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Immigration as a Response Variable to Climate Change from Mexico into the United States

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Abstract: *Climate change has been a controversial topic in many aspects of political public policy design, implementation, and response planning. However, historical models and scientific evidence supports the inevitability of changes that will occur in many regions of the world in the form of prolonged droughts and/or flooding due to many contributing factors, including human interaction with the environment. This study explores the historical trends associated with Mexico as well as the public policies that should be in place to support social responses to the projected future changes in environmental conditions in the Mexican region as well as the United States that may promote a need for immigration policy change.*

Keywords: Immigration, Climate change, Mexico, Drought, Holocene, Maya

1. Introduction

Climate change studied in many areas of science has been used to correlate many aspects of social constructs as well as sources for various decisions regarding migration. Population movement trends associated with social responses of people is used to report climate change impacts on social constructs and regions potentially affected by these changes (Moreno, Santoro, and Latorre, 2008). There is an overall international agreement and acceptance that anthropogenic changes to the environment are a result of human overexploitation of resources (Selin and VanDeveer, 2007). The purpose of this study was to examine the potential social responses related to climate change specifically the resulting recent controversial Mexican immigration into the United States.

Because Mexico is the largest source of immigration into the United States and is controversial in public policy,

causes and correlational responses related to climate change should be studied in order to project future changes in population shifts. History of Mexico's inhabitants and various studies surrounding the measurement of radiocarbon as well as pollen dating techniques have been able to provide more detailed explanations of the changes that have taken place in Mexico over time. Currently, the time span of human civilization and the history of Earth time records is relatively short lived and very little is known about potential climate shifts as a proven cause of human interaction or natural cyclic patterns of Earth history (Adger, 2003). Selin (2007) indicates that major changes in current policy will and should take place through international acceptance and implementation of policies that respond socially to eventual changes in environmental structures. As Archer and Rahmstorf (2010) indicated, the effects of climate change (global warming, droughts, flooding, ocean rise, solar radiation, etc.) have an uncertain direct as well as indirect influence on civilizations, but the historic models have shown a natural cyclic pattern of climatic shifts over specified time periods determined through various dating techniques. Because human civilizations are relatively new to the Earth, it is impossible to predict the exact consequences that human activities will have on the future climate of the Earth. However, a consensus among researchers agrees that overexploitation of agricultural resources as well as fossil fuels will have adverse impacts on human civilizations regardless of region (Anderson, Goudie, and Parker, 2007).

2 Literature Review

2.1 Historical Agricultural Impacts in Mexico Related to Potential Climate Change

By 2020, it is projected that annual precipitation in central areas of Mexico will reduce by approximately 12 % when compared to the year 2007 (Edmeades, 2009). This reduction is a severe problem due to Mexico's traditional vulnerability and recorded sensitivity to climate change (not only to people but to the large biodiversity of species) (Edmeades, 2009 & Magrin, Garcia et al., 2007 & Peterson,

Ortega-Huerta, et al., 2002). Also, the effects of a potential drought may cause the population as well as the potential influx of other Latin American countries into Mexico due to potential climate changes and resulting variations in agriculture production (Edmeades, 2009 & Magrin, Garcia et al., 2007 & Peterson, Ortega-Huerta, et al., 2002). The proven combination of potential adverse effects because of climate change has provided a reliable framework for creation of relationships between environmental changes and cultural changes in society (agriculture, family structures, economy, political influence, education, industry, etc.) (Moreno, 2008 & Turner, 2010, & Feynman, 2007).

Smith (1993) suggests that partial economic, social, and political responses in history can be assessed through the investigation into the agricultural techniques imposed in an area. In order to accurately assess today's Mexican climate systems, it is important to understand the Mayan history that precedes common agricultural practices today, but includes many similar aspects of climate change and potential social response that may occur in the future in order for civilizations to continually adapt to climate changes (Haug, Gunther, Peterson, et al., 2003). The Yucatan has been a major research area because of the impacts of climate change on the Mayan civilization that rapidly collapsed after a successful civilization structure had been developed (Metcalfe, Breen, Murray, et al., 2009 & Turner, 2010).

