**How will climate change impact migration patterns and policy responses in the Mexico–US border region?**

Fernando Corral Lozada

The Hertie School

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Thesis Supervisor: Asya Magazinnik

ABSTRACT

In light of the current climate change scenarios and its increasing impacts on Earth, migration patterns are correspondingly changing. This master thesis aims to analyze how current migration flows through Mexico will change due to increasing temperatures worldwide, causing environmental and socio-economic stress in immigrants’ host countries, Guatemala, Honduras, Mexico, and El Salvador, and heightened temperatures in the crossing zones of the Mexico–US border. Furthermore, this thesis will explore the impact of these changes in absolute terms on the immigration influx reaching the United States. The countries with the largest outflow of immigrants are Guatemala, Honduras, Mexico, and El Salvador, and will be the focus of this paper.

The paper will focus on people’s immigration intentions by utilizing a model on intentions,

The thesis will analyze people’s immigration patterns, particularly focusing on the destination of choice, which is the United States. Using the high, medium-low, medium-high models on climate change, the research will explore international migration, where the U.S. is the preferred destination. Moreover, the final aim of the thesis is to evaluate Mexico's preparedness and policy responses to address climate-induced immigration and related challenges, including potential strategies for accommodating immigrants seeking refuge.

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13. GLOSSARY/ ABBREVIATIONS

"Migration" generally refers to the movement of people from one place to another, whether it's within a country or across international borders. It's a broader term that encompasses various types of movements, including both immigration and emigration.

"Immigration," on the other hand, specifically refers to the act of people moving into a new country to settle there permanently or semi-permanently. It focuses on the receiving country's perspective and is often used to describe the process of individuals or groups coming to live in a new country.

GFDL: Geophysical Fluid Dynamics Laboratory

CM3 Global Climate Model:

CMIP: Coupled Model Intercomparison Project

RCP: Representative Concentration Pathways

Radiative Forcing: the balance between the energy coming into Earth’s atmosphere from the sun and the energy that Earth radiates back into space. When an imbalance occurs, it can lead to changes in Earth’s climate.

GHG: Greenhouse gases; consisting of carbon dioxide, methane, ozone, nitrous oxide, chlorofluorocarbons, and water vapors.

IPCC Intergovernmental Panel on Climate Change <https://www.ipcc.ch/>

Radiative Forcing: Radiative forcing is what happens when the amount of energy that enters the Earth’s atmosphere is different from the amount of energy that leaves it.

<https://climate.mit.edu/explainers/radiative-forcing>

1. INTRODUCTION

Climate change is the greatest human-made problem that the world has seen and the greatest challenge that society has yet faced. Global greenhouse gas emissions have continued to increase due to the extreme use of natural resources and exploitation of fossil fuels, resulting in a temperature increase of 1.1°C above the 1850–1900 average between 2011 and 2020 (Calvin et al., 2023). World-wide mass consumption, aggressive land use, and the release of gas pollutants into the atmosphere, all contribute to the ongoing global warming crisis we are facing. Historical contributions of CO2 emissions vary extensively across every region in the planet, with developed economies contributing to a higher extent of CO2 emissions and less developed countries emitting much lower per capita emissions.

Extensive alterations have taken place in the atmosphere, ocean, cryosphere, and biosphere. Human-induced climate change is presently impacting numerous weather and climate extremes globally, resulting in losses and damages to both ecosystems and human populations. Vulnerable communities, historically having the least contribution to ongoing climate change, are experiencing disproportionate impacts.

As stated in the Intergovernmental Panel on Climate Change (IPCC) report ‘Climate Change 2023: Synthesis Report’, roughly 3.3 to 3.6 billion individuals reside in areas highly susceptible to the impacts of climate change. Vulnerability of both humans and ecosystems is closely linked. Paradoxically, the majority of these populations facing significant development challenges and vulnerability to climatic hazards are the ones that contribute in a lesser extent to climate change but suffer the most. These severe effects of climate change have impacted food security and access to water, with the most affected regions being in Africa, Asia, Central and South America, Least Developed Countries (LDCs), Small Islands, and the Arctic. From 2010 to 2020, mortality rates resulting from floods, droughts, and storms were notably higher—15 times more—in highly vulnerable regions compared to those with very low vulnerability (Calvin et al., 2023).

