DROUGHT AND MEXICO-US MIGRATION

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INTRODUCTION

In 2010, Mexico ranked as the country with the highest rate of outward migration according to World Bank figures. It is clear that the specific dynamics of Mexico's migration patterns are inextricably tied to its economic and geopolitical proximity to the United States. However, droughts and desertification—specifically their link to extreme poverty in the most arid areas of the country—are a major factor driving outward migration for economic purposes. This study seeks to illuminate the link between drought and migration by examining how low agricultural yields and food insecurity may have contributed to the migration of scores of Mexicans to the country's northern neighbor, the United States. The first section will provide a survey of the incidence of drought and an analysis of the determinants of droughts and migration by providing a snapshot of the state of international discourse on environmental migration between Mexico and the United States. The second section will describe the characteristics of the drought of 2011. The third section will describe the migration patterns between Mexico and United States. The fourth section will explore the various government structures designed to mitigate the effect of drought and desertification on rural poverty. Finally, the fourth section will provide recommendations for a more robust government safety net for environmental shocks and will explore the potential of circular migration programs in mitigating the economic effects of climate change in Mexico.

1. MEXICO'S VULNERABILITY TO DROUGHTS AND DESERTIFICATION

The effects of and implications of environmental degradation in Mexico are significant. Currently, most of the country's territory is undergoing some process of degradation, and it is estimated that approximately 2,250 square kilometers of potentially productive farmlands are damaged or abandoned every year as a consequence (Leighton & Notini, 1994). The implications of desertification are particularly deleterious for people whose livelihood depends directly on the quality and overall health of the soil, such as subsistence farmers.

1.1. History of droughts in Mexico

Mexico's experience with droughts and desertification dates back as far as the eleventh century, and migration has been linked to this climatic phenomenon since the ancient civilizations of the Mexican valley (Liverman, 1990). In 1450-1454, it is believed that a famine caused by an intense drought led to mass out-migration from the Valley of Mexico under the Aztec Civilization. Although the Aztecs routinely distributed corn during times of famine, this drought period was so terrible that it led families to make human sacrifices to Tláloc, the god of rain, and to sell family members into slavery (Liverman, 1999). Recently, archeologists have also suggested that droughts could have played a role in the collapse of the Mayan and other Meso-American civilizations (Ibid 1990, Ibid 1999).

According to Florescanno (1995), droughts may have also played defining roles throughout Mexico's most important historical moments. He argues, for example, that the Hidalgo Rebellion of 1810, which marked a moment of catalysis in the Mexican War of Independence, and the War of the Castes of the 1830s could be linked to food insecurity crises due to droughts (Ibid; Florescano, 1980 quoted in Liverman, 1990). Over a century later, the events leading up to the Mexican Revolutionary War may also have been compounded by a particularly severe drought. (1995).

Florescano further argues that historical records also give strong indications that the adaptive capacities of inhabitants in the territory of contemporary Mexico have declined over time (1995). The indigenous populations of the Mesoamerican plateau are believed to have practiced conservation agriculture and other agroecological practices such as crop rotation; land management adapted to soil fertility; use of natural compost for fertilizer; and cultivation in terraces and embankments. Accounts from Toluca in the Mexico City Valley indicate that indigenous communities may have abandoned these practices by the sixteenth century with the arrival of Spanish colonizers. Over time, their traditional practices were replaced by the European parceling system and by mono-cropping, which severely compromised the health and productive capacity of their soils. The introduction of cattle, an animal species which is not endemic to the American continent, contributed to overgrazing, leading to further land degradation, and placed indigenous communities at a higher risk of vulnerability to droughts and food insecurity (1995; 35-43).

Climatic data shows that droughts have become less frequent but more intense from 1930 to 1970 (in CONAZA, 1994). During this period, 20 droughts were severe and six were extremely severe. Florescano (1980) estimates that in 1949 and 1969, losses linked to drought were 77% and 73% of total agricultural losses for each year respectively (Ibid). Other sources indicate that in the past century, the most severe episodes include the 1957, 1969, 1989, and 1997 droughts, which had ravaging effects for agriculture (Quintero, 2012). Liverman (1999) indicates that the effects of droughts coupled with poor economic and social conditions can be observed in the variations in corn production and imports since 1960. Using this data, decreases in production can be observed for the periods 1973-1976, 1979, 1982, and 1986-1989 which can be partly linked to droughts and compounded by economic crises.

Generally, the patterns observed suggest that droughts are severe and cyclical and that this climatic phenomenon has historically led to the loss of as much as 10% to 20% of the total planted area in Northern Mexico, particularly in the most vulnerable states of Aguascalientes, Nuevo León, and San Luis Potosí (1999).

1.2. Environmental determinants of droughts

One of the primary risk factors in the incidence of drought is desertification, which is the most prevalent form of land degradation in Mexico. Agenda 21 of the 1992 Rio Declaration defines desertification as the "degradation of land in arid, semi-arid, and sub-humid dry areas caused by climatic changes and human activities…accompanied by a reduction in the natural potential of the land" (United Nations, 1993). In Mexico the primary anthropogenic causes of desertification include the excessive clearing and cultivation of land unsuitable for agriculture, the exploitation of forests and biomass for fuel, overgrazing practices, unsuitable or inefficient irrigation practices, mining activities and urban expansion (Leighton & Notini, 1994, p. i). Droughts and desertification go hand in hand, and natural climatic changes are just as important as the evolution in political and economic frameworks that define the way Mexico's inhabitants interact with the environment.

According to government figures, mild forms of desertification affect over 90% of the territory and 60% are affected by more severe forms (CONAZA, 1994). Expert findings in 1978 reached the same conclusion, estimating that approximately 80% of the country's surface was affected by desertification, totaling over 150 million hectares of land (Leighton & Notini, 1994). A scenario drawn from the same study predicted that desertification would continue to overtake approximately 100,000 to 200,000 hectares of land per year, which is consistent with the current trend experienced in Mexico. Sodification and salinization, physical degradation, biological degradation, and chemical degradation also comprise the process of desertification. Of these, sodification and salinization— which are caused by inadequate irrigation practices— are of particular concern, affecting arid states like Sonora severely. It is estimated that about 10% of the country's surface is highly salinized. Moreover, between 50% and 80% of lands are arid or semi-arid. Of these lands, approximately 8 million hectares, making up 45% of land used for agriculture, are farmed or used for grazing. Overall, about 87% of desertification is believed to be caused by anthropogenic factors, while 13 percent is believed to be the result of natural climate change (Leighton & Notini, 1994). More specifically, 80% of the loss in soil fertility nationally is believed to be linked to inadequate use of the land (CONAZA, 1994).

