Storying Climate Change in Panama

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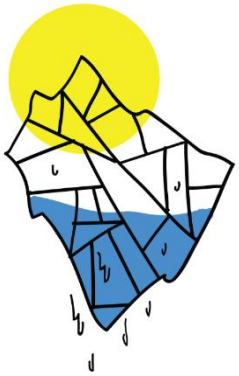

Sponsor
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Abstract

"Storying Climate Change" is a project collection sponsored by Professor Ingrid Shockey that addresses the lack of stories about the effects of climate change. Our project contributes to the collection by finding and amplifying the voices of people in Panama. Through heartfelt interviews, we created a documentary to empower Panamanian voices. We discovered that Indigenous and poor communities are disproportionately affected by climate change. Their stories highlight the need for climate justice and awareness regarding their climate change experiences.

Link to YouTube playlist containing documentary:
https://www.youtube.com/playlist?list=PLLp2Ec88EnEEE_zqmfH6o-Ex2uTtOboNC

Executive Summary

Introduction

In the 21st century, climate change has rapidly become a global issue, causing devastating effects on the environment and its inhabitants. The emission of greenhouse gases due to human activity is widely recognized as the primary cause of climate change. Sea levels are projected to rise by at least another foot within the century, severe weather phenomena will become stronger and more frequent, and millions of people will continue to be displaced because of climate change (NASA, 2023; “Displacement, disasters and climate change”, 2023). Amidst these concerns, climate change has already heavily impacted some regions of the world. One such region is Panama, which connects North and South America. Our project contributes to the “Storying Climate Change” project collection which aims to share the climate change narratives of people from around the world. To empower Panamanians, we created a documentary allowing them to share their experiences and concerns regarding climate change. The data gathered highlights the need to amplify unheard voices and call for action against climate change.

Literature Review

Climate change is the long-term changes in weather that are unnaturally exacerbated by unsustainable human activities such as the mass use of fossil fuels. With 67.2% of Panama's total energy generation relying on hydropower (“Energy profile: Panama,” 2022) and about 3.5% of Panama's GDP coming from the Panama Canal ("Trade Policy Review Report," 2022), extreme weather like droughts place the energy sector and the economy at a major risk. Over time, the increasing intensity of weather events resulting from climate change has been threatening ecosystems and causing both the displacement and death of many people and species. The continuation of these unsustainable practices such as deforestation, especially the removal of

mangroves, drastically minimizes carbon sequestration and plays a role in diminishing Panama's immense biodiversity. Despite the country not being a major contributor to climate change, with Panama being mainly surrounded by coastline, the country is incredibly vulnerable to coastal erosion, droughts, sea level rise, extreme weather, and other negative impacts of climate change.

The disproportionality of how climate change impacts Panamanians because of their various economic states further contributes to the minimal mitigation of it and increases Panama's vulnerability, especially since underprivileged people tend to lack the education and financial stability to get access to sustainable tools. Indigenous people are particularly vulnerable to climate change in Panama due to their dependency on nature to survive. Climate and environmental justice acknowledge the disparities in which the effects of climate change are felt by underrepresented and minority populations. With the unpredictability of weather, ocean, and soil patterns, not only are Indigenous people at risk of becoming climate refugees, but low-income people like farmers and fishermen are also at risk of losing their livelihoods as well. Because climate change has unequal impacts on various demographics, especially Indigenous communities, there has been an increase of climate activism for the government to implement climate policy to help these people mitigate and adapt to the effects of climate change. The increase in climate activism in recent years also raises awareness to protect specific groups of people from not only negative environmental effects, but also the negative health and economic effects that stem from climate change as well.

Since in recent years there is more awareness of how climate change negatively impacts various areas of society, Panama has implemented some laws that address these impacts. There are many laws and plans in place that address sustainable ecotourism, climate adaptation and mitigation tools that have been created by the Ministry of Environment, as well as a law created

in 2022 that recognizes and respects nature's right to exist in Panama. Ever since joining the Climate and Clean Air Coalition in 2018 Panama has also worked to move their waste sector towards a circular economy to reduce waste and promote sustainable practices as well as climate adaptation plans to increase resiliency in agricultural and fishing sectors (Climate and Clean Air Coalition, n.d.). Incorporating climate justice into discussions of policy making and allowing for the voices of vulnerable and underrepresented groups to be amplified in this conversion allows for just practices and actions.

Through Professor Ingrid Shockey's past "Storying Climate Change" projects done across the globe, which has the goal of amplifying the voices of various people on how climate change affects them, we discovered that many projects used the same technique of choosing interviews to collect these stories and using interviewee referrals to find more participants. Our group also observed that most of the past projects created documentaries as their deliverables in order to make the voices of the interviewees more accessible to all age groups. One of the largest themes found from these projects was a lack of sufficient climate change education and that more people are moving from rural to urban areas for better job opportunities since job security in the agricultural sector for example is declining. Overall, these "Storying Climate Change" projects put the voices of people in various countries at the forefront of climate conversations and highlight that more action and climate change awareness is necessary.

Methodology

The goal of this project was to create a documentary based off the narratives of Panamanians regarding their experience with climate change by conducting and recording a series of interviews. We followed these steps to achieve this goal.

Before arriving in Panama, our team conducted archival research to learn as much as we could about Panama, its culture, and its residents. During research, we split up our interviewees into three groups: Indigenous people, experts, and general residents. We also brainstormed the types of organizations and occupations we wanted to hear from, as well as locations that were affected by climate change.

Once we arrived in Panama, we reached out to Panamanians to setup interviews. Based on factors such as location and demographic, we created different questions for interviewees. For nearly all the interviews, our team travelled to our interviewees requested location. We maintained a less structured interview whenever possible in order to allow the interviewee to tell their story with little guidance from us, but this was not possible to do in Spanish as none of our team poke fluent Spanish. We utilized our phone camera to capture video and backup audio and a set of lapel mics and wireless receivers/transmitters to capture main audio. We also utilized a tripod to stabilize video.

After the interview process was over, we analyzed our footage by clearing the audio up and coding the clips by keyword and timestamp. This allowed us to group similar clips together in a Google Sheet, and then develop common threads between all the clips. We decided upon making the documentary about climate effects, economy, and education. We also added the direct quote of the interviewee for sections that had relevancy to our threads. We were able to reference and copy directly from this Google Sheet when we created the outline of our draft of our documentary. Since we had the direct quotes, we were able to piece together the documentary by reading the clips like a written story. This simplified the outline process, as we did not have to go through the videos and find clips by skimming through different timestamps.

Our team used Davinci Resolve, a free video editing software, to produce the final documentary. Since our clips were already outlined, the clipping and stitching process for the video was simplified. We had a collection of B-roll clips that we layered over the interviewees to provide more context to what they were speaking about and to make the video more compelling. We also wrote a script and layered B-roll to create an intro to our documentary, which highlights aspects of Panama such as its culture and biodiversity.

The documentary was our final deliverable, so once it was finished, we uploaded it to YouTube where it is now available to the public. It can also be found on the WPI website where it has joined the collection of other climate story documentaries that were created in other countries.

Results

Although many experts confirmed the definition and causes of climate change our team discovered through archival research, some interviewees proved to make claims with religious influence. Regarding causes, many people acknowledged CO_2 emissions, but pollution, an excess of cars, and mining were also stated as contributors to the climate crisis. Although definition and understanding of climate change varied among those interviewed, all noticed changes in their environment. Among these changes, increased temperature and heat were noticed the most, with changes in precipitation patterns, sea-level rise, water temperature increases, coral bleaching, loss of biodiversity, droughts, and floods also being mentioned.

While climate change has modified the environment in Panama, the effect it has had on people proves to be detrimental. With these changes in environment, some interviewees have either been directly affected or shared stories of other Panamanians that have experienced hardship due to climate change. We interviewed Panamanians who have lost their homes in

floods, are being displaced from their island due to sea-level rises and have suffered mental health afflictions due to climate change. Accessibility to clean water and food has been impacted due to droughts, and changes in water temperature and increases in extreme weather events have led to difficulties fishing.

Interviews also revealed opinions pertaining to the groups that have been impacted most by climate change. Indigenous, coastal, and poor communities were identified to be the most vulnerable demographics to climate change, with many interviewees mentioning the difficulties these groups will have adapting to and mitigating the effects of climate change due to inaccessibility of resources. One of these resources was revealed to be proper education in regard to climate change, leading to the utilization of unsustainable practices with little to no knowledge of the potential consequences. This theme progresses into the governmental and political climate in Panama. Many of our interviewees displayed disdain for the Panamanian government about enforcing laws and policies created to protect environments and communities from climate change. Some claimed the government did not interfere with illegal practices due to the economic benefit these practices could have for Panama.

Evidence was revealed to suggest the impact of climate change on the economy, with narratives of droughts affecting the Panama Canal and allowance of ships through the watershed, along with impacts on agriculture productions due to environmental shifts. Furthermore, destruction of habitat, reduction of biodiversity, and an increase in risk of bodily harm from extreme weather events has impacted tourism in Panama. With these impacts being felt and lived by those interviewed, there was a strong call for change in order to survive and an urgency in this demand. A prominent theme was the advocacy for the voices of the underrepresented to be heard in the argument of climate change adaptation. Many people desire for the voices of youth and

Indigenous groups to be amplified, claiming they pose as a solution to ensuring the future of our planet.

Conclusion

Our team composed a final documentary from eighteen interviews with Panamanian residents. Through their stories, we found several trends and themes that highlight their vulnerabilities, concerns, and experiences regarding climate change. Our project shares similar trends as many previous "Storying Climate Change" projects, but it also provides insight and experiences unique to Panama.

From our findings, we were able to develop findings for three groups of people: Future teams, Panamanians, and Global Populations. For future teams we recommend expanding the geographical location of this project, planning trips to important sites well in advance, and being cognizant of the population being interviewed. Our recommendations for Panamanians include enforcing current policies, increasing climate change education, implementing proper land use, and encouraging sustainable practices. For global populations, we believe it is important to acknowledge the disparity in global emissions, discourage environmentally unfriendly practices, and amplify unheard and vulnerable voices.

