International Review of Environmental and Resource Economics, 2016, 10: 37–56

Natural Disasters and Human Mobility

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ABSTRACT

This paper reviews the effect of natural disasters on human mobility or migration. Although there is an increase in natural disasters and migration recently and more patterns to observe, the relationship remains complex. While some authors find that disasters increase migration, others show that they have only a marginal or no effect or are even negative. Human mobility appears to be an insurance mechanism against environmental shocks and there are different transmission channels which can explain the relationship between natural disasters and migration. Moreover, migrants' remittances help to decrease households' vulnerability to shocks but also dampen their adverse effects. This paper provides a discussion of policy implications and potential future research avenues.

Keywords: Natural disasters, forced migration, channels, remittances, migration as insurance, floods, earthquakes, droughts

JEL Codes: J61, O15, Q54, Q56

*We thank Zac Rolnik for his encouragements, the Editors including Henk Folmer for their careful reading and important suggestions, and Victoria Finn for editorial remarks.

ISSN 1932-1465; DOI 10.1561/101.00000082

1 Introduction

Natural disasters are often considered an important driver of migration. However, historical evidence shows that this relationship is not new and has existed since the beginning of human history. Nevertheless, the reactions are not well documented and the implications are not yet fully understood, although the incidences of natural disasters and migration seem to have increased with more possibilities to study the evidence. The issue is very likely to become more relevant in the long run with global warming. Analyzing the short-term implications and the possible adjustment mechanisms is important, since this enables the introduction of reaction mechanisms to better deal with the consequences of a crisis. For instance, the migration response to a natural disaster is complex, it can be strong, moderate or even negative. People may be displaced and leave pushed by the challenges, or even move to the affected areas due to the new potentials arising.

The relationship between environmental disasters and migration is possibly one of the biggest challenges that future generations will face. Why is the relationship between natural disasters and migration so controversial? What are the transmission channels between natural disasters and migration? What are the consequences of migration decisions following natural disasters? This paper provides an overview of the literature on these specific points. The effect of natural disasters on migration is crucial because it has serious implications on economics, demography, and sociology. Subsequently, we draw on literature in these three areas.

This paper is structured as follows. Section 2 defines the topic and documents empirical trends. Section 3 explores the migration decision under the occurrence of natural disasters. Section 4 presents the transmission channels that can explain the relationship between natural disasters and migration. Section 5 discusses the consequences of the natural disasters on migration decision. More precisely, we assess if migration and associated remittances can help mitigate the environmental disasters' negative consequences, as well as the consequences in terms of other outputs. The last section presents the concluding remarks.

2 The Research Issue and Empirical Trends

A good reference introducing into the historical dimension of the topic is provided by Belasen and Polachek (2013), while we focus here more on historical empirical evidence since the mid-19th century to more recent events. Gottschang (1987) documents migration driven by natural disasters such as floods and droughts in Northern China and Manchuria from 1890 to 1942. Boustan *et al.*, 2012 use panel data from 1920 to 1940 in the United States (US) and consider disasters such as floods, tornadoes, earthquakes, and hurricanes in a context where migration is a self-protection mechanism. They show that young men leave areas affected by tornadoes to settle in areas affected by floods. In the same country during the 1930s, Hornbeck, 2012 documented how the Dust Bowl, caused by severe drought and intensive land use, had serious consequences on population decline in areas with high and medium erosion between 1930 and 1950.

Cross (2013) examines the period 1992–2008 to see how US communities deal with natural disasters such as storms, hurricanes, river flooding, and tornadoes in terms of demographic changes. He found post-disaster relocation as well as more loss of population in small communities. This effect is related to the communities' level of wealth. Hurricane Katrina in 2005 was the major recent disaster that heavily impacted the US (Gutmann and Field, 2010; Vigdor, 2008) and induced the migration of 10,000 people in 26 states of the United States.

Based on a study from 1980 to 2009, Afonso (2011) shows that severe tropical storms induce migration in Central America and the Caribbean. Hanson and McIntosh (2012) are interested in migration between 25 Latin American and Caribbean countries and Canada, Spain, the US, and the UK from 1980 to 2005. They found that labor supply, demand shocks, and natural disasters are push factors for migration from Latin America to the US while this is not the case for migration to the other countries.