International efforts to combat climate change have been done since the 1990’s with UN’s Framework Convention on Climate Change (UNFCCC) in 1994, setting a framework for global cooperation to stabilize greenhouse gas concentrations in the atmosphere. This framework was a follow up of the Montreal Protocol of 1987 where it bounded the states to act in the best interests of humanity focusing in lowering CO2 emissions to 1990 levels (*What Is the United Nations Framework Convention on Climate Change? | UNFCCC*, n.d.). By 1997 the Kyoto Protocol took place, extending and reiterating commitments of the UNFCCC where 37 members of industrialized economies were part of the treaty. An essential aspect of the Kyoto Protocol was the introduction of adaptable market mechanisms, centered on the exchange of emissions permits. While nations were primarily required to achieve their targets through domestic actions, the Protocol also provided alternative avenues for meeting these targets through three market-driven approaches and by monitoring emission targets (*What Is the Kyoto Protocol? | UNFCCC*, n.d.).

The Paris Agreement was the result of the UN Climate Change Conference (COP21) in Paris in December 2015 achieving a significant historic agreement among its members. Entering into force in November 2016, the Agreement outlines ambitious long-term objectives to guide all nations to substantially reduce global greenhouse emissions, striving to limit the rise in the global temperature by well below 2°C above pre-industrial levels, with efforts to cap it at 1.5°C, conducting periodical assesments, and provide financial support to developing nations to address climate change. Currently, 195 Parties, including 194 States and the European Union, have ratified this legally binding international treat (United Nations Framework Convention on Climate Change (FCCC), n.d.). Since then, the Paris Agreement has set the ground for the scientific community to evaluate possible future climate scenarios by creating effective policy and be better prepared for the future.

Since 2020, there has been a consistent yearly rise in the overall count of displaced individuals attributed to disasters compared to the preceding decade, averaging a 41% increase, according to studies done by the Internal Displacement Monitoring Centre in 2022, where climate refugees alone amounted to 36.2 million worldwide. This escalating pattern, notably concerning, has seen climate change emerge as the primary force propelling this surge in 'climate refugees,' a trend expected to persist (European Parliament, 2023). Over several years, the most devastating effects have been witnessed, particularly in the developing world, with extreme weather events such as floods, tsunamis, wildfires, and extended dry seasons leading to droughts. In its report "Migration, Environment and Climate Change: Assessing the Evidence," the International Organization for Migration (IOM) forecasts that this number might reach up to 1 billion displaced people by 2050 (Laczko et al., 2009).

In Latin America and the Caribbean, temperatures have risen by approximately 0.7°C to 1°C compared to the average from 1961 to 1980, as reported by the World Meteorological Organization in 2023 (Ignacio Fernández & José Eduardo Alatorre, 2023).

This temperature rise has led to an increase in the frequency of heatwaves, impacting productivity and economic growth, according to reports by the Intergovernmental Panel on Climate Change (IPCC) in 2022 (Calvin et al., 2023). Glaciers in the tropical Andes have lost around 30% of their surface area since 1980, affecting ecosystems, water resources, soil quality, erosion rates, and leading to an uptick in flooding and landslides. The region has faced severe droughts, notably in central Chile, which is likely the longest and most severe in at least a millennium; in the Paraná-La Plata Basin, it's the most severe since 1944; and over 50% of Mexico has grappled with severe to exceptional drought conditions, as documented by the WMO in 2023 (*World Meteorological Organization - 2024 - Socio-Economic Impacts.Pdf*, n.d.). Additionally, coral reefs are experiencing declines in abundance, density, and coverage, along with an increase in bleaching events, impacting the ecosystems they support. Forest fires and the spread of diseases carried by vectors have also been on the rise in the region, according to reports by IPCC and WMO in 2022 and 2023 respectively.