We found it important to empower people who often do not have a voice with respect to climate change. We would like to see this project continued by future groups because there are so many more stories waiting to be told. The stories have shown how great a threat climate change is in Panama. We hope through these stories people will be more aware and willing to act against the global threat that is climate change.

Acknowledgments

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Professor **Jim Chiarelli** who was unable to attend Panama but advised us in our preparatory term.

And the **interview participants** for sharing their stories and continuous amiability.

From left to right: Professor Ingrid Shockey, Professor Grant Burrier, Professor Curt Davis

Authorship

Benjamin Brooks: Co-author who contributed to significant portions of the drafting process. Contributed to editing and revising the paper. Designed cover pages and graphics. Assisted in recording footage and finding timestamps for the documentary.

Jayson Caissie: Co-author who contributed to significant portions of the drafting process. Made significant contributions to editing and revising the paper. Assisted in finding timestamps for the documentary, performing voiceovers, and adjusting audio.

Jewel Pauly: Co-author who contributed to significant portions of the drafting process. Contributed to editing and revising the paper. Assisted in finding timestamps for the documentary and facilitating the interviewing of participants.

Elliot Trilling: Co-author who contributed to portions of the drafting process. Contributed to editing and revising the paper. Significantly contributed to the documentary by leading the production and editing process.

Olivia Vogel: Corresponding author who contributed significantly to the drafting process of the paper. Made significant contributions to editing and revising the paper. Assisted in finding timestamps for the documentary.

Team Photo: (Left to Right), Benjamin Brooks, Jayson Caissie, Olivia Vogel, Jewel Pauly, Elliot Trilling

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Chapter 1

Chapter 1. Introduction

Climate change exerts a pervasive and far-reaching influence on the entirety of Panama's population. Just north of Panama, amidst the azure waters of the Caribbean, lies an archipelago known as the San Blas Islands. These tropical islands are home to the Guna Yala, an Indigenous community who are profoundly connected to their environment and traditions. The rising sea levels, driven by climate change, threaten the place they call their home. Although the Guna are the first recorded incidence of human displacement due to climate change in Panama, the entirety of the country is put at risk from the adverse effects threatening their population. An hour's drive from Panama City is one of the oldest municipalities in Panama known as Chepo. The town contains a rich history, diverse culture, and unique traditions. However, recent floods have become noticeably more intense and have threatened the livelihoods of those living in other rural areas. In the town, El Pájaro de Pesé droughts have been a major cause of concern. Crops and livestock have been destroyed because of this phenomenon, increasing the risk of food security for the whole of Panama.

Anthropogenic, or human-induced, climate change is a global phenomenon that negatively affects our quality of life and poses one of the most significant threats to the well-being of humanity (United Nations, n.d.-c). Climate change causes more frequent extreme weather events, disrupts food sources and ecosystems, and exacerbates mental health issues (World Health Organization, 2021). This crisis may increase inequalities between and within communities because climate has greater effects on poverty-stricken communities, younger and older populations, and ethnic minorities (World Vision International, 2022; Patnaik, 2020). Climate change also undermines social determinants for good health, such as economic opportunities and stable living conditions (World Health Organization, 2021). While extensive scientific reports and current research focus on the effects of climate change, our project aimed

to benefit the public by providing detailed stories on how climate change affects the day-to-day lives of people worldwide.

Currently, a lot of the information regarding climate change, such as statistics and mathematical models, does not provide a human perspective on the matter. Without personal narratives and recounts of their experiences, the topics of discussion for climate change are reduced to just scientific data. Personal narratives provide a human perspective on the climate crisis that increases believability and prosocial behavior (Andrews et al., 2022). By evaluating personal narratives, we can compel people by showing how Panamanians anticipate adjusting their lifestyles and environments, in addition to representing their concerns and experiences.

To understand the effects felt by individuals and communities in various regions across the globe, Worcester Polytechnic Institute (WPI) implemented an ongoing investigation to understand perceptions of climate change through the storytelling of those directly impacted. Since 2014, “Storying Climate Change” has enabled various student groups to conduct studies by collecting testimonials from residents in North America, Europe, Asia, and Oceania. They have analyzed the data provided by communities in these regions, displaying the feelings of individuals that may have never been voiced before ("Storying Climate Change," n.d.).

Our project sponsor, Professor Ingrid K. Shockey, is an environmental sociologist at WPI who has supported this type of project in several countries, including Australia, China, Iceland, India, Japan, New Zealand, and the United States. She believes that social research in climate change studies deserves greater recognition. Therefore, she has sought the perspectives of residents in various locations worldwide as she believes these stories can help inform the science of climate change. Through these projects, she has learned that many people do not widely consider the impacts of climate change on a personal level (I. Shockey, personal communication, 2023). Additionally, the project has discovered evidence for new human displacement, optimism

for rethinking global consciousness, and a variety of new perspectives through the global conversations collected thus far ("Storying Climate Change," n.d.).

Every region on Earth experiences the effects of climate change in varying degrees. Consequently, one of the most important research topics of the 21st century is determining the scale and scope of these changes as well as their impacts on various ecosystems, economies, and societies. Continuing this research in Panama reveals the various perspectives residents may hold regarding climate change depending on demographics, such as location, economic status, and occupation. This project has not yet been conducted in Latin America, so this cultural region has not been represented in "Storying Climate Change."

Our goal for the completion of this project was to share the compelling narrative of Panamanians through the medium of a documentary video, highlighting their struggles with and perspectives on climate change. This documentary was compiled using clips that were deemed important to the story our team was attempting to create. The video was edited, with names and titles of our interviews displayed on screen, as well as subtitles for interviews that were conducted in Spanish. The documentary can be found on our team's YouTube playlist (See Appendix D for the link).

Our team began by conducting research to gain necessary contextual information and to discover organizations or people from which we intended to collect interviews. We conducted interviews using open-ended questions, recording the stories of our participants, as well as recording our ethnographic experience. Our team then analyzed footage, determined themes revealed by our participants, and edited together the documentary video. Not only did our team collect stories of the impacts of environmental changes on the people of Panama, but we also revealed varying trends and themes our interviewees displayed. These trends and themes include definition and causes for climate change, a disappointment with the education and governmental

systems regarding addressing climate change, the negative impact climate change has had on the economy, as well as group our participants believed were most vulnerable to climate change.

Through this investigation, the team helped to reveal underlying inequities in how various groups of people are affected by climate change. We hope that our project can spread awareness as well as provide a voice for the vulnerable groups in Panama.

Literature Review

Chapter 2

Storying Climate Change in Panama

Chapter 2. Literature Review

In order to properly understand the context of the narratives we set out to collect, our team conducted a thorough literature review. We sought to understand more about climate change on a global scale, background information on Panama, various policies, and previous "Storying Climate Change" projects.

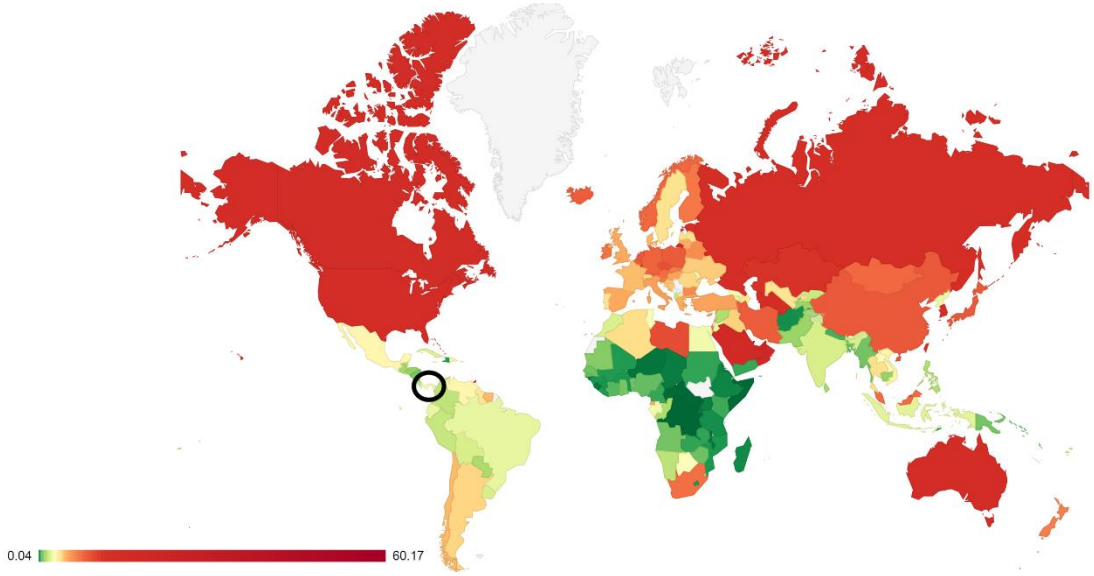
2.1 Climate Change on a Global Level

The United Nations defines climate change as long-term shifts in temperatures and weather patterns (United Nations, n.d.-a). While these shifts may occur naturally, it is widely recognized that recent human activity contributed significantly to climate change (European Commission, n.d.). Burning fossil fuels, such as oil, gas, and coal, has been the leading cause of this change. Fossil fuels emit CO_2 when burned, and CO_2 is one of the largest contributors to the greenhouse effect. The greenhouse effect is a process that allows gases in the atmosphere to trap thermal radiation from the sun in the atmosphere. ("Climate Change 2007: The Physical Science Basis," 2007). Adding more CO_2 to the atmosphere means more heat will be trapped and global temperatures will rise. Deforestation, agriculture, and cement production all play lesser roles in carbon dioxide emissions ("Causes of climate change", n.d.). These emissions increase global temperatures, which scientists have monitored closely. The Emissions Gap Report of 2022 shows that we are far from the Paris Agreement goal of limiting global warming to below 2 degrees Celsius, even though 1.5 degrees Celsius or lower is preferred. With current policies in place, trends suggest a 2.8-degree Celsius temperature rise by the end of the century. Thus, a 45% reduction in emissions by 2030 is necessary to avoid global catastrophe ("Emissions gap report," 2022).