Environmental shocks in Mexico are also the effect of the El Niño Southern Oscillation (ENSO), a non-regular cyclical (5-7years) climatic phenomenon associated with the changes in sea surface temperature and pressure in the tropical Pacific Ocean; and its counterpart La Niña (Aguilar and Vicarelli, 2011). ENSO generates extreme weather effects such as floods, heat waves, and droughts, while La Niña causes extreme precipitation. Both of these phenomena affect Mexico in a significant manner, particularly its southern regions such as

the states of Guerrero, Hidalgo, Michoacán, Puebla, and Veracruz, among others (Aguilar and Vicarelli, 2011).

1.3. Political determinants in vulnerability to droughts

Mexico's vulnerability to droughts should be assessed within the host of social, political, economic, and technological processes over time. Modernization of agriculture, for instance, may have contributed to the intensification of droughts indirectly by encouraging the expansion of farming activities into highly degraded water scarce areas (Liverman, 1990). Other stress factors that contribute to land degradation and the intensification of drought include population growth over time—the Mexican population has more than quadrupled over the past forty years—as well as the expansion of commercial agriculture (Ibid; Leighton and Notini, 1994).

Drought and extreme poverty

Perhaps most importantly, there is a high overlap between the segment of the Mexican population comprised of rural subsistence land ownersand those who live in extreme poverty conditions. Some estimates suggest that over 60% of rural dwellers live in extreme poverty, while more recent figures indicate that this proportion may be as high as 70% today (World Bank in Leighton and Notini 1996; La Jornada, 2012). Furthermore, it is estimated that currently over 40% of rural inhabitantsare affected by food poverty (La Jornada, 2012). Some of the causes of the high incidence of extreme poverty among subsistence smallholders can be attributed to the losses in agricultural and plant productivity that are linked to droughts and desertification.

Land tenure reform

The Plan de Ayala, which stipulated that one third of all lands held by large landowners be redistributed to landless farmers, served as the basis of the Mexican Revolution (1910-1920) (Lewis, 2002). The new agrarian law was one of a set of measures to enhance the autonomy of the peasant classes in Mexico, seeking to rectify the inequalities created during the dictatorship of Porfirio Diaz, which spanned over three decades from 1876 to 1910. At the completion of the Diaz dictatorship, over 96 percent of the Mexican population was landless, and 97 percent of the land was concentrated in the hands of 1 percent of the population (2002).

Some studies argue that despite its lofty intentions, the implementation of the communal land tenure laws or *ejido* system had serious flaws. While the *ejido* system was modeled after prehispanic systems, in the original granting of the land, the government promoted agricultural expansion and grazing in marginal lands, instead of taking land from large landowners (Liverman, 1990; Leighton and Notini, 1994). This has had a two-fold effect over time. First, peasants have contributed to the degradation of the marginal lands distributed by the government. Secondly, as these lands became increasingly less productive, smallholder farmers sought the authorization to take over other marginal lands that were also unsuitable for agriculture (Leighton and Notini, 1994). With amendments in the laws that allow ejido owners to sell or rent their land, this mechanism of marginalization through resettlement has continued as commercial land owners purchase the lands of poor farmers, displacing them into even more marginalized soils (Leighton and Notini, 1994).

Distorted fiscal incentives

Another important distortion in the safety net for smallholders stems from fiscal incentives given by the National Bank. Historically, the National Bank has financed the cultivation of staple crops such as beans and corn, often overlooking the suitability of these crops for the land in question (Ballin-Cortes and Vasquez Rocillo interview, 1993, in Leighton and Notini, 1994). These perverse fiscal incentives not only resulted in further land degradation, but in financial losses for the National Bank. Given the lack of productivity of these crops in certain areas, the loans given by the bank were often defaulted and reduced yields resulted in lack of profits (Leighton and Notini, 1994.

Amendments to exploitation rights

Finally, the amendment of Article 27 of the Mexican Constitution in 1992, which allowed *ejido* owners to sell or rent their land, has led to a changing of the demographic and economic picture of land exploitation in Mexico (Lewis, 2002). Almost two decades ago, Article 27 was amended to put an end to the repartition of *ejido* lands and to liberalize the use of these communal properties (Ibid, La Jornada, 2012). As a result of the new 1992 Agrarian Law, recent estimates indicate that 60% of *ejido* lands in the municipalities of northern Mexico are rented out to commercial farmers or for other economic land exploitation purposes such as mining (La Jornada, 2012).

Changes in economic and export/import patterns

Other important changes in the 1990s led to further marginalization of small holder farmers. In the past two decades the share of imported

agricultural products has risen by a factor of five from 10% to 50% (La Jornada, 2012). This process has been accompanied by the emigration of over 2 million Mexicans since the implementation of the new agrarian law in 1992. Moreover, a fall in credit of over 80% during the 1980s and 1990s has resulted in the abandonment of agricultural activities in over 10 million hectares each year and over 2 million rural jobs lost (La Jornada, 2012).

The fall in investment in agricultural activities and productivity losses have led to two important demographic trends in the last two decades. With the emigration of young male farmers, there has been a feminization of the agricultural sector in Mexico. In the past fifteen years, there were relatively no female official landowners. Currently, 1,138,969 women are official owners of about 11.6 million hectares and 25% of rural households are headed by women (Ibid, 2012). Another trend is the aging of the rural population. Currently, the average age of agricultural landowners is 56 years.

2. THE STATE OF THE DISCOURSE ON MEXICO-US ENVIRONMENTAL MIGRATION

According to the World Bank, Mexico is the largest sender country of emigrants in the world, and the United States-Mexico corridor is unparalleled in its scope (World Bank, 2011). Although it is difficult to produce precise data for these migration flows, estimates range from 150,000 to between 500,000 and 600,000 migrations per year (Leighton and Notini, 1994). Many studies have been conducted to understand the determinants of international migration and its different modalities. However, in assessing the empirical evidence available on the topic, we have ascertained that environmental considerations have only recently become prominent in the literature on Mexico-US migration. It is thus instrumental to recognize that although environmental degradation is pointed to in the literature as a potential determinant of migration, there has been no significant political recognition of environmental migrants on either side of the border.