Alterations in the climate system yield adverse consequences on economic endeavors, ecosystems, and human welfare. Various recent appraisals have been made regarding the worldwide economic ramifications of climate change. These assessments, characterized by variances in scope, methodology, and temporal perspective, indicate that the influence of climate change on per capita GDP could span from 4.6% to 30% by 2100, assuming a high-emissions scenario. Projections for 2030 already indicate a reduction ranging from 0.8% to 5% of per capita GDP. There have been many projections of how GDP per capita could evolve in Latin America and the Caribbean. Estimates from different analysis suggest a decline ranging from 0.8% to 6.3% by 2030 and potentially up to 23% by 2050. Solely considering the rise in temperature under a high-emissions scenario, could result in a decline of 1.3% and 3.3% in per capita GDP by 2030 and 2050, respectively, and potentially leading to a rise of 3.2 million individuals living in poverty (Ignacio Fernández & José Eduardo Alatorre, 2023).

However, in the context of Latin America, climate change and increasing temperatures are not the only factors that might weigh into the decision of migrating. Factors such as gang violence, income, food security and access to quality public services have their own role in deciding whether migrating or not. Although each of these factors might play an important cause by their own, there is empirical research that says they might be closely related to the rise of temperatures.

Strategically managed migration can effectively address various challenges within a nation's landscape. The 2014 OECD's Migration Policy Debates outline numerous benefits associated with migration. It helps alleviate shortages in the working-age population and contributes through tax payments.

In the labor market, immigrants significantly contribute to the expansion of the workforce, participating in sectors experiencing growth as well as those in decline. Economically, immigration increases the working-age population and introduces valuable skills that enhance the human capital of recipient countries. Additionally, immigrants play a role in advancing technological progress, ultimately stimulating overall economic development.

HERE: NEED TO FORMALLY INTRODUCE IMMIGRATION FROM LATAM INTO THE US

1. LITERATURE/ RELATED WORK

0/0/00 0:00:00 AM

UNDER THE RCP-SSP climate model scenarions 1, 2, 3, and 4 (write the names), with the TRAC (border-cross immigration data) data, and with the next socioconomic variables, X, Y, Z, (data retrieved from the World Bank) in the countries of El salvador, Mexico, Guatemala, and Honduras: predict how increasing temperatures will impact all of these variables

1. THEORY

ASYA’S QUESTIONS:

1) Assemble climate dataset: probably want it in a structure of monthly averages, but the questions is what time do we associate with a month in the border crossing/stopping data? e.g. if someone is stopped in April 2020, in what time/place does the climate inform their decision to migrate?

**Document name: REF5**

**Link:** [**https://www.science.org/doi/10.1126/science.aao0432#BIBL**](https://www.science.org/doi/10.1126/science.aao0432#BIBL)

Our estimation results indicate that self-reported exposure to environmental stress is associated with a higher probability of intending to migrate within the next 12 months both within and across national borders.

2) On the same topic, research what factors and over what period drive people to migrate. We’ll need to collect data on those other factors as well — yearly averages, for the countries of interest (about 10 or fewer), for the years (approximately) 2011-2022, on some political and economic variables like unemployment, crime, violent conflict. Need to research what these factors are exactly. Ok if you code them using your own judgment, using media accounts etc.

>>> violence, income, food security, amenities, urbanisation, rising temperature

3) What is the causal mechanism that links temperature to decision to migrate? Direct, e.g. high temperatures contribute to low quality of life —> drive people to migrate? High temperatures associated with climate disaster —> migration? High temperature —> local economy/society —> migration?

Controlling: holiding things constant

What does that ‘controled’ variable explains statistically about x and y.

Ex. Goin gto the doctor.

* Control variable: Going to the doctor when sick: 60% of times. Going when not sick: 10%. 60% - 10% = 50% is explained by being sick. (X and Y) We get rid of the variation by holding constant the X and Y.
* Outcome variable: People who were not sick, are now sick: 5%. People who were already sick, 90% will be sick. 90% - 5% = 85% is being explained by being sick before.
  1. (Ref 6) Rising temperature –> causes –> Productiviy Loss

Session with Asya March 12th

1. What if I find papers that contradict each other? What should I do in those cases? Ex. Some papers say that the most propense people to migrate are those from low economic background, others say that educated people.
2. Show the data.
3. Show the variables.
4. What if data or surveys like in this last paper is outdated? (2000 – 2010) (Ref 7)?
   1. About gallup data: the questions (in the excel file), should be all from the same year regardless if they are old results?