Climate change is a critically important issue because of its effects on the global population, animals, and their habitats. Rising sea levels, intense storm surges, and droughts are just some of the consequences of climate change (United Nations, n.d.-a). These effects cause tremendous emotional stress, force people to leave their homes, and result in injuries or death. Additionally, it is important to note that the 100 least-emitting countries generate three percent of global emissions, while the top ten countries with the largest fossil fuel emissions contribute 68% (United Nations, n.d.-a). Although the country of Panama is not a large contributor to climate change as shown in Figure 1, ranking 85th in least-emitting countries, the country is one of the most at risk for experiencing the adverse effects (*Panama - CO2 emission*, 2022).

Figure 1

Global map of CO_2 tons emission per capita 2021



Note. Panama, circled in black, had a CO_2 emission per capita of 2.87 tons in 2021, while the United States (colored in red) had a CO_2 emission per capita of 14.24 tons in 2021. From *CO2 emission*, by countryeconomy.com, 2022. (https://countryeconomy.com/energy-and-environment/co2-emissions). Copyright by countryeconomy.com.

2.2 Environmental Justice

Environmental Justice is a movement that is utilized in order to recognize and explain the disproportionate effects that are faced by poor, racialized, and marginalized communities in regard to environmental impacts (Levanda, 2021). This movement intends to facilitate and demand a response to inequitable burdens faced by these communities through the use of policies, recognition, and forms of reparations. Marginalized communities are less likely to be involved in processes pertaining to managing or governing the use of the environment and its subsequent effects. Environmental justice encompasses the prominence of group experiences and identities, while acknowledging social differences, such as gender, race, and indigeneity, to appropriately promote just processes and participation (Levanda, 2021). This movement can be traced back to the 1982 protests of contaminated soil at a landfill in North Carolina, where surrounding communities were poor and majority African American. While this event sparked interest across the country, and eventually, the globe, marginalized communities had been experiencing environmental concerns for decades prior. The environmental justice movement is also concerned with traditional environmental practices, with engagement from Indigenous ideology and conceptions of the relationship between humanity and nature (Schlosberg, 2014).

2.2.1 Indigenous Environmental Justice

Ecological unity and the sovereign rights of nature and the lives that are dependent on the environment have been main focuses of Indigenous voices in the environmental movement (Schlosberg, 2014). Indigenous environmental justice has become a subsection of this movement that is necessary to acknowledge and mitigate the issues faced by Indigenous communities pertaining to ecological injustices. This movement encompasses philosophies and epistemologies of Indigenous communities to reflect their perception of injustice. These communities have

unique conceptions of traditions and practices that generate harmony and balance with the earth. However, the government and economy banish and undermine these conceptions in systemic manners, leading Indigenous groups to create their own framework for environmental justice. These recommendations, as well as their voice and perspective, can contribute to the collective future of our planet (Schlosberg, 2014). This movement acknowledges the intellect Indigenous communities can provide, as well as their proposition for resilience, sustainability, and adaptation procedures not only in the face of environmental justice, but also in the emerging threat of climate change.

2.2.2 The Shift of Environmental Justice to Climate Justice

This movement has since developed around health and human rights, with concerns emphasizing issues of vulnerability and climate change. Sustainability and quality of environment for daily use, combined with social justice, have brought conversations of resource allocation, mitigation, and conceptualization of the environment in the increased emergence of climate change effects. Inequality for environmental costs, benefits, and conditions are considered when attempting to solve existing and future environmental burdens, and the reason for such inequality is also explored through this movement (McGregor, 2020). In 2001, The Environmental Justice and Climate Change Initiative was founded to better represent communities that have been negatively affected by ever increasing incidences of disasters exacerbated by climate change. Since then, climate justice has emerged from environmental justice and taken precedence in the limiting of carbon emissions and use of non-renewable resources. Furthermore, climate justice aims to protect vulnerable communities by advocating for community participation in decision-making, ensuring a just adaptation to sustainable practices, and enhancing resilience for future generations (McGregor, 2020).

2.3 Overview of Panama

Home to approximately 4.4 million people, Panama is an isthmus located in Central America bordering the Atlantic Ocean and the Pacific Ocean ("Overview: Panama," 2023). The country controls the Panama Canal, a crucial shortcut for global trade that connects the two oceans. The Canal contributes to Panama's ranking as one of the most developed economies in Latin America, with a GDP per capita of 17,358 USD, or 76.52 billion USD for the whole country in 2022 (World Bank, n.d.). Services, such as the Panama Canal, tourism, banking, and healthcare, contribute to roughly 70% of the nation's Gross Domestic Product (GDP). Agriculture, including livestock and timber, contributes to 6.2% of the GDP ("UNDP Climate Change Adaptation," n.d.).

Panama's landscape is mostly composed of rugged mountains, rainforest, and upland plains, which contrasts the plains and hills of the coastal areas. The main natural resources of Panama are copper, mahogany, and hydropower ("UNDP Climate Change Adaptation," n.d.). Deforestation of tropical rainforests threatens the sustainability of both the resources and livelihoods of those who extract these materials ("UNDP Climate Change Adaptation," n.d.). Land degradation, soil erosion, and water pollution pose an immediate threat to the health and stability of individuals in Panama, and all these risk factors are exacerbated by the effects of climate change.

2.3.1 Panamanian Energy Sector and Hydropower Contributions

Due to increased economic and population growth both globally and in Panama, energy demand continues to rise. This rise warrants governmental strategies and policies to produce solutions to energy needs in sustainable ways. By 2030, the World Bank and International Energy Agency estimate that global energy demand will increase by 33%, with renewable energy

sources contributing 40% to this increased demand. By 2035, Latin America is estimated to generate 71% of the renewable energy contribution due to the dominance of hydropower energy generation (Quinones, 2014). Among the countries of Central America, Panama is the number one consumer of energy ("Energy profile: Panama," 2022; "Installed capacity | practical law," 2023). They rely mostly on imported oil for their energy supply, currently importing more than 80% of their energy. In 2020, it is recorded that Panama had 4116 MW of installed capacity, which is the most electricity that a generation plant can produce ("Energy profile: Panama," 2022; "Installed capacity | practical law," 2023). Hydropower, or energy generated by the flow of water, is a crucial contributor to Panama's energy sector. This type of energy generates 43.9% of Panama's installed capacity and accounts for 67.2% of their total energy generation in 2020. Hydropower has the potential to help reduce Panama's use of non-renewable energy through the Nation Energy Plan, which is working to reduce dependence on imported oil in favor of greener solutions by 2050 ("Energy profile: Panama," 2022). Wind and solar energy are implemented in Panama on a smaller scale, but this plan hopes to increase reliance on these generation methods and produce biofuel to limit petroleum.

The Panama Canal is a large contributor to hydropower in Panama, as water is constantly flowing between the locks and the supplies of Gutan Lake and the Alajuela Reservoir. However, as extreme weather events, such as droughts and flooding, increase with climate change, hydroelectric plants are affected ("Energy profile: Panama," 2022). The price of electricity is also impacted by unpredictable weather patterns. Reliable electricity is accessible to 94% of Panamanians, but in primarily Indigenous areas, such as the Ngöbe-Buglé *Comarca* (an autonomous sub-province), only 4% of residences have reliable electricity ("Energy profile: Panama," 2022). Households like this are described as experiencing energy poverty, which

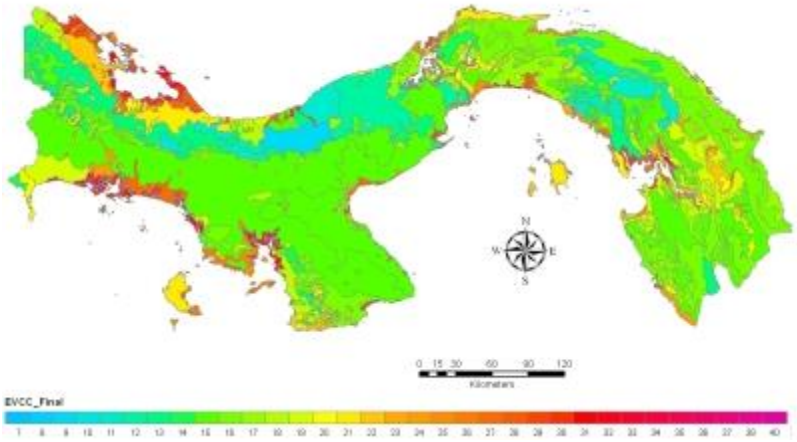
hydropower and other renewable energy sources have the potential of greatly reducing (Philipp, 2021).

2.3.2 Biodiversity

Panama is one of the most biologically diverse places on earth, ranked 22nd across all countries across the globe (Butler, 2019). The range of biodiversity in Panama is immense, especially considering the country is only approximately the size of the state of South Carolina, with only 29,081 square miles of land ("Panama," 2023-a; Anguizola et al., 2023). Panama harbors a variety of species, containing 255 species of mammals, 972 species of Indigenous birds, 222 species of amphibians, and 10,444 plant species (Panama Wildlife Conservation, 2023). There are several types of ecosystems in Panama, including biomes of tropical lowland humid forests, dry forests, and mountain forests, as well as wetlands, coral reefs, and tropical islands. Climate change threatens biodiversity in all regions of Panama, but it particularly threatens the tropical islands and coastal plains as shown in Figure 2.