A timeline creation of central Mexico by Figueroa-Rangel, Willis, and Overa-Vargas (2009) report and confirm a cyclic period of humid conditions (4000-2500 BP) (1000 BC) as well as drought (2500-1900 BP) (100 AD) through sedimentary sequencing and pollen analysis of agricultural vegetation (specifically maize) providing interval data of one sample every 32 years. This technique of using pollen dating and analysis has been used to develop a cycle for recording weather patterns including the recording of drought conditions in central areas of Mexico beginning at 1200 BP-850 BP (1100 AD), 500 BP- 200 BP (1700 AD) (Figueroa-Rangel, 2009 & Hodell, Brenner, Curtis, 2007). This pollen dating has also been used in the Yucatan peninsula to correlate climate change with agricultural indicators of

human caused environmental changes, which also includes subsequent deforestation and reforestation growth (Metcalfe, 2009 & Mueller, Islebe, Anselmetti, et al., 2010). Conclusions from Figueroa-Rangel stated that the past 1300 years have shown a change in climate that was probably driven by latitudinal migration of the inter-tropical convergence zone (2009). Hodell, Curtis, and Brenner (1995) reconstructed and developed a dating model of the Holocene climate change using variations in oxygen isotopes in sediment cores from Lake Chichancanab and reported that the driest time of the late Holocene epoch coincides with the Mayan collapse interval between 1300 and 1100 yr BP (AD 800- 1000). However, Joyce and Mueller (1992) also indicated that a high population and a responding rapid growth in population centers such as in the Oaxaca valley degraded agriculture land through overpopulation, resulting in landscape modification that left the land unsuitable for continued successful crop production.

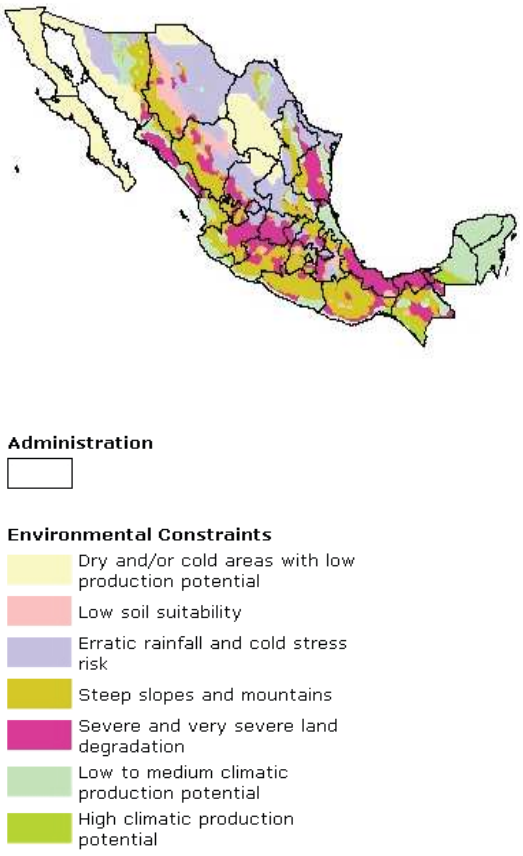
Haug (2003) confirmed through titanium percentages found in the Yucatan that drought periods not in one time span, but actually in repeated cyclic patterns but an overall mean change in weather patterns contributed partly to the demise of the Mayan civilization. Prior to the actual Terminal Classic Collapse (950 AD) research has indicated that the area previously had potentially wetter climatic times and population growth which was followed by an extended severe drought period (Haug, 2003). This suggests that the population had grown to a point of sustainability when compared to agricultural resources, but was not sufficient during times of inefficient agricultural practices as a result of drought and population growth exceeding environmental capacities for sustaining through agriculture production. The overall evidence suggests that the short term (6000 BP until present) climatic impacts which are a major part of human evolution contributes to the factor of instability and uncertainty when attempting to create climate change model and predictions in relation to human societal changes including population shifts as a result of a regions inability to sustain civilization growth.

Anselmetti, Hodell, Ariztegui, et al. (2007) and Orlove (2005) suggested that during times of drought and/or population growth, agricultural practices also destroyed land

that may have previously provided sufficient agricultural crops, but the overexploitation and resulting erosion of the land also contributed to the demise of the Mayan civilization. Mueller, et al. (2010) used pollen record dating techniques to note that periods of reforestation and deforestation cycles occurred between periods in which Mayan civilizations occupied the Yucatan peninsula. The reports of Mueller also indicate that the land was able to replenish soil fertility after the Mayan collapse and soil stabilization stratigraphy required a time of 120-280 years to replenish back to pre-Mayan forest-vegetation sustainability levels (2010).

According to Edmeades (2009), corn (maize) is the most important crop in Mexico, and a drastic precipitation drop would result in a reduction of land use productivity regardless of the agriculture staple, but may be more problematic with a single crop as opposed to a more diverse system. Because Mexico also has a varying degree of land use potential and elevation grades, assessments have been made to determine potential risks of agriculture constraints due to the environment (Figure 1). Noticeable differences found in Mexico are land degradation and steep slopes that can cause agriculture production to be limited as well as the potential for misuse of land causing further depletion of resources. In various geographic distributions of Mexico, Peterson, et al. (2001) reported historical patterns of migration, adaptation, and population shifts in history throughout various regions; however, a number of different factors may have caused these shifts. These shifting patterns (noted as a species relocating to changing environmental niches) are a result of individualized species either adapting or evolving over time as a result of climate change in Mexico (Peterson et al., 2001).