Look for polls:

<https://gallup.com/analytics/318875/global-research.aspx>

1. DATA

The python library that needs to be used to open the specific files that contain weather data such as temperature, humidity, pressure, windspeed, and direction, is called ‘netCDF4’. This library is built on top of HDF5, a high-performance data management and storage suite that supports n-dimensional datasets and each element of the dataset may itself be a complex object. <https://www.hdfgroup.org/solutions/hdf5/>

1. METHODOLOGY

**Coupled Model Intercomparison Project (CMIP)**

A black and white text on a white background

Description automatically generated

<https://www.unidata.ucar.edu/software/netcdf/software.html>

SESSION WITH ALEKSANDRA KAPP

1. Check the metadata of files in my basket. <https://esgf-data.dkrz.de/datacart/display/1/16944/>
2. Which software should I use? <https://www.unidata.ucar.edu/software/netcdf/software.html>
3. I believe raster data (temperature) is the best. Is it actually?
4. Which file format should I parse the .nc file to? <https://mygeodata.cloud/conversion>
5. Can I use the poster project in your class along with this same data?
6. Python or R? <https://docs.scipy.org/doc/scipy/reference/generated/scipy.io.netcdf_file.html>
7. Larry Horowitz: asking for latitude and longitude coordinates of the region. How to get those?
8. Leer primero esto: <https://www.unidata.ucar.edu/software/netcdf/software.html#Python>
9. Abrir su script y correclo en VSC y Jupyter: aleks\_air\_temp.py

Python:

1. Intentar con rasterio
2. <https://www.google.com/search?q=reading+netcdf+Unidata+NetCDF4+module+for+Python&oq=reading+netcdf+Unidata+NetCDF4+module+for+Python&gs_lcrp=EgZjaHJvbWUyBggAEEUYOTIKCAEQABiABBiiBDIKCAIQABiABBiiBDIKCAMQABiABBiiBDIKCAQQABiABBiiBDIKCAUQABiABBiiBNIBCDY2MDVqMGo3qAIAsAIA&sourceid=chrome&ie=UTF-8>
3. if not
4. Revisar el

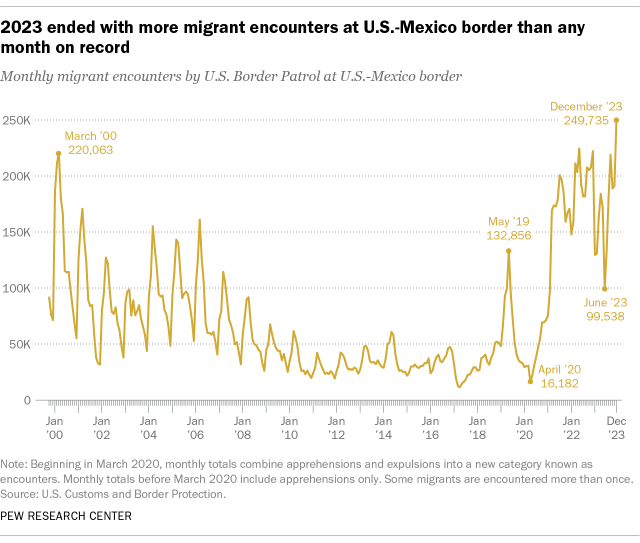
Revisar GDAL (for writing and reading raster and vector data): <https://gdal.org/index.html>

Revisar este libro: <https://py.geocompx.org/>

QUESTIONS FOR LARRY

Whoch SSP release version are these scenarios based on?

**WORDL BANK PARA DATOS ECONOMICOS**



<https://www.pewresearch.org/short-reads/2024/02/15/migrant-encounters-at-the-us-mexico-border-hit-a-record-high-at-the-end-of-2023/>

1. RESULTS
2. DISCUSSION
3. CONCLUSION
4. BIBLIOGRAPHY