Figure 2

Ecosystem Vulnerability to Climate Change



Note. A map of the most vulnerable areas to climate change where colors on the left of the spectrum are less vulnerable, and colors on the right side of the spectrum are more vulnerable. From *Ecosystems and Climate Change - SERVIR*, by SERVIR, 2008 (https://www.servir.net/servir-en-accion/analisis-ambientales/143-ecosystems-and-climate-change.html). Copyright by SERVIR.

These environments allow for a wide range of biodiversity. Panama is often referred to as the "Mesoamerican Biological Corridor" (*Panama*, 2023), a title that underscores its vital role in connecting the ecosystems of North America and South America. This unique geographic position allows many species of flora and fauna between the two continents to be distributed within Panama, making Panama a pivotal link in biodiversity exchange. Many livelihoods, economic opportunities, and tourist attractions depend on the conservation of land and the biodiversity that resides on it. Forests cover 60.4% of Panama's total a rea, of which approximately two thirds belong to Indigenous Peoples (*Harnessing biodiversity for sustainable rural livelihoods in Panama*, 2020). Although these lands are claimed and protected, they have been threatened by attempts of expansion of industrial and economic sectors. Deforestation, along with climatic changes, such as temperature increases and sea level rises, pose a direct threat to the biodiversity of Panama.

2.3.3 Forests

The forests of Panama are a vital factor in the longevity of blossoming biodiversity, and they also provide immense carbon offsets for the country. A carbon offset occurs when modes, such as reforestation, provide a decrease in greenhouse gas emissions or an increase in carbon storage that is used to compensate for emissions created elsewhere (Broekhoff et al., 2019). In Panama, forestry occupies approximately 43.6% of land use ("Panama," 2023-a). Globally, between 2001 and 2019, forests sequestered almost twice the amount of CO_2 that they emitted, and they produce a carbon sink, a location that absorbs CO_2 from the atmosphere, that absorbs billions of tons of CO_2 every year (Harris et al., 2021). Tropical rainforests mitigate climate change and absorb more carbon from the atmosphere than any other type of forest (Harris et al., 2021). Deforestation threatens this carbon offset and increases CO_2 emissions alongside other disturbances in the forest. During the UN Climate Change Conference (COP26) in 2021, many countries, including Panama, stated their support in halting deforestation and supporting tropical environments (Hall et al., 2022). Furthermore, soil in forests is essential for water security due to the absorption of water during the wet season and the subsequent release of water during the dry season. This phenomenon is known as the "sponge effect" and establishes a strong basis for the expansion of forests using a socio-economic standpoint when compared to land use for cattle ranching (Hall et al., 2022). While the forests of Panama support biodiversity and protection against the threats of climate change for the terrestrial environment, mangroves provide similar benefits for marine and coastal sectors.

2.3.4 Mangroves and Marine Life

Panama has an immense coastline proportional to the size of the country. The length of Panama is only 480 miles, with an area of 29,762 square miles. However, Panama has a

combined coastline length of 1,786 miles, bordering both the Caribbean Sea and Pacific Ocean. (Nations Encyclopedia, n.d.) Mangroves are tropical shrubs or trees with exposed, supporting roots that extend above soil. These plants can live in high salinity environments and populate the coastlines of Panama (Encyclopedia Britannica, 2023). They are a vital aspect of maintaining balance within communities, comprising an estimated 2.3% of the total area of the country and 5.2% of the total forest area in Panama (Gómez et al., 2023). However, mangrove populations in Panama have been reduced by almost 50% since 1972 due to factors, such as drought and land conversion ("Good news!," 2021). Droughts were caused by the 2015-2016 El Niño event in areas of subtropical regions. Precipitation dropped 26% below average, which caused nationwide droughts, and loss of species of mangroves were correlated with this event ("Good news!," 2021). These alterations in typical precipitation patterns affect the location in which these species can thrive due to changes in water salinity, by inhibiting seedling survival, and by increasing competition between various plant species.

Contrastingly, increases of precipitation in areas of the central and eastern part of Panama, due to the increase of water vapor transport originating in the Caribbean Sea, affect mangroves (Kusunoki et al., 2019). Increased precipitation leads to stronger growth rates and diversity of mangrove species. In areas that are not equipped to handle such changes this can disturb existing environmental systems where stronger species outcompete less climate-change-resilient species.

Another threat to mangroves is sea-level rise, which is a consequence of global warming events associated with climate change. By 2099, global sea levels are expected to rise 0.18 to 0.59 m from measurements recorded in 1999, with some projections displaying a higher, accelerated rate in coming years (Milne et al., 2009). Mangroves are unable to produce sediment at sufficient rates to maintain systemic balance with sea-level rises, increasing vulnerability and

mortality rates. Increases in frequency and intensity of extreme weather events also pose a concern for mangroves due to physical damage to the plants, as well as sulfide soil toxicity and stress.

An essential feature of mangroves is their ability to store underground carbon. The one hundred seventy-seven thousand hectares of mangroves in Panama store more than fifty-two million tons of carbon, with an estimated 1.6 million tons of CO_2 absorbed by mangroves per year. This feat is made possible due to mangrove soils lacking storage capacity, enabling the continuous maintenance of carbon storing that has the potential to persist for centuries (Gómez et al., 2023). Furthermore, mangroves act as a barrier for coastal hazards, shielding populations from erosion, flooding, and other extreme weather events.

Mangrove soils, rich in organic matter, harbor a dense network of roots that work to protect soil from erosion. These plants can reduce the potential damage of waves, winds, and surges by providing an obstacle that these risk factors must pass through. Energy dissipates and the height of waves diminishes by 13% to 66% per one hundred meters of mangroves. This effect limits destruction of homes or sea walls, while also inhibiting the erosion of soil. During storm surges, mangroves can reduce water depths by five to fifty centimeters per kilometer of mangrove, reducing the extent of flood incidence (Spalding M et al., 2014).

While reduction in mangrove population would cause a negative effect on CO_2 sequestering, protection against weather events, and services for humans, the elimination of these species in Panama has the potential to cause devastating effects regarding biodiversity. Mangroves provide a migratory stop for thousands of birds. In the Bay of Panama alone, it is estimated that two million birds pass through during their migration route (AFP, 2022). Mangroves also serve as a fish and crustacean nursery habitat, as species are enticed by the provided shelter from predators, which is made possible by the roots of these plants. Due to the

accumulation of bacteria and mangrove tree detritus, there is a high food availability and an oxygen rich environment that enables increased production of numerous marine species ("Mangroves: Nurseries for the world's Seafood Supply," 2017).

Along with mangroves, other effects of climate change, such as increased ocean temperatures and declining coral reefs limit fish biodiversity. As sea temperatures rise, species migrate to climates that are better suited for their survival, which causes a change in spatial distribution of essential species for Panama's ecosystem. This change is particularly detrimental for trade fishermen, who rely on the abundance of traditionally harvested fish to survive. Sea-level rises, as well as the frequency and intensity of climate variability events, also contribute to the vulnerability of artisanal fishermen in Panama. The continuous change of erosion and sedimentation patterns increases the turbidity of water and affects the populated areas of the coast (Posada et al., 2017).

2.4 Panamanian Vulnerability to Climate Change

Climate change poses a direct threat to the human and ecological systems in Panama with impacts on agriculture, water resources, and population health. The country is also at risk for more frequent and extreme storms, floods, and droughts ("Climate Change Knowledge Portal", 2021). Changing weather patterns will likely result in economic losses and casualties that particularly impact the least wealthy and most marginalized groups of society. Despite tremendous wealth, Panama is a highly unequal society with a Gini Coefficient of 0.51 (*Panamá - índice de Gini,* n.d.).[1] Roughly 30% of Panamanians live in poverty (UNDP Climate Change Adaptation, n.d.). The wide economic disparity means that certain groups of people do not have equal access to public resources, and often exploit protected resources and ecosystems to

[1] A coefficient of 0 equals perfect equality, while a coefficient of 1 equals perfect inequality, while a coefficient of around 0.5 corresponds with severe income disparity (Huang et al., 2023).

survive. This exploitation is not necessarily malicious or intentional, as educational resources vary among individuals in Panama. Inaccessibility to these financial and educational resources leads to a disadvantage in resilience and adapting to climate change.

With significant variation among individual Panamanians to adapt to the climate crisis, Panamanians may also be disproportionately afflicted by the effects of climate change. According to the World Bank, Panama only contributed 3.15 metric tons of CO_2 emission per capita in 2019 ("Climate Watch Historical GHG Emissions," 2022; Ritchie et al., 2020). Compared to the carbon emissions per capita of the United States in the same year (14.67 metric tons), Panama proves to be a minor contributor to climate change. However, Panama ranks 14th among countries most exposed to multiple hazards based on land area and bears some of the harshest estimated impacts of climate change ("Climate Change Knowledge Portal", 2021).

One of the largest, immediate related threats facing Panama is unpredictable rainfall, with precipitation expected to increase by 80% and extreme precipitation events increase up to 50% by 2080 ("Climate risk and Adaptation Country Profile: Panama," 2011). In recent years, droughts have also been a concern and have put pressure on the operation of the locks in the Panama Canal, which is one of Panama's largest sources of income. For the locks to properly operate, approximately 2 billion gallons of fresh water is used each day ("Panama Canal grapples with climate change threat," 2022). Thus, there is an immediate need to find more places to store excess water during rainy years for use during times of drought. Unpredictable rainfall also has the potential to damage crop production. In a country where about 18% of total employment is based in agriculture, this could be devastating ("Climate risk and Adaptation Country Profile: Panama," 2011).

Climate change also causes rises in sea levels that place additional stresses on water resources in Panama, which contributes to coastal erosion and increased salinity in estuaries. The

increase in floods due to storms threatens the tidal range in rivers and bays, as well as sedimentation patterns (“Climate risk and Adaptation Country Profile: Panama,” 2011). As sea levels continue to rise in the next century (possibly by up to 8 feet) these communities will be forced to migrate elsewhere (NASA, 2023). Migration in Panama due to sea levels has already begun. Over 1,200 inhabitants on the island of Gardi Sugdub are relocating to mainland Panama in 2023 (“Independent Digital News and Media”, 2022). Mass relocation creates a huge problem as entire communities must leave their homes, causing economic and emotional suffering. Inland cities might not be able to provide the housing and resources that migrants require. Furthermore, there is the possibility of social fragmentation and the loss of tightly knit communities due to relocation. Individuals not only lose their routine and familiarity, but it can also result in the elimination of culture or tradition.