Furthermore, both developed and developing countries are already dealing with an increase in the severity of disasters and their effects. Figures related to natural disasters are both impressive and alarming.

In developing countries such as Indonesia, a tsunami caused 500,000 victims in 2004 (Smith, 2007). Although the number of victims due to disasters decreased compared to the decade 1990–2000, it still remains high. According to the Annual Disasters and Statistical Review 2014 (Guha-Sapir *et al.*, 2015), the annual average number of victims between 2004 and 2013 is estimated at 199.2 million people around the world. Economic damages from natural disasters are estimated at USD 99.2 billion in 2014.

The attached figures from the online appendix provided by Drabo and Mbaye (2015) document recent empirical evidence. The graphs show the trends of both natural disasters and migration from 1975 to 2000 with a focus on developing countries. For all regions of the world, natural disasters and migration exhibit an increasing trend over the period. The only exception was for Central Europe and Central Asia, where there was a decrease before 1990 but an increase then followed.

The Centre for Research in Epidemiological Disasters (CRED) considers all disasters sub-groups of extra-terrestrial disasters. Consequently, the term natural disasters include those that are geophysical (earthquake, mass movement, volcanic activity), meteorological (extreme temperature, fog, storm), hydrological (flood, landslide, wave action), climatological (glacial lake outburst, wildfire), and biological (epidemic, insect and animal infestation).

In the literature, different types of variables have been considered that pertain to the relationship between environmental factors and natural disasters. For instance, Reuveny and Moore (2009) found that environmental degradation, including both storms and land scarcity, increases out-migration. Other studies showed that weather anomalies measured through long-term deviations of rainfall and temperature are a migration determinant in Sub-Saharan Africa (Barrios *et al.*, 2010; Marchiori *et al.*, 2012). Beine and Parsons (2015) are interested both in long-term environmental factors with the use of rainfall and temperature data and short-term variables measured through natural disasters.

In this paper, we use the CRED's natural disasters definition, which relates to short-term shocks, and we also consider a broader concept of disasters that includes weather anomalies in a long-term perspective.

3 Natural Disasters and Migration: A Controversial Relationship

To date, there is no consensus on the impact of natural disasters on migration. Studies by Black (2001) and Piguet and Pecoud (2011) highlight the need to relativize the scope of the natural disaster effect on so-called environmental refugees. The mixed evidence related to the role of disasters on migration is probably due to the fact that this relationship is complex and less straightforward than perceived by common knowledge.

Reuveny and Moore (2009) highlight the positive effect of environmental degradation on migration to developed countries. Drabo and Mbaye (2015), based on a study that focuses on developing countries, show that natural disasters mainly related to climate change increase overall migration. They specify in their study that this effect is driven by the most educated people, who can afford migration costs. Robalino *et al.* (2015) study the impact of hydro-meteorological disasters on internal migration in Costa Rica from 1995 to 2000. They find that there is a difference in the migratory response depending on the severity of shocks. On average, emergencies increase migration. However, those with the most severe consequences, measured in terms of death people, decrease migration. Gray and Bilsborrow (2013) confirm that climate variability may increase migration but the relationship is complex and presents some non-linearities. Using retrospective migration survey and data on topography, climate and weather shocks, they find that negative environmental shocks do not necessarily increase rural out-migration and can even decrease it. While internal migration does not necessarily respond to rainfall shocks, international migration is significantly influenced by environmental shocks.

Some studies find that environmental factors lead to both internal and international migration. This holds true for Marchiori *et al.* (2012), who find that weather anomalies may cause both internal and international migration in Sub-Saharan Africa. However, other studies show that seasonal and circular migration are more common than international mobility in the case of environmental shocks. Gray (2009) uses empirical evidence from Ecuador and shows that adverse environmental conditions do not necessarily increase out migration but do have an effect on internal migration. This has been confirmed by Beine and Parsons (2015) in a macroeconomic study; however, this internal effect

depends on regions. For instance, Barrios *et al.* (2006) find an increasing effect of climate variables on internal migration only in Sub-Saharan Africa.