Figure 1 Baseline Map: Current Major Environmental Constraints Related to Agricultural Potential



Source: FAO Note: Mexico and agricultural resources

Sustainability in agriculture (Yohe, Lasco, Ahmad et al., 2007) involves specific planning by regions and countries to implement programs that assess and reduce vulnerability of regions by adverse environmental exposure to crop areas. In order for a region or country to survive in a changing climate, it would require agriculture production to be diverse and many communities would need to work together as a society in order to be successful in supporting themselves. When this societal system breaks down, people may choose to migrate to other areas in order to survive. This may be a

partial reasoning for inhabitants of Mexico migrating into the United States.

United States Public Policy Related to Mexico and Migration

According to Feng, Krueger, and Oppenheimber (2010), the North American Free Trade Agreement (NAFTA) has resulted in negative labor demands, cheaper agriculture imports, and changes in United States immigration policy. There has also been a trend of people moving from rural farming communities to larger cities as industry becomes more economically feasible for not only small communities, but also entire regions (Cifuentes, Borja-Aburto, et al., 2001). Climate change (such as severe droughts or flooding) can cause mass migration from countries that are adversely affected by changes in specific regions (Feng, 2010). Yohe, et al., (2007) reported with high confidence that future climate changes will hinder many affected nations' ability to cope with climate change though specific mitigation and adaptation policies that would be required to alleviate detrimental results of human contribution to the climate changes. However, the specific amounts of potential changes in regions (specifically Mexico) are only speculative and few studies have provided empirical evidence of the actual amount of change that will occur as a result of human impacts.

In order to change the current trends, there must be mitigation and/or adaptation policies addressing climate change response through sociological perspectivesand changes in current sociological trends found in a worldwide society (Orlove, 2005). According to Selin (2003), the social learning model for implementing climate change policy must include international agreement of implementation in order to mitigate current conditions that adversely affect the environment. However, current policies have been developed within single nations with shared goals and ideas for implementing mitigation and adaptation to climate change structures (Selin, 2003). Although Yohe, et al. provides a model of sustainable development through human response and a relation to accessible resources, a consensus among theorists is that in order for populations to continue to agriculturally thrive and adapt will take the sharing of social,

ecological, and economic resources of various regions (2007). This sharing of resources between Latin America and the United States would require the creation of policies that change current immigration laws and resource availability currently enforced in the United States that hinders migration from Mexico and many Central American countries that will be affected by climate change in the projected future. Figure 2 graphically represents the number of children that are malnourished as well as the noticeably prevalent poverty that is found throughout Mexico. This rate of malnourished population is an indication of insufficient agriculture production to sustain the population now living in the region. If a region or country has malnourished inhabitants that cannot be supported, a social response to survive would naturally occur. Malnutrition is a direct result of inefficient agriculture and research has shown that climate change and the inability of a civilization to create a sustainable environment may be a result of climate change and subsequent population growths.

Figure 2. Child malnutrition rates by region

Source: Taken from CIMMYT (2001).

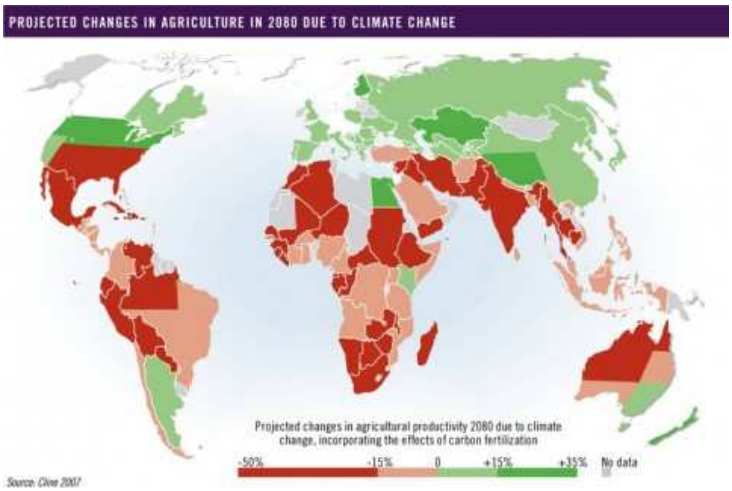
3. Future of Mexico and Climate Change

The widespread change in climate will cause many regions to become unsuitable for agriculture production that can sustain the growing populations (McLeman and Smit, 2006). The result of land changes and drought conditions may cause migration to occur as a result of adaptation and mitigation of controllable environmental conditions (McLeman and Smit, 2006).