2.5 Extreme Weather Events in Panama

Extreme Weather Events (EWEs) are defined as occurrences of unusually severe weather or climate conditions (United States Department of Agriculture, n.d.). Climate change is a main contributor to increased EWEs, with Panama experiencing the brutal repercussions. These extreme weather events can devastate communities by destroying agricultural and natural ecosystems, while floods can destroy soil through contamination or erosion. Floodwater can kill crops and destroy soil due to the difference in pH levels of the water and soil. Pollutants from the land, such as oil on roads and trash on the streets can also contaminate soil. Extreme weather events can also cause economic disasters, or directly harm humans. In Latin America, the occurrences of EWEs caused by climate change have increased by a factor of 2.4 since 1970 ("Climate Change Knowledge Portal: Panama," 2021). Panama sustained 32 natural disaster events between 1982 and 2008, suffering a loss of US $86 million in economic damages and 249

human lives ("Climate Change Knowledge Portal: Panama," 2021). While natural disasters are unavoidable, the extent of these events is exacerbated by climate change, increasing possibility for damages (“Climate and Clean Air Coalition”, n.d.).

2.5.1 El Niño-Southern Oscillation

El Niño-Southern Oscillation (ENSO) is the interannual climate variability caused by the oceanic component of El Niño, which originates in the tropical Pacific due to ocean-atmosphere interactions (Chen et al., 2019). ENSO contributes to the variation in seasonal climate, which directly affects the duration and intensity of the wet and dry seasons in Panama (Chen et al., 2019). New El Niño events, called the central-Pacific El Niño, have occurred more frequently due to climate changes and are associated with maximum warm anomalies. Climatic shifts in the past three decades have increased the frequency of El Niño events in the central equatorial Pacific, with intensity increasing by a factor of two (Chen et al., 2019). These events have disastrous economic, environmental, and social potential, contributing to the intensity and frequency of EWEs.

2.5.2 Droughts

In 2015-2016, Panama experienced a severe El Niño event, which resulted in prolonged drought, restricted access to clean water, halted livelihoods, and negatively affected native species. This event resulted in severe drought conditions, which affected over 90% of the country, and was recorded as the third longest dry season experienced by Panama (“Plant water use responses along secondary forest succession during the 2015–2016 El Niño drought in Panama,” 2018). Droughts, along with contributing factors, such as soil nutrients, temperature, and biotic interactions, result in increased tree mortality, which leads to decreased biodiversity as many tropical plants depend on the structure of the trees. As drying trends change in various

locations, drought-tolerant species force out drought-intolerant species, which alters forest composition (“The Impact of a Severe El Niño Event on Vascular Epiphytes in Lowland Panama,” 2022). Tree mortality also affects livelihoods, such as the loggers who rely on the flourishing forests of Panama.

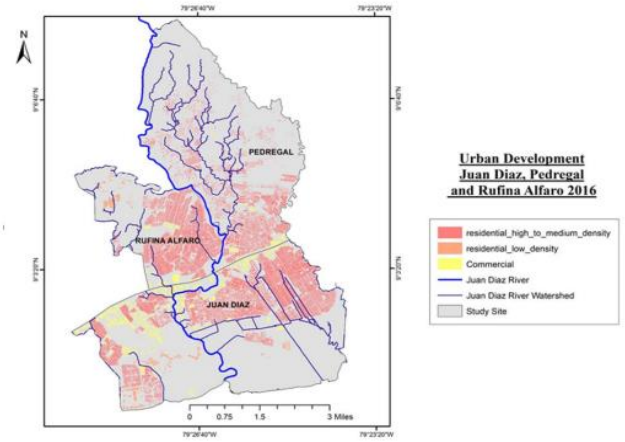
Droughts also affect the Panama Canal. According to the *Maritime Post*, around 13,000 to 14,000 ships pass through the canal each year (Giri, 2022). The canal generates about US $2 billion a year, and approximately 40% (US $800 million) goes to Panama’s General Treasury. The Panama Canal alone contributes to roughly 3.5% of Panama's GDP ("Trade Policy Review Report," 2022). Thus, there are catastrophic effects when the canal runs low on water. As global temperatures increase, evaporation in Panama Canal’s reservoirs also accelerate (Timperley, 2020). Gatun Lake is an artificial lake that provides the canal with millions of liters of water each time a ship needs to pass through the canal. In the past few years, water levels at the Gatun Lake have measured around 26.6 meters during September (Labrut, 2023). However, in September 2023 the water levels were currently down to 24.2 meters. Consequently, the Panama Canal Authority (ACP) had to reduce the daily passages to thirty-two ships per day, down from the average of thirty-six per day in normal conditions. Earlier in the year, the ACP had to reduce the draught, or draft, which is the depth of water necessary to safely navigate a ship. Now, further reducing the draught appears to no longer be an option. The ACP Administrator, Ricaurte Vasquez, stated that: “[i]f we must consider transit reductions, we will. This would be to continue with a draught of 13.4 meters. We will not reduce draught. If we do that, it will impact 70% of our shippers” (Labrut, 2023, para. 2). Vasquez has expressed a desire to work with the government on a project that leads to additional reservoirs. It is evident that adaptation measures are not just desirable, but they are essential for preserving the canal’s crucial role in global trade.

2.5.3 Floods

Increased precipitation levels along with increased EWEs can cause life-threatening floods. Floods are defined as incidences in which water from a bank fully occupies a floodplain (Boudreau et al., 2023). Between 2000 and 2006, floods had the highest negative human and economic impact in Panama. Approximately 63,000 floods affected people in eight events, with the cost of damages totaling US $8.8 million ("Climate Change Knowledge Portal: Panama," 2021). Towards the end of 2010, unusually heavy rain and floods occurred in Panama ("Panama: Floods Emergency…," 2011). In December, authorities were even forced to close the canal, an unfortunate event, which had only happened twice before (Spanne, 2014). Agriculture is also affected by these floods, which kill livestock, deplete crops, and destroy land. Flooding causes soil and bank erosion, siltation, and landslides, damaging vegetation, and contaminating water through the distribution of pollutants through the water (Floodinfo.ie, n.d.). In some cases, such as in the Township of Juan Diaz, shown in Figure 3, a jurisdiction within Panama City, unrestricted urbanization of impervious land exacerbates these floods.

Figure 3

Map of the urban development with hydrology composed of residential and commercial buildings.



Note. From "The Effects of Urban Development and the Incidence of Flooding and Discharge Changes from 1956-2016: A Case Study from Juan Diaz Township, Republic of Panama", by Q.

Rodriguez and V.,de Jesus, 2019, University of Arkansas ProQuest Dissertations Publishing, p. 20. Copyright 2019 by University of Arkansas ProQuest Dissertations Publishing.

In this location, rivers have been diverted in unnecessary manners and drainage systems prove to be insufficient ("A Case Study from Juan Diaz Township, Republic of Panama," 2019). As the surface of improperly urbanized surfaces increases, the frequency and runoff, or flood magnitude, also increases. While floods typically correlate to climate conditions of rapid precipitation and low permeability of soils, the anthropogenic effect on the natural environment poses an increased threat. Along with continuously growing overpopulation levels, deforestation has also affected the frequency and intensity of floods. When land is converted from forestry to agricultural pastures and fields, there is an increase in runoff ("A Case Study from Juan Diaz Township, Republic of Panama," 2019).

2.6 Adaptation and Mitigation Policy

Panama has implemented several policies to counter the effects of climate change globally and internally. In 2018, Panama joined the Climate and Clean Air Coalition, committing to mitigate short-term climate pollutants and to deliver benefits relating to climate, clean air, health, and socioeconomics (Climate and Clean Air Coalition, n.d.). Panama contributes only 0.045% of global greenhouse gas emissions and is only one of three countries denoted as carbon-negative due to its small population and forest coverage (Climate and Clean Air Coalition, n.d.). While Panama emits proportionately less carbon than many of the world's countries, it is highly vulnerable to the effects of global climate change. Due to this fact, Panama has set mitigation goals through its Nationally Determined Contributions to the United Nations Framework Convention on Climate Change and other policy frameworks by committing to reduce emissions in energy and waste sectors by 11.5% by 2030 (Climate and Clean Air Coalition, n.d.).

In the waste sector of Panama, the country plans to develop a circular economy plan. In the agriculture and fishing sector, there is a plan to enhance productivity and sustainability while committing to the restoration of the national forests in order to absorb approximately 2.6 million tons of carbon dioxide by 2050 (Climate and Clean Air Coalition, n.d.). To further address the problems in this sector, Panama launched its National Plan on Climate Change for Agriculture in 2018 to enhance resiliency and adjust production practices to reduce greenhouse gas emissions (Climate and Clean Air Coalition, n.d.). While government policies aim to help reduce the impacts of climate change, they do not address the effects that are already being felt by the individuals of Panama.

One of these laws is Law 287 of Panama, which provides nature the rights to "exist, persist and regenerate their life cycles; …timely and effective restoration; and … preserve its water cycles" (Ministerio de Ambiente Prensa, 2022, para. 2). This law, created by American marine biologist, conservationist, and ecologist Callie Veelenturf in 2022, holds people, corporations, and the government accountable if nature is not respected and preserved, thus contributing to minimizing the impacts of climate change. This law is especially important due to Panama's immense biodiversity. This law heavily recognizes Indigenous views on nature and the law incorporates Indigenous, as well as scientific methods and knowledge of protecting nature to protect Panama's biodiversity.