On the other hand, Deng (2011) explores the relationship between natural disasters and urban insecurity in China with rural–urban migration as a channel. Using Chinese data from 2002, her findings show that while natural disasters only slightly increase migration, they impact the composition of migrants in a structural way. Natural disasters force rural inhabitants to move while they would have stayed without the occurrence of these shocks. Moreover, in terms of wages, they earn less in urban areas than their counterparts, which may lead to an increase in urban insecurity.

Nonetheless, other evidence highlights the fact that long-term migration responds less to natural disasters than short-term migration. Henry *et al.* (2004) and Findley (1994) show in the case of West Africa (Burkina Faso and Mali, respectively) drought causes temporary and permanent migration to rural areas that have higher levels of rainfall. However, this effect depends on the destination and duration of migration.

Different types of disasters can cause different types of migration. Using multivariate events-history models with panel data from Bangladesh over the period 1994–2010, Gray and Mueller (2012a) show that floods only have marginal effects on migration. However, they mainly affect women and the poorest are not necessarily the most affected. On the other hand, crop failures highly influence migration. Finally, they suggest that natural disasters related to climate do not necessarily have an increasing effect on overall migration but can have a long-term effect on migration of rural populations. According to Koubi *et al.* (2016), individual perceptions of drought, which can be assimilated to long-term environmental event, decrease migration while perceptions of floods, assimilated to sudden environmental event, increase migration.

More generally it is even possible that disasters reduce migration. Halliday (2006) shows that in El Salvador, earthquakes decrease migration prospects by limiting access to savings and credits. The negative effect of disasters on migration is also due to the fact that public investment in affected areas can dampen the effect of self-protection mechanisms such as migration or because labor demand increases in affected areas (Boustan *et al.*, 2012; Gray and Mueller, 2012b; Henry *et al.*, 2004).

4 Indirect Effects of Disasters on Migration: Exploring Transmission Channels

Migration is a coping mechanism against shocks (Rosenzweig and Stark, 1989; Stark and Levhari, 1982). The New Economics of Labor Migration literature developed the idea of migration as a strategy of risk diversification. More recently, Naudé (2010) and Beine and Parsons (2015) do not find a direct effect of natural disasters on migration but rather an indirect effect. For instance, Naudé (2010) argues that disasters may affect migration from Sub-Saharan Africa by inducing conflicts and negatively affecting Gross Domestic Product (GDP). When disasters increase vulnerability through channels such as agricultural productivity, economic growth, poverty, or conflicts, people have to find coping mechanisms and migration is one of them. In this part, we will draw of literature on the impact of disasters on these transmission channels.

4.1 Natural Disasters, Economic Growth and Migration

Felbermayr and Gröschl (2014), with data on physical strength of natural disasters from 1979 to 2010 recorded by geophysicists or meteorologists, find a negative relationship between disasters and real GDP per capita. More precisely, their results show that a disaster in the top 1 percentile of the disaster index distribution decreases GDP per capita by 6.83% while a disaster in the top 5 percentile disasters decreases GDP per capita by 0.46%. Fomby *et al.* (2013) use a cross-country panel data of 84 countries including 60 developing countries and 24 developed ones from 1960 to 2007. Their findings show that severe disasters have detrimental effects on growth. However, there are some differences depending on the type of disasters. While droughts have negative impacts on GDP growth, floods have positive effects. Negative impacts of growth appear in the short-term after the occurrence of the shock while the positive effects, if any, appear with some delays. Similar results have also been found previously by Loayza *et al.* (2012).