2.1. Environmental Determinants of Mexico-US Migration

Although studies often point to the potential role of environmental degradation as a causal factor of migration, there are a limited number of studies that have directly examined the environment-migration nexus in Mexico. Notably, in 1978, Fernando Medellin estimated that around 600,000 Mexicans resorted to migration as a survival strategy in the context of poor agricultural outputs linked to land degradation and desertification (Quoted in Alscher, 2008). In 1993, Norman Myers called this tendency, coupled with other stress factors such as high population growth, an "agricultural squeeze" (141, quoted in Alscher, 2008). In 1994, Taylor deployed data from an investigation in Oaxaca highlighting that there is a negative correlation between rural productivity and migration, and suggesting that migration results in disinvestment in land-quality dependent activities. An important takeaway from this study is that the higher incidence of livestock raising can exacerbate overgrazing and land degradation, and the opportunity cost of land conservation in the context of migration can serve as a disincentive for practices that decrease the vulnerability to droughts (Correspondence with Taylor, 1994, in Leighton and Notini, 1994).

In 1990, the U.S. Commission on Immigration Reform was authorized as a bipartisan effort to analyze the socioeconomic, demographic, and environmental effects of US-Mexico migration policy. One of the outcomes of the commission's initiatives was a report that examined the link between desertification and migration carried out by the Natural Heritage Institute in California. Although an exhaustive research undertaking was beyond the scope of the study's mandate, the authors used an analysis of geo-statistical and migration data to conclude that for individuals whose livelihood depends primarily on the agricultural output of their land, the economic costs of desertification are a strong inducement to migrate toward the United States (Leighton and Notini, 1994).

Table 1. US migration outlook – Mexican migrants (2010)

Country	Population
Total US population	308,745,538
Number of migrants in the US	39,956,000
Share of the population	*12.9%*
Number of Mexican migrants in the US	11,587,250
Share of the migrants population	*29%*

Source: U.S. Census Bureau

2.2. The 2011 Situation

In 2011 alone, more than 28 states in Mexico were affected by droughts (Notimex, 2012). In the states of Sinaloa, Chihuahua, and Durango, this drought period constitutes the most severe in the past 70 years. Although it is estimated that droughts will not subside until the start of this year's rainy season, droughts have already affected over 2

million hectares of land at the national level, leading to the total loss of over 7% of the country's agricultural land (El Universal, 2012; Zabludovsky, 2012). Moreover, roughly 450,000 cattle have perished in arid lands, dams were at less than half of their typical capacity relative to the same time last year, and many farmers in states like Durango have begun to migrate due to the high levels of food insecurity (Torres, 2012).

Drought coupled with cold snap in the beginning of 2011 also led to significant losses in food production. Production of corn for example, has been predicted to fall from the projected 23 million tons to 20 million tons, and production of beans is expected to fall by 28% (Notimex, 2012). As one of the world's top five producers of corn, Mexico's drought crisis is likely to drive up the price of this staple crop. Ignacio Rivera, an official at the Mexican Ministry of Agriculture and Rural Development predicted that corn production would likely recover to 25 million tons in 2012, aided by government assistance. Thus far, of the 8.1 million hectares insured against natural disaster—Mexico has total arable land of 22 million hectares—approximately 600,000 claims have been filed, reporting losses on 3.8 million hectares. The government has allocated over 1.6 billion pesos to cover these losses (Ibid).

Although the government has a permanent safety net of programs against drought in place, it responded with large sums of disaster relief aid in late 2011 and the early months of 2012. It is important to note that Mexico is no longer a recipient of humanitarian or foreign development aid, so the bulk of disaster management and assistance falls within the jurisdiction of the national government. Reports indicate that the government became aware of the severity of the drought in May, 2011, and responded by creating a Strategy to Assist States Affected by Drought (Pérez, 2012). Since then, it has approved over $2.63 billion pesos in aid, including the creation of temporary jobs in the areas most affected by drought, the distribution of potable water and food aid. The National Comission of Watter (CONAGUA) , and other agencies have also distributed water for personal consumption, and doctors and nurses have been deployed to the most affected states. Recently, the government has also created a new mechanism within the Inter-ministerial Commission for Sustainable Rural Development to evaluate and measure the impacts of the 2011 drought (Michel, 2012).

The 2011 drought is not the first to have hit Mexico in the past decade, but it is different for a number of reasons. First, this crisis has attracted more attention and support from the government due to the media coverage that it has received from national and international sources alike. In early January 2012, an independent group posted a video on social media claiming that crop failure had driven more than 50 Tarahumara Indians to commit suicide by jumping off a local cliff (BBC, 2012). Although this report was later denied by local authorities, the news that the Tarahumara—who call themselves the raramuris and are known for their resilience and long-distance running abilities—were being affected by the worst drought in 70 years led to a wave of support including supplies and foodstuffs. However, the government's strategy has not escaped criticism. Notably, Javier Avila told *El Informador*, a Mexican newspaper, that human rights groups are "interested in tackling the causes, not the effects, because every year food and blankets are sent, but…every year indigenous people suffer hunger" (2012).

The plight of the Tarahumara has become emblematic of the mismanagement of drought hazards in Mexico. Recently, Isaac Oxenhaut, national aid coordinator for the Mexican Red Cross, said that the situation of the Tarahumara could be considered extreme poverty, and that "[the Tarahumara] don't have anywhere to harvest absolutely anything" (Zabludobsky, 2012). A recurring message in the media coverage of the 2011 drought is that this climatic phenomenon is not only cyclical, but also relatively predictable. Yet, as each drought hits with increasing intensity, the government continues to handle it as a temporal crisis situation. Instead, a systematic improvement of the programs in place should be undertaken so that the preventable conditions that increase vulnerability to drought such as inadequate land and water management, and unsuitable agricultural practices are addressed prior to the onset of a food crisis.

2.3. Monitoring the 2011 Drought

The Mexican National Weather Service establishes four different types of droughts. The first is Abnormally Dry, which is not considered as a drought it is just a dryness condition. It usually appears in the start or at the end of a drought. It affects the growth of crops or grasslands, and leads to higher risk of fire and water deficit. The first level of drought is the Moderate Drought. In this level there is direct damage to crops and grasslands and low levels of water deposits. In Severe Drought there is a probability of losing crops and grasslands. There is a lack of water. The last two levels that happen rarely are Extreme Droughts and Exceptional Droughts. The former means a larger loss of crops and grasslands, higher risk of fire and general water shortage. The latter has a