The Sustainable Tourism Master Plan 2020-2025 is another set of laws within the Panamanian legislature that protects and promotes the culture and traditions of Indigenous people through ecotourism (Chan, 2022). This plan brings tourists to local Indigenous communities and ensures monetary benefits go towards improving infrastructure and general living standards for the people that create this tourism revenue in the first place. Since this plan is still being implemented with results progressing towards the end of this five-year project, the

Ministry of Tourism intends to make Panama's sustainable tourism model an openly available resource from which other countries can learn (Chan, 2022).

Panama also offers businesses tools to reduce their carbon footprint, such as the *Guide of Good Practices for Business Sustainability*. This is a book that can be accessed through the government and was prepared by the Ministry of Environment. This book helps create a more circular and sustainable economy where "sharing, renting, reusing, repairing, renewing, and recycling [is done] ...as many times as possible to create added value" and reduce wastage (Swissinfo, 2022, para. 6). This effort to drive Panamanian businesses to produce as little waste as possible and promote sustainability helps many industries reduce their carbon footprint. According to Miguel Angel Flores, the Director of Environmental Performance Verification Directorate, although many small businesses have been reluctant to follow this sustainability guide, many medium and larger companies have been more agreeable to adopting the protocols in it (Swissinfo, 2022).

2.7 Past Climate Stories Projects

"Storying Climate Change" is a project that has been conducted by various student researchers at WPI. Professor Ingrid Shockey sponsors these projects and compiles their stories to discover how climate change affects different parts of the world. As of September 2023, stories have been gathered from Asia, Europe, North America, and Oceania ("Storying Climate Change," n.d.), further shown in Figure 4. Many project groups discovered climate stories by using the same techniques; they interviewed local residents and experts. Specific methods for finding interviewees in past projects differed; however, many groups reached out to experts via email. They also utilized referrals from other interviewees to find new participants. An interesting methodology from the groups that went to India is that they used an Instagram page to

report climate stories. This method allows the author to reach a younger demographic, as a study done by the Pew Research Center states that over 60% of 18- to 29-year-olds use Instagram. ("How Age Influences Social Media Preferences," n.d.). However, the same study showed that no older age group came close to even a 50% usage rate for the social media app. Ultimately, most groups opted to create a video documentary. While documentaries may be more time-consuming for a team to produce and may require more attention from an audience, this deliverable has many benefits. It can be more accessible to those who do not have Instagram and provide more depth than Instagram posts. Moreover, they allow the voices of the interviewee to be heard which can help trigger the audience's senses and emotions (Underbjerg & Steen, 2023).

Figure 4

Map of Storying Climate Change Project Locations

Note. Locations visited in previous years in dark blue and Panama in light blue.

The previous projects share many connections, yet they also provide unique perspectives. Most groups, such as China's 2019 B-term students, tried to get a diverse group of representation by interviewing people both in urban and rural areas (Marko et al., 2019). A common theme that

was found is that more people are moving to urban areas due to the increased job opportunities that cities often provide. Different project groups found this migration pattern to have differing consequences. The group that investigated China, reported how pollution was more prevalent in the city and people moving there would only increase this climate issue. Meanwhile, a group of students that investigated India in D-term of 2019, did not discuss the increased pollution. Instead, they found that when people moved to urban are bas, it negatively impacted the agriculture industry (Baptista et al., 2023).

Previous iterations of the Storying Climate Change projects found that local residents recognized basic climate indicators. For example, the 2019 A-term Japan group, found that people often reported hotter summers and less snowfall during the winter months (Engel et al., 2019). Despite these findings, a major takeaway we discovered from previous climate story projects is that there is often an apparent lack of civic education and awareness regarding climate change causes, adaptation options, and outcomes. One surprising finding from the 2020 Australia C-term group was that the farmers interviewed reported being skeptical of anthropogenic climate change (Lopes et al., 2020). Many organizations, such as the United Nations, recognize that the rate of climate change has accelerated due to humans, so it is interesting that the farmers interviewed are hesitant to believe this statement. Additionally, the 2019 India group found that awareness about climate change among interview participants from rural villages was low and there was a clear communication gap between residents and the government policy that supported adaptation or retraining (Baptista et al., 2023). Stories like these highlight the importance of experts and governmental agencies in raising awareness about climate change. Furthermore, it demonstrates the need for enforced policies to be implemented that protect those who are most vulnerable.

In sum, these past projects have highlighted the importance of listening to the experience of climate change from around the world. Community participants share common themes and present unique insights about how climate change has been felt. The collection of stories so far makes it evident that more action and awareness is necessary.

Methodology

Chapter 3

Chapter 3. Methodology

The goal of this project was to conduct and record a series of video and audio interviews to capture the narratives of Panamanian residents regarding their experiences with climate change. These narratives provide a qualitative viewpoint on climate change to supplement the existing quantitative scientific research. Our team was able to complete this goal through the following objectives:

- Archival Research on the Demographics of Panama for Participant Selection
- Contacting Relevant Interviewees
- Conducting 1-on-1 Interviews
- Collecting Interviews, Analyzing Data, and Compiling Footage for the Documentary

3.1 Introduction of Methodology

One of the most important aspects of discovering climate stories was finding a diverse sample of people who were willing to discuss their experiences. In Panama, the population in 2023 is approximately 4.4 million people. More than half of the population lives in the Panama City-Colón metropolitan region, and roughly 12% of the overall population is Indigenous (Panama Population 2023, 2023). Additionally, the Afro-Panamanian population makes up 24.5%. (Video: For the inclusion of the Afro-Panamanian people in the 2020 census…, 2023) These statistics were essential in determining the voices that should be represented and amplified when developing climate narratives in Panama. We decided to interview three demographics to organize and provide different perspectives on climate change. These three groups included the general population, the Indigenous population, and experts in the field of climate change. Experts ranged from researchers, scientists, policymakers, and activists. We set up these three groups to

incorporate a variety of different viewpoints due to their different knowledge and backgrounds regarding climate change.

3.2 Demographics

Our group decided on three target groups to interview: the general population, Indigenous population, and experts. We decided these groups would provide us with a broad range of stories to best represent the various demographics of Panama.

3.2.1 General Population

The first group that we interviewed was the general Panamanian population. This group of people does not have a technical background or formal education on climate change, but they still personally experience its effects. An excellent example is Juan Carlos, a local teacher whose house was recently destroyed due to flooding. People within the general Panamanian population have lived in Panama for many years. They provide insight on how climate indicators, policies, education, and other signs of climate change have changed over time. They also explained how they anticipated adapting to climate change in the future.

We gathered narratives from different segments of the general population by interviewing people in different economic areas and occupations because they did not always share the same viewpoints. They were also affected by climate change on different magnitudes. For example, lower-income residents may feel the effects of climate change more than higher-income residents and are thus less adaptable to these harsh effects. Afro-Panamanian people are a specific demographic that are historically impacted by economic hardship, and therefore may have higher disadvantages in the face of climate change. Some relevant subgroups we wanted to interview included agricultural workers and fishers. For instance, Corozal, one of the districts within

Panama City, had many fishermen at a local fish-taco restaurant that we interviewed. We also sought perspectives from professors and other residents in both urban and rural areas.

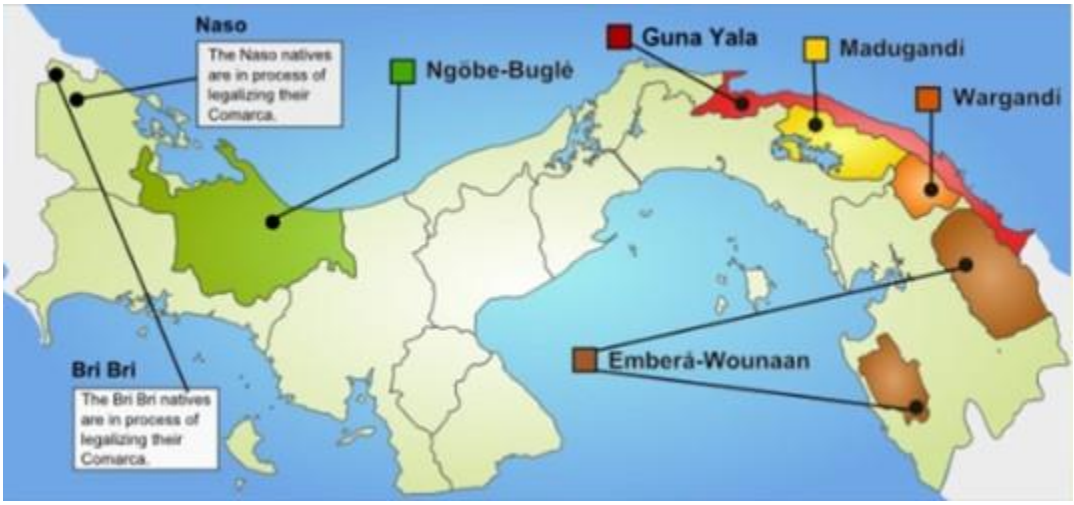
Our preselection of interviewees, such as fishers and farmers, provided insight into industries affected by climate change, but led to underrepresentation of common Panamanians in our documentary. To reduce the potential self-selection bias in our interview subjects, we interviewed people through chance encounters. For example, our team selected people at bus stations, in markets, and those walking in the streets of Panama to participate in our project. We selected people that did not appear to be busy. For example, if vendors did not have any customers, we would interview them. However, this method is not perfect. By only interviewing people who were not busy, we are consciously selecting interviewees. Our team made this compromise to limit intrusiveness.

3.2.2 Indigenous Population

The second group that we interviewed was the Indigenous population. The Indigenous population in Panama consists of seven main Indigenous communities as seen in Figure 5 (Nativa Tours, n.d.). The main three Indigenous groups being the Emberá, Ngäbe-Buglé, and Guna Yala. Together, all seven communities encompass around 12% of Panama's population (IWGIA). Although they make up roughly a tenth of the population, Indigenous voices do not always get the same opportunity to express their views (Garcia, 2018); It was important that we included this marginalized community. They also provide an alternative view of nature and the environment that differs from hegemonic western ideas of capitalism and materialism. They often live closer to the natural world and maintain a stronger spiritual and collective connection to the environment (World Bank, n.d.)