The latter also show that there is some heterogeneity in the effects of weather shocks between developing and developed countries with more pronounced effects in the first type of countries. This has also been found by other studies in the literature. For instance, Gallup *et al.* (1999) find that extreme hot weather is correlated with poverty in 1950, and tropical

countries are 50% poorer and have a slower growth rate (0.9 percentage points) per year between 1965 and 1990. Nordhaus (2006) shows that geographic factors including weather variables can explain 20% of the difference in income between Africa and industrialize countries. Looking at the link between historical variations in temperatures within countries and economic growth, Dell *et al.* (2012) find that high temperatures decrease economic growth but only in poor countries. Indeed, a 1°C increase in temperature decreases economic growth in poor countries by 1.39 percentage points. This negative effect of climate shocks is even more important for African and vulnerable countries.

For a cross-country analysis, Barrios *et al.* (2010) use panel climatic data, in particular rainfall anomalies and data from 1960 to 1990 of 60 countries including 22 African countries. They find that since the 1960s a decrease in rainfall is responsible for the reduction between 15 and 40% of the gap in the African GDP per capita compared to other developing countries. Rasmussen (2004) shows that the cost of natural disasters is higher for small islands which are very vulnerable. Moreover, natural disasters decrease economic output, worsen the external and fiscal balance, and increase poverty. In the same line, Noy (2009) found that developing countries and small economies suffer the most in the short-term in terms of adverse macroeconomic consequences of disasters.

4.2 Weather Shocks, Agricultural Productivity and Migration

Natural disasters can affect economic growth through different channels such as labor productivity (Seppanen *et al.*, 2003), industrial outputs (Dell *et al.*, 2012; Hsiang, 2010); health and mortality (Burgess *et al.*, 2011; Deschênes and Greenstone, 2011), but also education and individual economic performance (Maccini and Yang, 2009).[1] Among all these factors, the most related to natural disasters is the agricultural productivity. Weather variables can negatively influence agricultural productivity (Schlenker and Lobell, 2010; Yang and Choi, 2007). For instance, Dell *et al.* (2012) show that an increase of 1°C in temperatures

[1]Dell *et al.* (2014) provide a review of the literature on the impact of the variation in temperature, rainfall and other extreme weather events on economic outcomes such as agricultural and industrial outputs, labor productivity, energy demand, health, conflict, and economic growth. They discuss various studies, mainly based on panel estimates, which show that weather conditions have a significant impact on economic outcomes.

decreases growth in agricultural output by 2.66 percentage points in poor countries.

The negative consequence of weather shocks on crop yields can in turn translate into higher migration (e.g., Gray and Mueller, 2012a; Hornbeck, 2012). For instance, rural families who have to deal with agricultural production risks may send a member to migrate to urban areas in order to diversify the household's income sources (Stark and Levhari, 1982). Munshi (2003) showed that a decrease in rainfall in Mexico leads to more emigration to the US. Using country-level panel data from 1970 to 2009, Feng *et al.* (2012) show a negative relationship between countries level out-migration and crop yields in the Corn-Belt in the US. More precisely, they find that a 1% decline in crop yields due to weather shocks increases the migration of the adult population by 0.17%. Weather-induced yield shocks also impact negatively internal migration from the US (Feng *et al.*, 2010).

4.3 Natural Disasters, Vulnerability and Migration

Vulnerability is another channel closely linked to economic growth which can explain the relationship between natural disasters and migration. Carter *et al.* (2007) study severe environmental shocks' long-run economic impact in Ethiopia and Honduras. They find that these shocks severely affect the most vulnerable people, who can be caught into poverty traps. Poor households are thus put in a vicious circle. Since they are more vulnerable, they fall into poverty more easily than wealthier households and subsequently, this situation increases their vulnerability. The latter affects different groups in different ways. For instance, studies showed that women are more vulnerable to disasters (Enarson, 2000). Neumayer and Plümper (2007) focus on how natural disasters affect the gender gap in life expectancy. From an analysis based on 141 countries over the period 1981 to 2002, they show that natural disasters decrease life expectancy of women compared to men. This effect is persistent with the intensity of the disasters. Put differently, the natural disaster effect on the gender gap life expectancy increases with shock intensity. Countries where women have good socioeconomic status tend to have a lower effect of disasters on the gender gap life expectancy.