Table 2. Timeline of key events 2011-2012

DATE	EVENT	DETAILS
May 2011	Government becomes aware of extreme drought	Government prepares to respond
July 2011	First national policy response	Establishment of the Strategy to Assist States Affected by Drought
Early November 2011	National meteorological service announces 70% of territory is affected by drought	Authorities qualify drought situation as "dramatic" and historically severe
November 2011	Food production falls by 40% compared to previous year's levels	Price increases of corn and beans predicted
2011	Over 50% of country's municipalities affected	1,200 municipalities across Mexico are affected by drought
End of 2011	New funds added to Natural Disaster Fund	18,700 MP added to FONDEN for a total of 21,400 MP available for disaster relief
January 2011	Ministry of Interior announces 7 natural disaster declarations are underway	Affected states include Aguascalientes, Coahuila, Chihuahua, Durango, Jalisco, Sonora, and Zacatecas
January 5, 2011	Ministry of Social Development continues to disburse water support	9 million liters of water are distributed to 2.5 million people most affected by drought
January 23, 2011	Disaster relief funds fail to reach beneficiaries	It is estimated that only 40.7% of funds have been received by beneficiaries in 19 states affected by extreme and severe drought
January 24, 2011	President Felipe Calderon announces emergency relief funding	33,000 MP are allocated to a comprehensive national program to address drought losses in 2012
February 4, 2012	Red Cross and DIF announce United against Drought	National cash and food collection programs runs from February 7-20
February 2012	Ministry of Health sends medical personnel to affected states	Over 10,000 doctors and 19 nurses sent to 5 most affected states
February 2012	CONAGUA continues to administer support	Over 3,000 MP are distributed in 596 municipalities in 21 states
February 20, 2012	Losses amount to 12,000 MP	Losses in productivity and land decapitalisation reach record high
April 2012		Mechanism to evaluate and measure impacts of drought is instituted within the Interministerial Commission for Sustainable Rural Development

Source: Own elaboration with information from El Universal

general and atypical loss of crops and grasslands and there are usually emergency situations due to water shortage.

The National Weather Service is part of the North American Drought Monitor which is a system created by Canada, Mexico and the United States that monitors drought across the continent. The analysis of the 2011 situation in Mexico can be found in the databases and maps of the system. Since December 2010, there have been abnormal conditions in Mexican temperatures and land indicators. It was in this month that the dryer conditions started and the first clues of extreme drought appeared. This was a consequence of the reduction of precipitation since fall of 2010. By the end of the month the levels of dryness in the country could be found in 40.1% of the territory. The conditions affected the spring-summer agricultural cycle and the growth of livestock directly.

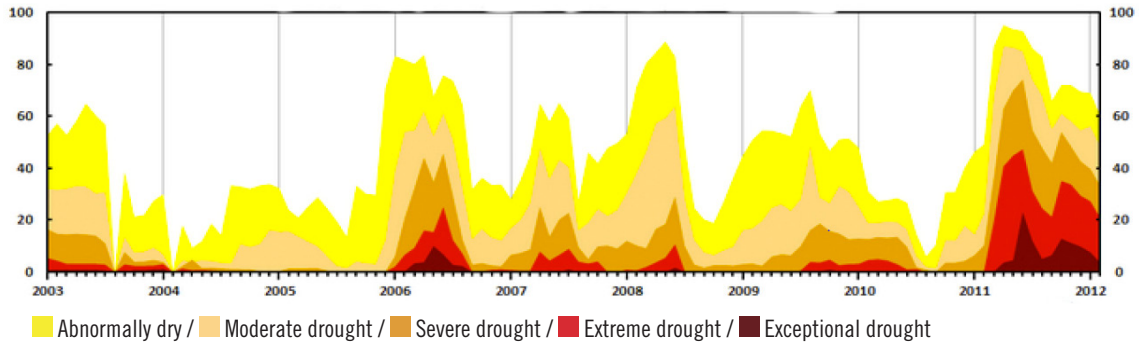
Despite the fact that the northern territory of Mexico is characterized by its dry conditions, 2011 was an atypical year due to the increase of extreme and exceptional droughts. Since 2006 these cases of droughts did not happen and it is considered the largest period of extreme and exceptional drought since 1941 (the year when the meteorological measurements started). The year 2011 was extreme because 95% of the territory was affected by droughts. There was a higher incidence of exceptional droughts, perhaps the natural dryness of the northern region of Mexico. According to the National Meteorological System during the agricultural cycle of 2011 only 53.4% of the agricultural lands were seeded.

3. MIGRATION PATTERNS OVER TIME

3.1. General patterns

Mexico shares a 3,100 kilometer border with the United States.. Historically, as neighbor countries, they have had a conflicting relationship, sharing enormous flows of people crossing illegally every year. Mexicans make up about 93% of these border crossers (Henderson, 2011). Currently, the Mexico-US corridor is said to be the most important migration nexus in the world (Castles y Miller, 1998). According to Durand and Massey, migration has been recorded since the Mexican American war of 1848. And is still, nowadays, one of the biggest foreign affairs issues that have to be dealt by both countries.

Figure 1. Percentage of areas by droughts in Mexico



Source: National Weather Service

The modern era of what is understood as Mexico-U.S. migration began after the end of the Bracero Program, which was a temporary labor program for the agricultural sector of the United States during World War II. It has been the only program that implemented a legal framework to cover the labor shortages in the United States. Currently, there has been a tremendous change; that started with the highest peak of Mexican-American migration in 1970-1980 (in the wake of Mexico's debt crisis). Aggregately, Mexico has sent 11% of their population and 18% of their labor to the United States (Alba, Castillo and Verduzco, 2010). In these last decades migration has increased in an unprecedented fashion in both countries history. It has increased from 30,000 migrants to 400,000 per year.

In the last 40 years, the migration flows have changed in size, intensity and demographic characteristics. They have passed from being temporary and circular, to being permanent and more stable. Most of the migrants used to be men, but currently one third of the migrant population is women (Verduzco, 2010: 168). According to the most commonly cited estimate, today there are almost 12 million Mexicans who have established themselves in United States (Alba, 2010).