Figure 5

A map displaying where the major Indigenous communities' lands are in Panama



We contacted the Emberá people via a contact of Professor Burrier of WPI. The Emberá, an Indigenous community living in the Darien rainforest, provide an option for visitors to stay at their *comarca* for a day and immerse themselves in their customs and culture; an opportunity that was taken to get further context on how various traditional practices have been affected by climate change. We visited the Emberá to learn more about visual indicators of climate change that we implemented in the documentary-style deliverable at the end of the project.

We contacted a member of the Guna Yala people via a mutual connection of the Casco Antiguo Spanish School. They reside in the San Blas islands of Panama and are among the first Indigenous communities to be displaced due to climate change (BBC, 2022). Many of their islands are being covered in water due to rising sea levels, which forces many residents to leave their lives behind. Climate change induced damage to coral reefs around their islands also exacerbate the effects of extreme weather effects and threaten this Indigenous group, their ancestral land, and many aspects of their culture. Coral reefs provide natural protection to coasts against waves, storms, and floods (National Ocean Service, 2014).

3.2.3 Experts

The third and final target audience our team interviewed was Panamanian climate scientists and experts. Experts possess a technical background that makes them reputable sources on the trends, policies, and effects of climate change. While our project aims to provide meaningful narratives rather than strictly scientific data, the perspectives of climate experts were valuable. Most experts told stories they could share along with the data they found, which made our project more compelling. We used specific stories to locate more interviewees and gain a bigger picture of certain narratives. Some of these experts include ecologists, agricultural researchers, and marine biologists.

Various non-governmental organizations (NGOs) have collected a plethora of data that can help provide a clear picture of how climate change has affected an area chronologically. NGOs such as MarViva, an organization that focuses on marine health, work with multiple countries in Latin America, including Panama. One of these projects, PROADAPT, involves helping small Latin American businesses adapt to climate change (*Marviva Foundation*, 2018). The Panama City location for MarViva provided statistical analysis and detailed projections on how the economic state factors into how much climate change impacts Panamanian residents' livelihoods.

We also interviewed professors from the Technological University of Panama. The university is the highest rated university in the country for science and technology (*Universidad tecnológica de Panamá* 2023), and many of the professors have extensive background knowledge and experience in environmental topics. The school was also easily accessible to us, so we were able to request many interviews from the university.

Smithsonian Tropical Research Institute (STRI) is a research institution that began work in Panama in 1910. STRI is one research center that is part of the Smithsonian Institution (SI)

and is SI's only research center located outside of the United States. The researchers at STRI work together on over 350 projects and publish more than 400 peer reviewed articles in scientific journals every year. The researchers perform research on tropical environments and their relation to human welfare (Smithsonian Tropical Research Institute). The research informs policymakers, students, and worldwide residents, which is why the Institution is important to Panama and the world.

Fundación de Acción Social por Panamá (FAS Panamá, n.d.), or the Foundation of Social Action for Panama, is a non-profit organization that promotes initiatives to improve the quality of life and the environment (FAS Panamá, n.d.). FAS Panama designs solutions to refine solid waste management techniques in order to work towards their initiative, which betters the environmental performance of companies, organizations, communities, and institutions. FAS Panama was founded in 1994 due to the need to promote sustainable human development projects, and ultimately contributed to the common good in order to build an inclusive, equitable, and supportive society (FAS Panamá). This organization is nationally recognized for its many projects that have maintained objectives of the social and corporate responsibilities, while implementing a harmonious relationship with the environment.

3.3 Methods of Contacting Interviewees

Our team utilized the directory of the city we were staying in, the City of Knowledge, to find organizations to reach out to. We also conducted research about organizations and people that we believed would be beneficial to speak to and found their contact information on websites or media such as LinkedIn. We created an Excel spreadsheet to organize who and how we should contact interviewees. We contacted experts and people at Indigenous *comarcas*, via email or phone to request and set up interviews in advance. Experts included people in outreach

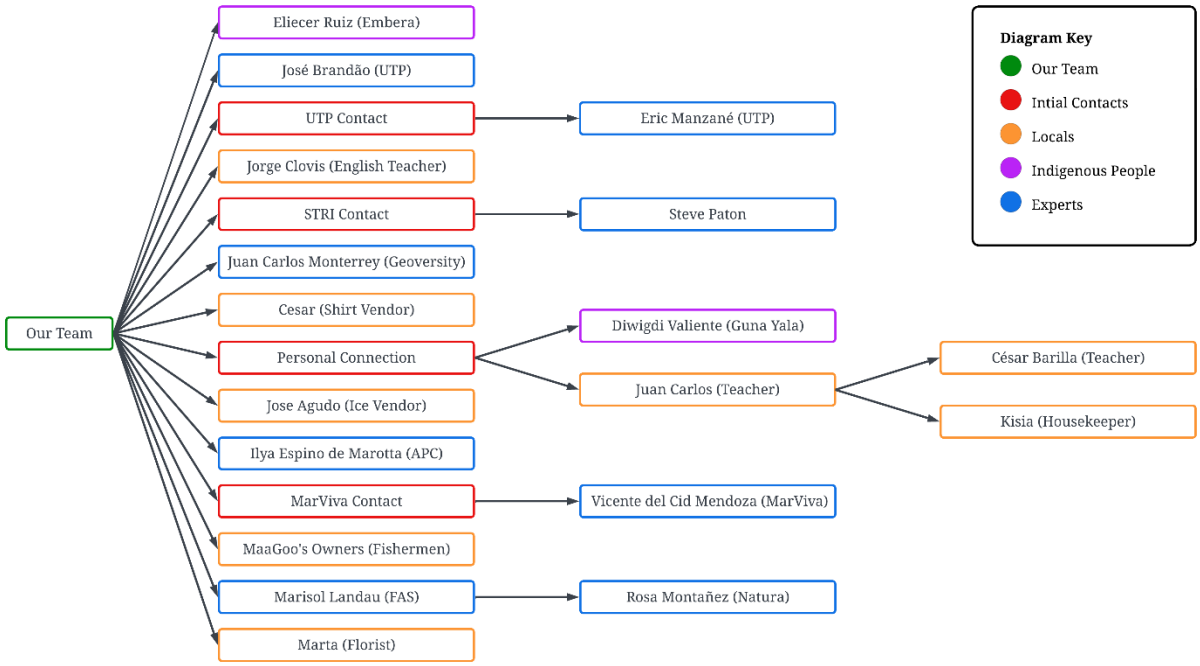
organizations, activists, and former government officials. Most of the general population was either contacted in-person by approaching them on the spot or through one of their acquaintances. We conducted our first interviews in a historic area called Casco Viejo to gain information about other areas where we should travel. We also asked experts about other areas where people were being affected by climate change.

A major method for receiving interview contacts was through snowball sampling. In research, snowball sampling is a recruitment technique where research participants help in finding other potential candidates (Naderifar, 2017). After interviews, we asked each interviewee if they could provide our team with additional contacts that could contribute to our project. This query often gave us additional contacts that our team could follow up on and helped provide our documentary with more depth as seen in Figure 6.

Throughout the duration of the project, our team reached out to a total of 51 people via email. From these emails, our team received four confirmations of willingness to participate in the project. Following every interview, our team asked the participant to supply the contact information of any individual they knew that could be beneficial to the project. The snowballing method proved to be effective, providing our team with eight more participants We acquired an additional five interviews from locals by approaching them in-person and requesting participation.

Figure 6

Web diagram of initial contacts and interviewees



Note. This figure shows who led us to certain interviewees. Most interviews originated from our team, while snowball sampling provided our team with eight additional interviews.

3.4 Recording and Conducting Interviews

Our team conducted a series of video and audio interviews in the Panama City Metropolitan area to record and analyze climate stories from Panamanians. We then analyzed the interview clips to construct our documentary in a coherent way, as well as to understand what common subjects came up in our interviews the most.

3.4.1 What is a Narrative

A narrative is a storytelling technique in which characters explain the events of a story, experiences, or details from their viewpoint (*"What is a Narrative…,"* 2023). Narratives, which often direct their attention to human conversations, consist of a setting, plot, characters, obstacles, and conflict. There are many different types of narratives, which refer to the sequence in which stories are told. Most relevant to our project is the non-linear narrative. This type of

narrative does not follow a strict chronological sequence and instead focuses on weaving different perspectives and stories together (*"What is a Narrative…,"* 2023). One of the drawbacks of this approach is that interviewees can deviate too far from the question and provide us with non-relevant data. In the end, the goal of our project was to piece together these unique interpretations on climate change that allow the viewer to imagine the obstacles and experiences facing Panamanians and sympathize with Panamanians.

3.4.2 Power of Videos

Narratives can take on many different forms. Cave drawings, oral tradition, and written words have each contributed to storytelling throughout humankind (Mendoza, 2015). In the past two centuries, technology and media have greatly altered how we interact and share stories with others (Mendoza, 2015). Those with access to the internet can share their stories online and potentially reach millions of people. ("Staying Authentic…", n.d.). Worldwide, humans consume billions of hours of YouTube each day ("Staying Authentic…", n.d.). While our team discussed different forms of media, such as Instagram Posts, TikTok videos, and photo galleries, we decided that we should create a video documentary style for various reasons. Moreover, videos can be a powerful way to effect change. In an article about the power of video, Forbes states, "[v]ideo has proven to be an effective method for teaching and sharing with your audience…" (James, 2018, para. 7). By appealing to the audience's emotions and senses, a good documentary can create a change in minds by providing the audience with a greater understanding and awareness of the video topic. (Underbjerg & Steen, 2023).