Schultz and Elliott (2013) use census and environmental hazards data from the US in the 1990s to show that disasters are positively associated with changes in local population growth and housing. Furthermore, post-disaster recovery can be at the origin of polarization in the socioeconomic structure of affected areas. Put differently, families at the top of the income distribution would positively benefit from these shocks while there would be no decrease in the number of poor in the communities.

There are other factors beyond vulnerability and inequality which can be considered as transmission channels between shocks and disasters. Arouri *et al.* (2015) use fixed effects at the commune level to assess the effects of natural disasters on poverty and welfare in rural Vietnam. Considering floods, storms, and droughts, they find that these shocks negatively affect household expenditures and income. However, while these studies suggest that disasters can affect migration through different channels, other studies show that this is not necessary always the case. Gignoux and Menéndez (2016) use panel individual-level data and study the long-term effects of earthquakes in rural Indonesia since 1985. They find some economic losses due to the shocks in the short-term. In the first 2 years after the shock, total expenditure per capita decrease by 10 percentage points compared to the situation before the earthquake. However, in the medium run, meaning between 2 and 5 years after the shock, individuals start recovering and in the long term or 6 to 12 years after the shock, total expenditure per capita is 10% higher than before the shock. These positive effects of the earthquake are mainly due to external aid which allows reconstituting physical assets and investing in public infrastructures. Gignoux and Menéndez (2016) do no find any large population movement or reallocation of labor across sectors.

4.4 Natural Disasters, Conflict, and Migration

Natural disasters can induce some income shocks which will trigger conflict and then migration. For instance, Ghimire *et al.* (2015) compiled historical data on civil conflicts, large floods, and displacement from 126 countries over the period 1985 to 2009. They show that while migration due to large floods is not at the origin of new conflicts, it can exacerbate existing conflicts, above all in developing countries, although this effect does not last over time. According to Reuveny (2007), climate-induced

migration can lead to conflict in receiving areas. Subsequently, we are drawing literature on the link between natural disasters and conflicts.

Miguel *et al.* (2004) use rainfall variation as instrumental variable for economic growth in 41 African countries between 1981 and 1999. Controlling for country-fixed effects, they found that a negative growth shock of 5 percentage points increases the likelihood of civil conflict by one-half in the following year. Moreover in the reduced-form, they show that the higher is the level of rainfall, the lower will be the likelihood of civil conflict in Africa. In the same vain, Miguel (2005) uses rainfall data from 67 villages in Tanzania for 11 years (1992–2002) and shows that extreme rainfall variation measuring income shocks is at the origin of violence and crime such as the murder of elderly women accused of witchcraft by their relatives.

Dell *et al.* (2012) found that high temperatures are associated with political instability and conflicts in poor countries. More precisely, a 1°C rise in temperature increases the likelihood of having a leader transition by 3.1 percentage points, in particular, through coups. Hsiang *et al.* (2013) use quantitative findings from 10,000 years BC to now, across the world and across disciplines to show that rainfall and temperatures variations have substantial effect on different conflict outcomes. More precisely, they found that one standard deviation change in extreme weather increases the frequency of interpersonal violence by 4% and intergroup conflict by 14%.

5 Consequences of Migration Decisions Following Disasters: The Role of Remittances

In this part, we draw on the literature that assesses how migration can reduce the adverse effects of environmental disasters, particularly through remittances. Remittances are critical in dealing with natural disasters, both during the disaster and in the aftermath (Fagen, 2006). Indeed, compared to non-recipients, remittance receivers show decreased vulnerability to disasters and have better opportunities to deal with them (Savage and Suleri, 2006). Amuedo-Dorantes *et al.* (2010) are interested in the impact of natural disasters, foreign development aid, and real exchange rates on remittances in the context of Small Islands Developing States. Using Panel VAR methods to deal with endogeneity issues,

they found that both remittances inflows and foreign aid are positively responsive to natural disasters. Migrants clearly show altruistic behavior when their left-behind relatives have to deal with adverse negative shocks. At the same time, they show that remittances tend to be substitutable for other inflows such as foreign aid.