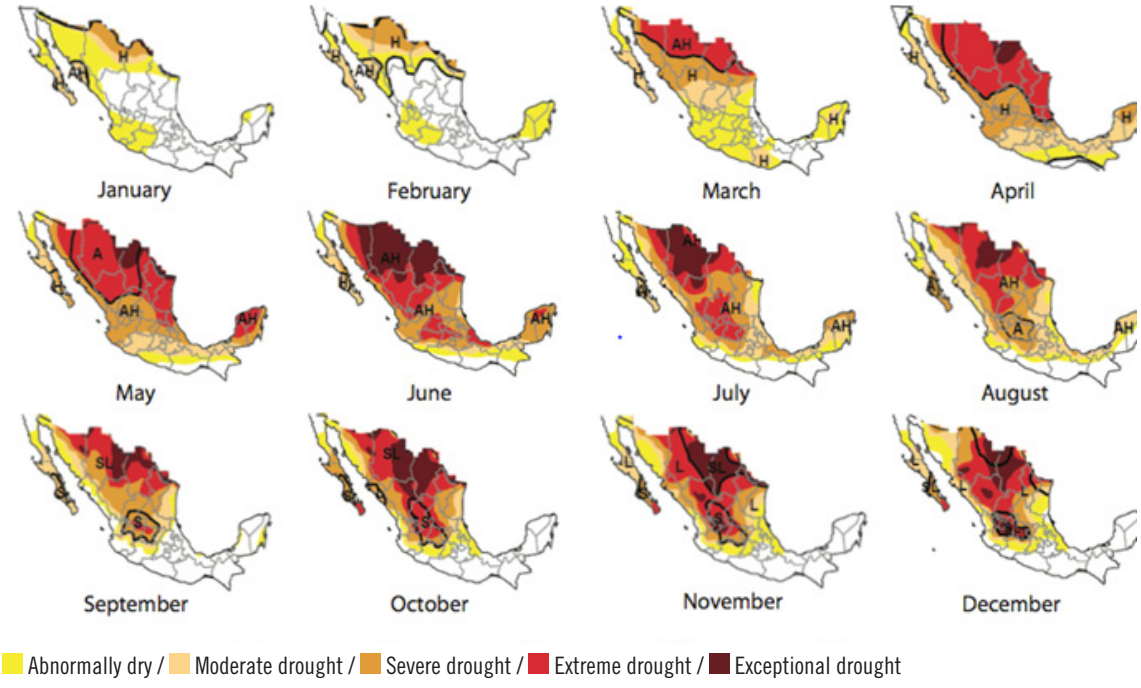
It is said that immigration involves push and pull factors that include economic, social, cultural and demographic characteristics. In addition to these factos the Mexico-United States migration deals with the vast asymmetries within both countries. Finally, the environment also has an important role in explaining the dynamic characteristics of the Mexican-American border. Especially for the impact in agricultural performance and its importance in the northern region of Mexico.

3.2. NAFTA and Mexican agriculture

In the late 1980s there were important economic reforms in Mexico. Miguel de la Madrid brought Mexico into the General Agreement on Tariffs and Trade (GATT) in 1986, showing the world Mexico's willingness to open up its economy (Henderson, 2011). In the following years, there was privatization, deregulation and liberalization of the Mexican economy. Under Carlos Salinas de Gortari's presidency, negotiations began for the North American Free Trade Agreement (NAFTA) or Tratado de Libre Comercio (TLC). He pursued the idea of Mexico as a "first world" country. NAFTA was seen as a long-term solution to the immigration problem between Mexico and the United States. As Carlos Salinas said: "Mexico will soon be exporting its goods instead of its people."Nevertheless, Mexico, the United States and Canada ignored the fact that Mexico was not in the same conditions to enter a trade agreement, especially as an equal partner. Not only was Mexico's economy smaller, poorer and more unequal, it was plagued by many other internal problems (Henderson, 2001: 121). The free trade agreement was never what it was thought to be; it has eased the regional disparities and has exacerbated the local inequalities. Job creation in Mexico has been slow, poverty has not decreased and the volume of migration to United States has increased, from 370,000 1994 per year to 575,000 in 2004 (Henderson, 2011: 137). The continuous flow of migrants along the border has shown that the benefits attributed to NAFTA have not been materialized.

According to Henderson, Mexico's agricultural policies continued to be heavily skewed in favor of larger agricultural business instead of local farmers. The harshest effect of NAFTA in the agricultural sector was felt in 2009, when the 15 years

Map 1. Maps of droughts in Mexico (January-December 2011)



Source: Own elaboration with information of National Weather Service

enactment that eliminated tariffs on corn imports from the United States and Canada was applied. Mexico's small-scale corn farmers would have to compete with the subsidies given to American farmers(the United States in 2008 had farm subsidies totaled $25 billion). Michael Pollan says that the US subsidized cheap corn is a plague impoverishing farmers in Mexico and in the countries to which they export (Oing Hing, 2010). The implementation of NAFTA in the Mexican context has had a direct significance in the income of agricultural farmers. This has a relation with the impact of droughts, because impoverished farmers are not able to reverse the environmental effects in their production.

3.3. Rural emigration

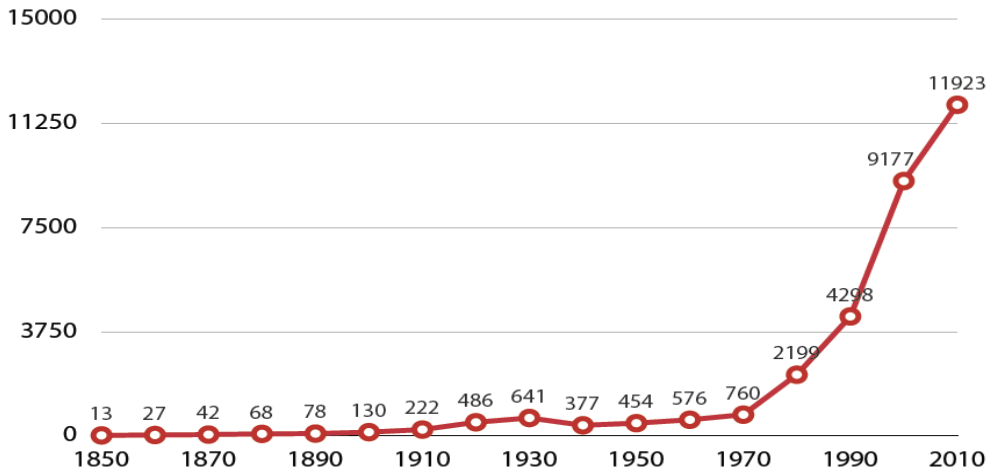
International migration has to be understood as a central process of economic globalization, especially for its influence and effects in the labor and remittances markets. Most of the time people emigrate to improve their quality of life or to reduce the effects of unequal economic development. That is why international migration flows usually involve developed and developing countries. This asymmetric relationship can be seen in the relationship between Mexican and American migration.

According to the National Survey of Rural Homes in Mexico 2007 (ENHRUM II) since the 1980s, the rate of rural emigration has increased considerably, especially toward the United States. During this period of time the median annual growth rate of rural emigration was 6.9%, while the urban migration was 4.7%. This means that since 2004, the number of rural migrants to the United States is larger than the urban ones (Yúñez and Mora, 2010).

