gommes and du Guerny (1998), cases 8, 10-15, 17-19 from IPCC (2001c); cases 9, 16 from Nicholls and Leatherman (1996); and cases 20, 21 are from WDR (2002). Populations are from mid-1990s; for cases 20-21, they are from 2001.

rise by building coastal defenses is likely to be lengthy, complex and expensive.[30]

In the absence of adaptation, climate change is expected to hit LDCs harder than DCs (IPCC, 2001b, 2001c). Key concerns in LDCs include threats to food security and health, economic decline, inundation of coastal areas, and (in some cases) physical existence. Key concerns in DCs generally are less extreme and more localized, including coastal erosion, damage to coastal property, adverse impacts on tourism, rising insurance costs, and declining crop yields. At the same time, LDCs have a lower capacity to adapt to climate change than DCs due to poverty, less technological advancement, and higher dependence on the environment for subsistence. The likelihood of climate change-induced environmental migration is therefore higher in LDCs than in DCs.

It is generally agreed that in the absence of adaptation, the effects of climate change are likely to be costly. Yet the exact scope and geographical distribution of the costs is not fully known. Mitigating the effects of climate change also will likely be costly. Facing uncertain, yet high costs, one could take a "wait and see" approach; or one could act sooner assuming that costs will escalate. This tension stands at the center of the last section of the paper.

8. Public Policy Implications

This paper seeks to gain insight into the expected effects of climate change on migration and conflict. The theoretical argument focused on the possibility of either migration or defense in response to environmental degradation; and the possibility of conflict in the migration's destination. The empirical analysis employed recent history as a laboratory. The results from two case studies and three macro-oriented analyses supported the paper's theory.

What are the policy implications of these findings? Answering this question requires defining the policy goal and the policymaking audience. Assuming the goal is minimizing prospects for environmental

[30] For example, it took decades for the Netherlands to build defenses along its Northern Sea Coasts (Allen, 1998). It is estimated that the cost of defending the Japanese cities of Nagoya, Tokyo and Osaka from a 1 meter rise in sea-level is $80 Billion (IPCC, 2001c).

migration due to climate change, two audiences come to mind: the governments of DCs and LDCs. Unlike DCs, LDCs probably will not be able to defend against climate change damages on their own (IPCC, 2001b, 2001c). I therefore write this section for policymakers in DCs, but can public policy mitigate environmental migration? Once again, we can gain insight from history.

Similar to the 1930s, in the 1890s and 1910s, droughts provoked migration from the U.S. Great Planes. While the drought in the 1930s was one of the worst in US history, "the percentage decline in population in hard-hit drought areas [of the Great Plains] was considerably less than those of previous droughts (Warrick, 1980:111)." The reason for the difference had to do with public policy. In January 1935, the federal government formed the Drought Relief Service to coordinate aid to farmers. In April 1935, congress established the Soil Conservation Service, declaring soil erosion "a national menace." The new service developed techniques that would guard against soil erosion, and paid farmers to use them. These policies encouraged adaptation-in-place, and reduced the extent of migration (Warrik, 1980; O'neal et al., 2001, PBS, 2002). Canada also had large migration due to the drought of the 1930s; and while the drought in the 1980s was more severe than in the 1930s, migration was not a major problem in the 1980s because public policy encouraged adaptation-in-place (Rosenzweigh and Hillel, 1993; IISD, 1997). Similar public policies generally were undertaken to a much smaller extent in Bangladesh. The U.S. of the 1930s, while less developed than today, was relatively more able and effective than the Bangladeshi government in promoting adaptation-in-place.

It is apparent that public policy can alleviate environmental migration from droughts. Which policy approach could minimize environmental migration from climate change? It is useful to begin this discussion with a survey of current migration patterns. In 2000, 60% of the world's 175 million migrants lived in DCs (IMR, 2002). Since systematic flow data are not available, it is hard to make exact statements about origins and destinations. However, it is generally agreed that migration pressures of LDCs (often referred to as the South) on DCs (the North) are rising (Martin and Widgren, 2002; Hatton and Williamson, 2002, Refugees, 2002). For example, BCIS (2003) estimates that each year 350 thousand

people enter the US illegally, and Hatton and Williamson (2002) estimate that 500 thousand enter Western Europe. The number of unauthorized foreign residents in the US has reportedly risen from 3.9 million in 1992 to 7 million in 2000 (Martin and Widgren, 2002; BCIS, 2003). Most of these migrants are from LDCs. Almost all of the 20-25 million internally displaced persons in the world are in LDCs (USCR, 1999, 2002a; IMR, 2002; WDR, 2002), as were 13 million out of 16 million refugees (people who flee across borders due to persecution and war) in the world at the end of 2000 (IMR, 2002). In 2000, 560 thousand people from LDCs sought asylum in DCs, and 1 million awaited final decisions regarding their request for asylum in DCs (Hatton and Williamson, 2002). Facing these pressures, in recent years the DCs have made entry from LDCs more difficult (Andreas and Snyder, 2001; IMR, 2002; Wood, 2001).