In another study, Mohapatra *et al.* (2012) look at remittances in the aftermath of natural disasters such as floods, earthquakes and droughts. They are also interested in examining if remittances help to prepare for future disasters. Using both macro and microeconomic analyses, they show that remittances are positively correlated with natural disasters in origin countries that have a high share of migrants relative to the total population. This positive effect of remittances is demonstrated in the ex-ante preparation of natural disasters, particularly from high-income countries since they are much larger amounts compared to internal migration transfer flows. Remittances also positively benefit households in responding to adverse environmental shocks. More specifically, evidence from Burkina Faso and Ghana show that those receiving remittance from OECD countries have better coping strategies for natural disasters because migrants' transfers provide them with opportunities to live in concrete houses and have easier access to means of communication. In Ethiopia, international remittance receivers can rely more on inflows than on household assets to insure food security in the case of shocks. Finally, the example of Bangladesh shows that in the aftermath of a flood in 1998, per capita household consumption was higher for remittance receivers.

Although natural disasters are cited among the determinants of remittances volatility (Jackman, 2013), in addition to the study of Mohapatra *et al.* (2012), other analyses show that remittances help dampen environmental disasters' negative effects. For instance, Arouri *et al.* (2015) found that internal remittances help to make households more resilient to natural disasters. Yang and Choi (2007) use rainfall shocks as instrumental variables to assess the relationship between remittances and income variations in the Philippines. They find that international remittances fulfill an insurance role during income shocks, with the replacement rate almost equal to 100%. Similarly, Yang (2008) shows that hurricanes increase the remittances in poor countries. Finally, from a sample of 113 developing countries over the period 1980 to 2007, Combes and Ebeke (2011) find that while natural disasters increase

output growth volatility, remittances attenuated disasters' marginal destabilizing impact. However, this effect is not linear. For remittances rationed between 8 and 17% of GDP, the dampening effect of migrants' transfers is maximized. However in this same interval, remittances increase the instability due to disasters.

6 Concluding Remarks

Both developing and developed countries have to deal with natural disasters. Migration plays an insurance role when households face adverse shocks. Moreover, due to remittances, migration helps those left-behind to cope with disasters.

The overview of the literature allows to understand why the relationship between natural disasters and migration is so controversial and why a consensus is so difficult to find in the literature. Indeed, while some studies find that natural disasters increase migration, others find that they decrease it or do not even have any impact on migration. One explanation is that it has been found that the effect of natural disasters on migration depends on the type of disaster and the effects need to be explored through a short- or long-term perspective. This illustrates the complexity of this relationship. More events have to be studied to obtain stable insights.

The variation in findings consequently raises various questions. The first one relates to the engagement of governments and public services in their work to assist people facing adverse environmental shocks. Indeed, if people only rely on migrants to help them to deal with shocks, what about those who do not have migrants in their households? This raises some important equity issues. The more vulnerable probably have fewer migrants in their households and thus are more exposed during shocks. This raises the issue to what extent public support and the use of private funds generated by migrants need to be coordinated.

The second issue is related to the research perspective. There is a need to better identify who exactly migrates when environmental disasters occur. It is also important to know whether remittances are sufficient enough to deal with shocks in the long term. Furthermore, as shown in the paper, natural disasters can affect migration through different channels such as economic growth, agricultural productivity

or conflict. It would be important to have more research on how post-disaster interventions to mitigate negative effects of shocks on these outcomes can affect migration flows. This opens various future avenues for research related to natural disasters and migration.