Mexican migration is mostly attributed to the central-northern states of the country where rural areas predominate. According to the results of ENHRUM II, the largest number of migrants come from the central-western and northern part of Mexico, even though the region with the lowest development index is located in the southern states. In Mexico, migration has been concentrated in a traditional zone that includes the states of: Michoacán, Jalisco, Guanajuato, Zacatecas, San Luis Potosí, Durango and Chihuahua.

The 8.7% of Mexican households have a migrant relative in the United States. Nevertheless, this rate doubles to 20% in the central, western and northern regions of the country (Verduzco, 2010: 174). From the 2,443 municipalities in Mexico, at least 96% of them have a nexus with the migratory phenomenon. There are 97 municipalities that have a higher incidence of migration, 87% of these are rural municipalities with less than 20,000 inhabitants (Verduzco, 2010). Their economy is principally based in agricultural activities.

Figure 2. Mexican population living in the US (1850-2010, in thousands)



Source: Gibson and Jung, 2006. US Census Bureau, 2009.

Migration and desertification in Mexico have been both deeply studied. Nonetheless environmental migration has not been properly analyzed, nor has a link been found between these two topics. According to a study developed by Mora and Yúnez Naude in 2008, environmental variables might have a direct impact in rural emigration from Mexico. The authors measure the level of rural inhabitants who decide to emigrate either to the United States or domestically within Mexico as a result of climate change based on the demographic characteristics of the individual, their homes and their communities.

Using the average temperatures from 1971-2000, the results show that people living in communities with higher temperatures during spring and autumn are more likely to emigrate, especially to the United States. On the other hand, people living in communities with higher temperatures during the summer have a lower probability to be environmental migrants. The authors also use precipitation rates in the communities concluding that people living in communities with higher levels of precipitation during summer and winter have a lower probability to emigrate. The contrary effect appears in the communities with rain during autumn (Mora and Yúnez Naude, 2008).

In a chapter written for El Colegio de México, the authors explain that climate change affects rural migration. Nevertheless there are not many studies that seek to explain the effects of this variable. Yúnez says that the need to expand and deepen this type of studies is relevant, important and urgent (Yúnez Naude, 2010:152). For example, it would be instrumental to build a model that estimates the effect of climate change in the productive activities of rural households and the effect of the latter on migration (Yúnez Naude, 2010:152).

3.4. Internal migration

Internal migration has also been a characteristic of the Mexican population distribution since the second half of twentieth century. Rural-urban migration has been the primary type of movement, as a result of the implementation of the Import Substitution Industrialization Model (ISI). Internal migration has had a huge impact on urbanization and metropolization of the principal cities in Mexico such as Mexico City, Guadalajara, Monterrey, Puebla and León (López and Velarde, 2011). Even though economic factors are the main explanation of the migration tendencies in Mexico, there are other factors that might influence the domestic movements. For example, improved of quality of life; better education opportunities, security and natural disasters (Castillo, 2007:147; Rojas Wiesner, 2007: 26).

4. POLICY RESPONSES

4.1. Migration policy responses

The policy responses of the Mexican government are at a turning point looking for participation of both countries. The problem is that the economic crisis of 2008 and security reinforcement have increased anti-immigration policies in the United States. There has not been a direct Mexican response to reduce migration rates. According to

Table 3. Demographic characteristics of national and international rural emigration (2002-2007)

	2002		2007	
	National Immigrants	Immigrants to US	National Immigrants	Immigrants to US
Home demographics				
Head of family average age	52.68	58.49	53.36	55.63
Years of school	3.69	3.58	4.92	4.37
Individual demographics				
Average age	30.13	32.58	32.69	33.66
Years of school	7.43	6.64	8.47	7.38
Gender [percentage]				
Masculine	67.28	84.36	78.02	76.15
Feminine	32.72	15.64	21.98	23.85
Civil Status [percentage]				
Married	62.86	71.84	70.00	75.33
Single	37.14	28.16	30.00	24.77

Source: Yúnez Naude and Mora Rivera, 2010.

IOM, the mexican government has only focused on services for migrants and giving assistance in the United States by improving return procedures. Most of the migration-related programs try to take advantage of the remittances that are sent by the citizens living abroad. The most famous program related to migration is the one called "3 x 1" the goal of the program is that for each peso that a migrant invests in their communities the local and federal governments will invest three. In this way, the Mexican government increases the commitment of the Mexican migrants to their local communities.

4.2. Temporary Worker Programs

Temporary work programs aim to add workers to the labor force without adding permanent residents to the population. The largest temporary work program between United States and Mexico was the Bracero Program that took place from 1942 to 1964. In the 1990s some micro temporary work programs were implemented. Each of these programs had specific admission criteria, length of stay and change of immigrant status (Martin, 2006). All of these programs have different visas requirements depending of their goal.

In Martin's study (2006) for the United Nations, he says there are 20 non-immigrant programs that permit foreigners to work in the United States. The three major worker visa categories are H-1B for specialty workers, H-2A for agricultural workers and H-2B for nonfarm workers (Martin, 2006: 22). The first one allows employers to have foreign professionals to fill specialized jobs. Usually, workers are asked to have a university degree and a certain degree of experience. On the other hand, there are programs for unskilled workers. They focus on agricultural and non-agricultural employees. In the case of H-2A (Agricultural Visa) the employers must receive permission to recruit them, have to offer higher wages and provide free housing to migrants (Martin, 2006: 17).

The U.S. Department of State's Bureau of Consular Affairs says that in 2009, 55,693 Mexicans were employed with this type of visa and 55,921 were employed in 2010 (USDS, 2012). Nevertheless, the program has the problem that most of the employees do not respect the temporary request of the work. Usually, the migrants change work from farm to farm, staying permanently in the United States. The temporary working programs, specially the agricultural ones, represent a good and safe opportunity for Mexican farmers.

4.3. Desertification policy responses

There is a need of governmental responses, not only for reducing the consequences of droughts, but for preventing the imminent damages they can cause. The Federal Government has designed different programs that have a diversity of objectives. The main goals focus on prevention action, such as risk management or agricultural insurance, research, development and emergency natural disaster funds. The Mexican case demands the implementation of policies that can reverse the effects of droughts and desertification on national productivity.

4.3.1. CONAZA

In order to fight land degradation and desertification problems and to drive the development in the northern part of Mexico, the government created a decentralized public organism called CONAZA (National Commission of Arid Zones) in 1970. The

Map 2. Principal migration states in Mexico

Source: Own elaboration

commission works with a federal budget and it is in charge of studying the arid zones of the country to promote different economical activities that will improve their agricultural production. Currently, CONAZA is part of the Ministry of Agriculture (SAGARPA) and develops programs to combat desertification and droughts.