These pressures, and particularly the possibility of large climate change-induced environmental migration in LDCs, pose an ethical problem to DCs, the spirit of which goes back to Hardin (1974). He pictures rich people who live on a few well-equipped and relatively empty life-boats. Poor people live on many ill-equipped life-boats, filled almost to capacity and seek to join rich boats. If the rich boats were to admit all the poor people, they would sink. They could admit some poor people, but who should be excluded? They also could reject everyone. Poor people then face four choices: move across poor boats, change places within poor boats, jump into the water, or sneak into a rich boat. Metaphors, of course, simplify the real world. In reality environmental migration across and within boats can promote conflict.

Some scholars believe that human ingenuity will solve all problems (e.g., Simon, 1996). This view is debated, but accepting it for the moment, innovation is not instantaneous. The burning of fossil fuels, which propels the global economy, drives climate change. Energy substitutes for fossil fuels are not well developed; and thus far, nations have not agreed on strategies to mitigate climate change. Thus, we can expect climate change to intensify in coming years.

LDCs will likely experience more climate change-induced migration and therefore more conflict than DCs. However, the political fallout may extend beyond LDCs. Large scale migration is likely to

promote bad feelings, fostering a fertile atmosphere for global terrorism recruitment. Environmental migration could also increase friction between major powers. For example, China, might accuse the DCs' over-reliance on fossil fuels of driving environmental migration from its coastal zones due to a rising sea-level, and might demand compensation for damages. Key allies of DCs in the developing world could experience environmental migration-induced conflicts, drawing major powers into disputes.

An unequal international distribution of income exacerbates the problem. LDCs cannot adapt easily to climate change, but DCs generally ignore this point. This is ethically problematic because DCs are the primary source of climate change, but the problem goes beyond ethics. Historically, highly skewed national distributions of income were politically unstable (e.g., Russian revolution). The current situation is more dangerous, since some LDCs have, or try to obtain, nuclear, biological or chemical weapons. Obviously, environmental migration may not lead to conflict, localized conflict may not spread, and international conflicts may be resolved diplomatically. Historically, however, environmental migration played a role in violence, local conflicts have spread, and many international conflicts became violent.

It is tempting to argue that economic growth in LDCs will solve the problem eventually, but this approach faces a dilemma: prosperity in LDCs will considerably raise their demand for energy and, with the current technology, accelerate climate change. A better policy approach is to preemptively counter expected costly effects of climate change, particularly in the LDCs that are most vulnerable to environmental migration. It is possible to illustrate this approach with two examples. Consider building defenses against rising sea level. This project requires design, technological sophistication, and financial resources, all of which LDCs cannot arrange quickly. A second example involves reducing the economic dependence of LDCs on the environment. This task also is complex and LDCs cannot implement it quickly. Delaying these efforts until climate change begins to generate large costs may result in the dislocation of millions of people before policymakers find a suitable resolution.

Adapting to climate change is costly. Where would the required funds come from? In

considering this issue, it is helpful to recall that the primary cause of climate change is the over-reliance of DCs on fossil fuels. The principle of “the polluter pays” is implemented by most DCs at home. Extending this principle to the international arena implies that DCs should finance most of the efforts required to defend LDCs against climate change effects. One way to finance this plan would be to increase taxes in DCs. The extra revenue could be used to finance adaptation to climate change.

The implementation of this approach is problematic. Since socioeconomic-ecological processes are slow, the benefits may not be readily apparent, and policymakers may face temptation to divert the tax revenue to other uses. Also, there may be problems of international collective action. DCs are likely to reject this program. The proposed approach may be initiated in response to a climate change-induced massive ecological-social-political crisis. However, such a crisis may cause irreversible damages. Thus, whether DCs accept this program depends mainly on attitudes toward risk. While exact figures are still not known, if we continue with business as usual, the expected cost of climate change-induced environmental migration will likely rise. This supports adopting the proposed approach sooner, rather than later.