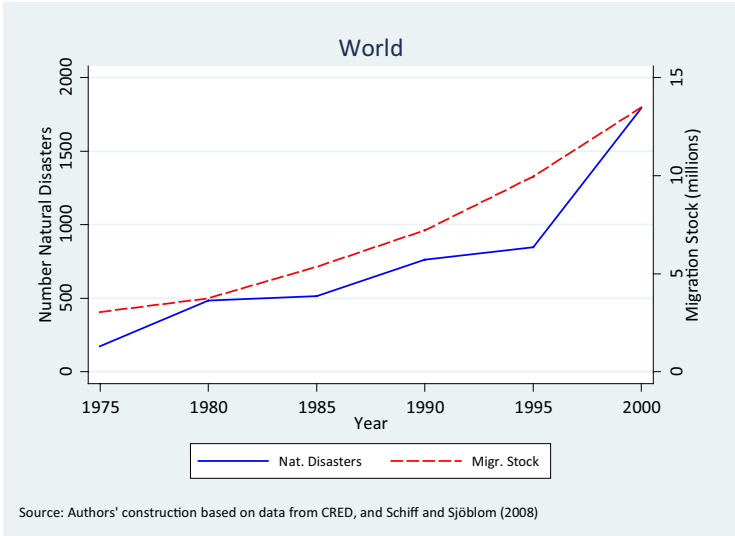
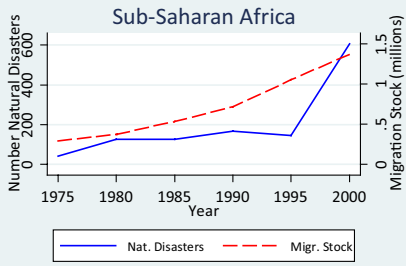


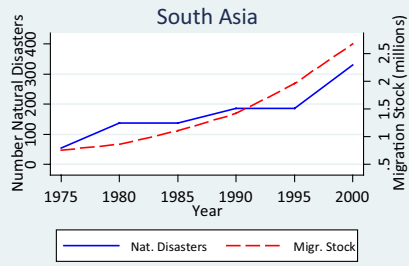
Figure 1: Trends of natural disasters and migrant stocks from low and lower middle income countries.

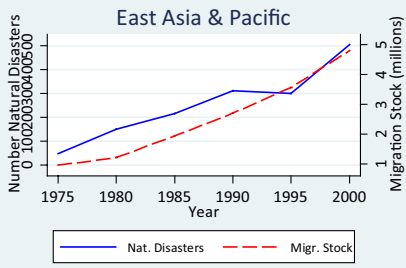
Source: Drabo and Mbaye (2015).

Figures are taken from the Supplementary materials and methods provided in the online appendix of Drabo and Mbaye (2015).

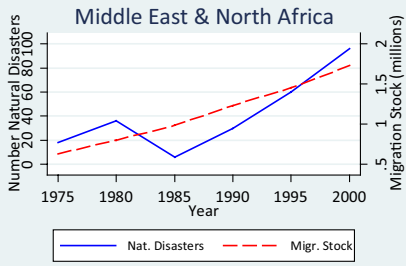
In Drabo and Mbaye (2015), number of natural disasters represents the number of natural disasters over the period 1975–2000 and which are related to climate change such as meteorological disasters (storms), hydrological disasters (floods, and other wet mass-movements) and climatological disasters (drought, wildfire and extremely high temperatures). For the migration variable, emigration rates are calculated as the stocks of migrants from origin countries to the six main destination countries (Australia, Canada, France, Germany, the UK and the United States) for low, medium and high education levels, divided by the stock of people over 25 years old corresponding to the same education level in the origin country, plus the stock of migrants of the sending countries.

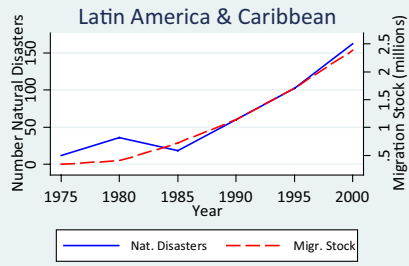


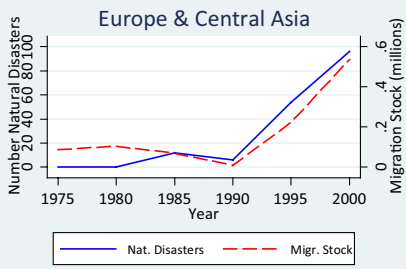




Source: Authors' construction based on data from CRED, and Schiff and Sjöblom (2008)







Source: Authors' construction based on data from CRED, and Schiff and Sjöblom (2008)

Figure 1: (*Continued*)

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