CONAZA is part of the National Action Plan for Combating Desertification (PACD-MÉXICO) whose main goal is to prevent and delay the advance of desertification in arid and semiarid zones and seeks to improve the quality of life for inhabitants in these regions. Moreover, it seeks to reinforce programs to fight poverty in arid zones. Lastly, its goal includes the creation of programs that will alleviate the effects of droughts in Mexico (PACD, 2004).

Three programs are developed by CONAZA as part of the Ministry of Agriculture's plan to fight desertification. The first program is for land conservation and sustainable use of water, the second is an alimentary program, and the third is the construction of hydraulic infrastructure in arid zones. Currently, all of these programs are part of the National Development Plan 2007-2012 impelled by the current Calderon administration.

The program of Land Conservation and Sustainable Use of Water (COUSSA) aims to improve the country's land management strategies and to warranty the sustainable use of soil, water and natural resources required for agriculture. It supports the construction, establishment and development of rural projects related to the collection, transmission, storage and filtration of rainwater. It also supports rural projects that develop strategies and mechanisms to prevent soil degradation. It works directly with local governments or implements direct programs in the communities (CONAZA, 2011).

A second program, the Transversal Project for the Development of Arid Zones (PRODEZA) not only attends farmers living in arid zones, but also seeks to improve the living standards of people living in high-poverty municipalities that depend on agricultural production. It is the only program that focuses not only on the agriculture, but also pays attention to its relationship with marginal zones. This is relevant because 70% of the people living in rural areas live in conditions of poverty or extreme poverty (INEGI, 2011). PRODEZA attends 686 municipalities in 19 different states, and almost 70% of the population attended live in semi-arid or arid zones.

In 2011, the situation of droughts and land degradation required a larger reaction by the government. The federal government has started to implement programs to alleviate the effects of droughts in affected states for 2011-2012 (Programa Nacional de Atención a la Sequía 2011-2012). The program seeks to support schemes of coordination between the federal, local and municipal levels with producers and civil society in projects related to health, temporary employment, water,

food markets and agricultural business. It is within these national goals that CONAZA, PRODEZA and COUSSA have played an important role as a government response against the effects of droughts.

The Secretary of Agriculture, Francisco Mayorga Castañeda, announced on March, 2012, that there are several emergency preventive measures and that the resources will be invested in conservation and sustainable use of soil and water, modernization of irrigation patterns and the change of cropping production (Sagarpa, 2012). In 2011, there was a budget of 2, 392 million pesos invested in CONAZA representing an increase of 113% compared with 2010. The Federal Government invested in 1,792 COUSSA projects through SAGARPA, to help improve the conditions of water availability. This benefited 48,000,201 producers from 28 states of the country. In the case of PRODEZA, there has been an investment of 684 million pesos ($26 million) in 308 different projects (Sagarpa, 2012).

4.3.2. FONDEN (Natural Disasters National Fund)

The Natural Disasters National Fund (FONDEN) was created in 1996 with the goal of giving financial aid to states affected by a natural phenomenon whose magnitude overwhelms the operational and financial capacities of the state. The two main reasons for using the FONDEN are long-term or emergency natural disasters. Types of disasters include geological (earthquakes), hydrometeorological (which include droughts, floods, hurricanes and tornados) or fires.

The damaged states ask for financial assistance from the federal government. The federal dependencies corroborate the information and in the case of droughts the National Water Commission (CONAGUA) is in charge of this task. CONAGUA sends the evaluation and quantification of the damages to the Ministry of State (SEGOB) and the Ministry of Finance and Treasury (SHCP), which approve the necessary resources. Finally, these funds are allocated to the victims. At present, CONAGUA has confirmed droughts in 1,213 Mexican municipalities. In 90% of them the funds have been approved and are waiting to be allocated.

CONAGUA is the office responsible for corroborating the environmental status of affected areas and also aiding the population by sending drinking water pipes and the installation of storage tanks. In order to reduce the impact of droughts, it supports projects that make a more efficient use of water and temporary working programs. According to the director of CONAGUA José Luis Luege Tamargo, they will invest $5 million ($385,000 USD) to mitigate the effects of droughts across the country.

The FONDEN has been used in this atypical drought that has affected mostly the northern part of the country. According to José Antonio Meade, the Ministry of Treasury the Federal Government has allocated 23,800 million pesos from FONDEN's 33,8000 million peso budget for droughts (Notimex, 2012). The most affected states, Aguascalientes, Coahuila, Sonora, Sinaloa, Guanajuato, Durango, San Luis Potosí and Chihuahua, have requested the aid of FONDEN to alleviate the effects of the disaster. The Ministry of State, Alejandro Poiré, said that during 2011 there were 54 emergency statements, the resources from the FONDEN assigned helped 1,232,000 people affected in more than 400 communities in 17 of the 32 states (Notimex, 2012).

Even though there have been several changes in the operational rules to account for the exceptional droughts affecting Mexico, the relief is often not delivered on time to the affected communities. This has produced a lack of solutions or direct investment in infrastructure to mitigate the impact of the droughts in 40% of Mexican territory. Nevertheless, the resources are still there, waiting to be transferred from the federal government to the states and then to the municipalities.

4.3.3. Agricultural Insurance (AGROASEMEX)

Droughts have had a significant impact on the production capability of the rural sector in Mexico. In recent years, weather-indexed insurance has gained attention because it is considered to be an effective tool for providing coverage to farms against climatic shocks (Fuchs and Wolff, 2010:2). For that purpose, an agricultural insurance company known as AGROASEMEX was created to guarantee the protection of the crops and cattle.

AGROASEMEX is a public company that seeks to contribute to the formation of a national risk management system for the protection of the rural sector and to promote an insurance culture. AGROASEMEX hast two main objectives: work as a private insurance company and as a subsidy to the insurance premiums agricultural producers pay. It is related to environmental catastrophes; seeking to mitigate potential losses related to the natural disaster of environmental changes. The climate risks are measured with the precipitation and temperature levels that might cause a total loss in an agricultural cycle. A disaster takes place when precipitation is lower than expected or temperatures are higher or lower than a crop can handle. The insurance gives an indemnity of the total amount of crop covered.