Although McLeman and Smit (2006) do not cite specific evidence of the Mexican population shifts, the study does provide evidence of shifts within regions of the United States during severe droughts that cause large numbers of farmers to migrate within country limits in order to sustain a hunger limitation on the environment. There is also a potential increase of population from Latin America into Mexico as climate change could bring in more severe droughts as well as more frequent hurricane activity (Magrin,

2007). Reuveny (2007) indicated that areas more directly dependent on the environment for survival would be more likely to migrate to other areas where the environment proves more favorable for survival. As Figure 3 indicates, by 2080 there will be more frequent droughts in areas along the equator as well as the tropics, indicating a potential migration trend toward the poles (Cline, 2007). There is a need for policy makers and society to cross boundaries of various regions in order to assist with social implications and effects of climate change (Shackley and Wynne, 1996). Worldwide implications of change are required in order for individual regions to address population survival as a result to climate change.

Figure 3. Projected Agriculture changes in 2080 as a result of climate change.



Source: Taken from Cline (2007)

Policies that have been created to prevent migration into areas for survival have often been met with violence (Reuveny, 2007). The Mayan civilization did not migrate to other areas of the world and faced a severe collapse in population as well as the Polynesians on Easter Island. When ramifications are placed on current populations such as the border policies in place between Mexico and the

United States, the results can become violent as well as unlawful. Reuveny (2007) indicated that when climate changes occur, developed countries have technology and finan cial abilities to mitigate changes while less developed countries must remain in the area and adapt or migrate to areas where the environment is more favorable to support the lives of the inhabitants. When food production or land degradation threatens the economic or direct survival of a population in a less developed country such as many areas of Mexico, the people must respond in order to survive. Because the United States is a thriving country agriculturally and economically (relatively speaking), the people of Mexico may choose to come to the United States as a means of survival as opposed to convenience (Reuveny, 2007).

Shackley (1996) suggested that policy making through a certain amount of uncertainty between a global community prevents social interaction between nations and suggests that boundary-crossing among the scientific and social communities would enhance knowledge as well as be profitable for climate change response in terms of policy design and implementation. The continuous potential climate change cycle could result in extreme drought and flooding variation; thus causing change in environmental and social constructs that would be detrimental to human societies by increasing famine in affected areas, which in turn could develop chain reactions to other nations having to support an increase in population shift (Moreno, 2008). As Orlove (2005) stated, civilizations must adapt to inevitable climate changes in order to continually survive and meet the basic needs for social survival. Civilizational survival is dependent on many factors, but a primary factor is the interdependence of resources found within adjacent civilizations and the ability of individuals and groups to rely on each other in order to adapt to changes (Adger, 2003).

This collective action among civilizations should be the center for policy development for management of natural resources and should exist under policy regimes for community resource involvement and utilization in developed countries when responding to and aiding less

developed countries (Adger, 2003). This is a role played by individuals, termed social capital, in which groups work interdependently under similar policies in order to continue to survive and follow similar policy implementation in order to adapt to the changing environments, such as the IPCC (Intergovernmental Panel on Climate Change) (Adger, 2003). Reuveny (2007) stated that if mitigation efforts are not developed and implemented in order to remediate environmental changes, the effects of climate change would be costly, not only economically but biologically as well. While developed countries continually contribute to the burning of fossil fuels without immediate consequence, the less developed countries will continue to suffer and migration from these less developed to more developed countries will continue to occur (Reuveny, 2007). This may also prove to become more violent as resources diminish without developed solutions or policies to respond to the climate change situations that are predicted to occur in the future (Reuveny, 2007).

4. Recommendations and Implications

Although the IPCC briefly discusses the impacts of climate changes on migration patterns, there is evidence suggesting that as regions are unable to continually agriculturally and economically sustain the current lives of people present in a specified region, the population will shift in order to increase survival rates for future generations (McLeman and Smit, 2006). The Mayan as well as other civilizations that contributed to the degradation of the land in Mexico may have also assist with impeding current agricultural production by overexploiting the resources at the time. With populations continuing to grow in the country, it may be impossible for the current land to become sustainable for agricultural commodity growth because of the impacts of civilizations that occupied the land 2000 years ago as well as the current projected climate shifts in the region. Risks associated with specific locales of groups within regions (such as the limited capabilities of Mexico to agriculturally provide for the social community) must rely on outside resources (i.e. the U.S.) in order to survive and grow as a nation. However, policy creation and implementation

must be developed that could be respected and supported by all stakeholders. However, the supporting groups should not develop policies that ultimately hinder their own production of support for the region by attempting to assist other regions. Therefore, both regions should collectively develop policies that would help international societies thrive by offering and accepting economically feasible and cooperative solutions that would assist in the adaptation of impeding changes that may occur in the future. A worldwide adoption of policy should be implemented and supported in order to support social constructs between all nations. Although many developed nations have the ability to have the greatest impact on natural resource use, the support from less developed countries would be required for successful adaptation and mitigation of adverse climate contributing conditions that human civilizations have supported for the last century.

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