Even though AGROSEMEX works as an insurance company it also works with federal resources that

are used to subsidize the insurance premium paid by the agricultural holders. The Federal Government allocated $397, 852, 016 pesos (29 million dollars) in 2002 to subsidize insurance premiums to the affected producers. Nevertheless the federal budget for AGROAESEMEX has increased reaching its highest peak in 2011. According to the Taxable Year Report $ 1,118,100,000 pesos (87 million dollars) have been allocated.

This federal insurance focuses on crops and cattle. The agricultural insurance subsidies cover the producer for environmental risks including droughts, excess of precipitation, frosts, low temperatures, floods, hail, fire, hurricane, tornadoes, and heat wave, among others and biological risks such asplagues. The program covers a total of $280 dollars premium subsidy per hectare. In 2011, 80.7% of the budget was allocated for agricultural purposes. The insurances covered 2,671,939 hectares protecting 503,895 beneficiaries. In the beginning of 2012 the federal government will allocate 2,000,785 million pesos, plus the contributions of the states estimated to be 550 million pesos, to cover 30 states and 10.6 million hectares with a subsidy for insurance premiums (Sagarpa, 2012).

> *"In 2003, the emergency insurance coverage began with just 95 000 hectares of crops in 2012 and aims to reach 10 million hectares in collaboration with state governments. In the case of cattle, in 2006 began with 261,000 animal units and by 2012 the goal is to reach almost six million." (Mayorga, 2012)*

The agricultural insurance might sound like a panacea to the risks agricultural producers face, nevertheless it has some deficiencies. On one hand, it has developed an "insurance culture" within the agricultural community. According to a historical analysis of the budget, the number of beneficiaries has increased from 2002 to 2011. "The insurance presence positively and significantly affects insured counties' maize yields with respect to uninsured counties" (Fuchs and Wolff, 2010:4).On the other hand,

according to design evaluations of the program applied by CONEVAL, it has several deficiencies. First, as it works as a subsidy, it only reduces the prime, and does not give a monetary transfer to producers. This gives the feeling to the beneficiaries that they are not receiving direct governmental help. Second, the majority of beneficiaries end up being larger agricultural producers and not small rural farmers, for whom agricultural losses have larger consequences on their budget and their development. This unequal allocation of resources is related to a larger risk management "culture" of commercial farmers and small holders. These agricultural risks that farmers are exposed to without insurance should be seen as a potential motivation to migrate. According to Fuchs and Wolff (2010) insurance has poverty traps because most investment decisions are conflicted with risk management decisions: risk-averse farmers tend to under invest and concentrate in the production of lower yielding yet safer crops.

5. POLICY RECOMMENDATIONS

1. A cross-sectional approach to enhance Mexico´s readiness to cope with the effects of droughts and desertification entails reframing the issue as an ongoing challenge rather than a natural disaster. Although the effects of drought are increasingly severe, the nature of this climatic shock is cyclical and the technology to predict the onset of drought exists. Improving the efficacy of Mexico´s current policies will require a long-term vision and abandoning the current "crisis" mentality. For example, shifting the focus to prevention through more sustainable land use practices, rather than simply providing emergency work and food relief programs, could alleviate the severity of drought losses for subsistence farmers.

2. The tightening of border controls on the part of the United States has significantly increased the number of undocumented Mexican immigrants. Although the increasing militarization of the border has not decreased the number of apprehensions of illegal migrants, it has increased the number of deaths at the border and has prevented Mexican workers from exercising their natural inclination to return to their home country. Shifting the focus toward an immigration policy based on enhanced guest worker programsi has the potential of regulating the risks of migration while giving workers the opportunity to derive the benefits of temporary labor migration. Specifically, enforcing employers' responsibility under the current guest worker program to provide workers with the means to return to Mexico after the end of the agricultural cycle would reduce illegal immigration. In the long-term, the United States could improve the functioning of its programs by emulating the highly successful temporary worker scheme between Canada and Mexico, by establishing a bilateral collaboration to be regulated by the Ministry of Labor of each respective country.

3. Regarding the AGROSAMEX weather-indexed agricultural insurance program, the Mexican government should undertake a two-pronged approach. First, the government should address farmers´ lack of familiarity with the benefits of agricultural insurance by pursuing a comprehensive

awareness campaign among smallholder farmers, particularly those most impoverished and food insecure. Secondly, the prices of the premiums should be regulated so they remain within the reach of those farmers who need them most, and to reduce the inequity in the distribution of benefits, which currently favors large agribusiness.

4. There is great untapped potential in the use of low-input, high-yield agricultural techniques such as conservation agriculture, and agroecology. The government subsidy and fiscal incentive programs should be revised so that the crops and techniques they advocate and promote are in line with the productive capacity and natural ecosystem of the soils. More specifically, overgrazing, mono-cropping, and inadequate irrigation systems should be controlled, and a more integrated vision that seeks to create synergies between the environment, livestock and the humans who derive a livelihood from them be applied in Mexico's agricultural sector.

5. The current national plan to combat desertification in Mexico is comprised of a fragmented network of programs divided among a variety of ministries and secretariats with different short-, medium-, and long-term objectives, as well as different fiscal and legal frameworks. An effective strategy should have a long-term vision, but should also be implemented at a program rather than a project level. This national program strategy should integrate, within the umbrella of a single organization, the goals of achieving adequate use of land, water, and other natural resources, as well as continued improvement and adaptation of agricultural techniques.

6. The drivers of drought and desertification are both natural, and anthropogenic. Hence, the legal and political provisions that contribute to the further degradation and marginalization of the country's agricultural lands should be assessed and revised to eliminate perverse incentives that lead to further soil degradation.

7. A final cross-cutting issue that affects the Mexican government's ability to plan and improve the efficacy of its programs is its lack of data-collection capacity and the dearth of comprehensive program evaluations. The design of the government's drought and desertification social safety net programs should include the development of measurable indicators, as well as credible short-, middle-, and long-term objectives, and include mechanisms that involve local beneficiaries in the decision-making process.

6. CONCLUSION

The case of droughts and Mexico-US migration demonstrates the complex relationship between the environment, humans, and the social and political frameworks that organize their interactions. As has been presented in this chapter, Mexico's experience with droughts dates back centuries, yet Mexico's preparedness in facing the cyclical crises that arise from extreme drought episodes has been aggressively developed only in the past decade. The lack of an effective safety net against droughts and desertification affects Mexico's most vulnerable, those who depend on their land for subsistence consumption. Often, this segment of the population has no other viable option but to migrate to the United States. While Mexican migrants have not been recognized as environmental migrants on either side of the border, the results from this case study have illuminated various areas of promise in the management of extreme poverty in arid and semi-arid areas, as well as coping with the increases in Mexico-US migration in the past decades.

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