3.4.3 Equipment

Our team borrowed videography equipment from the WPI Global Lab. We met with a member of the Global Lab to discuss what equipment we would need to conduct interviews. The

WPI Global Lab lent us four pieces of equipment: a Zoom H5 portable recorder with a microphone, a Saramonic Blink 900 b2 clip-on microphone for capturing the audio of the interviewee, two GoPro cameras to capture video, and a lightweight collapsible tripod for the GoPro cameras. After arriving in Panama, our team decided to use phone cameras instead of GoPros to capture video and photography due to the phone's more accurate lighting and tighter field of view. We mostly used the Blink 900s for our interviews as they removed the need to hold the Zoom H5 up to the interviewee's face.

3.4.4 Interview Structure

Our team gathered stories by conducting a series of both structured and unstructured interviews depending on the scenario. Both interview methods have their own pros and cons, as well as situations in which one method would be more favorable than the other.

Instead of entering the interviews with every question in mind, we asked open-ended questions and allowed the interviewees to tell their own stories with little guidance from us. For example, one question we asked was, "Have you noticed any changes in the weather or the environment over the course of your life?" Based on the response, we could ask unique follow-up questions that were related to the story they were telling. This method enabled the interviewee to express their thoughts and further dictated the narrative they wished to perpetuate.

Our team also conducted structured interviews. This was very useful for us when we were entering a site which we had background on, and when we wanted to obtain specific information. For example, a question for an area that frequently floods was, "can you please tell us about how the floods affect your daily life?" Also, structured interviews were used when we conducted interviews in Spanish. Since our team did not have a way to translate the speaker on-site, we had to adhere to a structured interview.

3.4.5 Sensitivity

Throughout the outreach and interview process, we remained sensitive to be cognizant of the interviewee's situation. Approaching emotionally difficult topics and researching vulnerable populations requires an awareness of the potential impacts certain questions or attitudes can leave. Many participants have experienced devastation brought on by the effects of climate change, which is a struggle the research team will never fully comprehend. Furthermore, our team is not inculcated with the traditions and customs performed by the residents of Panama, meaning cultural education is required before beginning the interview process. To avoid potentially disrespecting or belittling an interviewee's experience, our team maintained a level of self-awareness and recognition of privilege while trying to accommodate the participant as best as possible.

3.5 Recording Climate Indicators

In addition to the interviews, we wanted to capture the feel of Panama as well. It was important to accurately and honestly represent Panama to differentiate our project from past climate stories projects. We captured footage of the landscape, daily life, and specific locations that were relevant to the interviewees' narratives. We utilized this footage in the background of our video as the interviewee spoke to provide more context to the narrative. We also recorded live music that provided cultural insight on Panama, as well as provided appropriate background for our final video.

We utilized various photography techniques, such as simplification and the rule of thirds to accurately and successfully capture how climate change has affected Panama. The rule of thirds is a guideline in photography/videography. Four imaginary lines divide a scene into nine equal rectangles. Two lines are placed equidistant horizontally in the scene, and two lines are

placed equidistant vertically in the scene. The idea is that placing key elements into the areas where the lines intersect create a more balanced and visually pleasing scene (Lin et al., n.d.).

3.6 Producing a Documentary

After recording interviews, we analyzed our footage in Google Sheets by coding them based on keywords. We directly used these coded snippets by copying them into a Google Sheets which constructed our documentary outline.

3.6.1 Coding Footage

After recording all our footage, our team divided each interview into sections. Each section was "coded" by labeling them with one or two keywords or tags to describe what the interviewee was talking about as seen in Figure 7. While this process took time, it enhanced the efficiency of our story outlining and subsequent analysis in our report.

Figure 7

A Google Sheet of how out team coded clips.

Timestamp	Section	Subsection	Who	Clip Duration	Description
45:10 - 45:30	Call to action		Marisol	20	Human's have the intelligence to reverse climate change
2:16 - 3:05	Cause	Anthropogenic	Diwi	49	cause of environment changes bc of human activity
0:46 - 1:23	Cause	Earthquakes	Ice Vendor	37	Cause - It is small, but other
1:55 - 2:33	Cause	Earthquakes	Ice Vendor	38	Says that earthquakes in North America are now taking place in Panama, Costa Rica, Colombia
4:50 - 5:36	Cause	Religion	Ice Vendor	46	If the weather has to be hot it is, nature orders it from God
5:36 - 6:43	Cause	Religion	Ice Vendor	67	Many people complain about faults, but God isn't to blame (Ex: Construction company builds house close to river)
6:00 - 7:30	Cause		Jose Brandao	90	talking about how humans are causir
32:33 - 33:00	Cause	Anthropogenic	Marisol	27	RE - SUMMARIZATION: We are the cause. We are generating the problem
13:10 - 13:38	Cause	Pollution	Marisol	28	On average, a person in Panama generates 1.2kg of waste, which is the highest rate in South America

Note. The "Section" column is the keyword that we coded clips based off. This is just a tiny portion of the Google Sheet.

3.6.2 Story Outlining

Once all our footage was coded, our team outlined how we wanted the final video to be arranged. We decided to break up clips into three threads: perceived causes of climate change, environmental effects, and economic effects. Each of these threads also contained subsections to give us more structure. We also chose some themes that we wanted to express such as mental health and policy, which helped us form a cohesive final video. We chose these themes, because we noticed they appeared in many of our interviews, and we felt that they would be particularly compelling for viewers.

3.6.3 Drafting our Documentary

With our outline in hand, our team used Google Sheets to piece our coded clips together into a cohesive story based on the structure we had from outlining as seen in Figure 8. This allowed us to see exactly how our documentary would flow and make small adjustments easily. We also pulled the text from the transcript and placed them in their corresponding clips to be able to read our documentary through as if it were a written story.

Figure 8

A Google Sheet of how out outlined our documentary

Timestamp	Section	Who	Duration	Total Time	Quote
					Color Legend
					Documentary transition
					Section heading
					Already in documentry
					To add to documentry
					Think about adding to documentry
					Remove from documentry
	What Is Climate Change?				
	Definition of Climate Change				
15:41 - 15:58	Definition of Climate Change	Eric M	17	00:17	"Climate change is this rapid change that we have in the climate pattern in the last 100 years that is a product of the amount of CO2 that humanity is pumping to the atmosphere. We have to be clear on that."
			0	00:17	
	What Do You Believe The Main Cause Of Climate Change Is?				
	Causes		0	00:17	
2:16 - 2:42	Cause	Diwi	26	00:43	"I know that the causes of changes in the environment are the human activities that we carry out on a daily basis to keep our lifestyle. The food we eat, the materials we produce, the oil we take out of ground, all that is having a carbon footprint that is not easy to understand."
17:25 - 17:40	Cause	Steve Paton	15	00:58	"I believe that it is fundamentally a question of producing I really do believe that. And so those greenhouse gases are anthropogenic in origin. So it's us."

Note. The "Section" column is the keyword that we coded clips based off. This is just a tiny portion of the Google Sheet.

3.6.4 Editing Footage

We used DaVinci Resolve (a popular free video editing software) to edit the footage we got from the interviews. Using our draft, we were able to quickly cut and combine clips into one final video. We added music, a voiceover, and other media, like ambient sounds or landscapes, to enhance the video and make it more emotionally impactful.

3.7 Missed Opportunities

Unfortunately, our team was unable to view all the locations we had intended to visit. One place we actively sought to attend was the San Blas Islands. The coast near the San Blas Islands is a three hour drive each way from where we were staying. Additionally, ferries or water taxis are required to reach the islands, making this at least a full-day trip. Originally, Diwigdi Valiente, a representative of the Guna community and our first interviewee, offered to assist us in visiting the islands. However, due to conflicting schedules we were not able to join him. Towards the end of the term, we had tried to visit again with our advisors this time, but the need to finish deliverables took precedent. This trip would have provided our team with a rich experience. The Guna Yala lives throughout the San Blas Islands, and we heard many interviewees mention their vulnerability due to climate change. More specifically, the island of Gardi Sugdub has plans to relocate within the next year, making them one of the most affected people in Panama. Visiting them would have helped amplify their voices and provide the reader with insight on how forced climate migration has affected the Indigenous communities in Panama.

Another place our team wanted to visit was the Fish Market. While we briefly walked into the fish market and the surrounding area, we did not receive permission to record in the

market and we did not have time to interview anyone there. Gathering footage and interviews at the Fish Market would have provided the reader with more visuals about the importance of fishing in Panama and the practices that may contribute to climate change. It is also possible that we would have been able to talk to local fisherman which would have given us more insight into how the industry is affected by climate change and triangulate with the owners of the MaaGoo's Fish Taco Restaurant. We were very fortunate to hear from the owners of MaaGoo's, but being able to take video at the Fish Market would have further enhanced the stories.

Our team wanted to visit a variety of other locations that we could not due to time constraints. Gatun Lake, which has been affected by droughts, is one place that we had wanted to visit. This would have provided us with visual evidence on how the Panama Canal has been affected by climate change. While we briefly visited Bocas del Toro, a Northwest province in Panama with several islands, we had wanted to gather Indigenous stories in that region. Unfortunately, we did not have the time or resources for this as well. Sadly, our time had become so constricted that we even had to cancel planned interviews with meteorologists, activists, and other experts. Overall, this showed our team that there are so many stories that can be captured in Panama. While we may not have been able to visit every place we had hoped for or interview every person we had aimed for, our team did not see this as a failure. These shortcomings highlight the fact that this is a continuous research project, and that other project groups should add on to these stories.

3.8 Pros and Cons of Different Research Methods

When researching, we utilized a variety of research methods. Each research method has its own pros and cons. We utilized all the following research methods in conjunction to mitigate all the cons. We used: archival research, interviews, observation, and ethnographic research.

The first research method we used was archival research, because it is unobtrusive and allowed us to build an intellectual foundation for our project. We compiled data and information about demographics to be prepared and efficient in managing the use of our volunteers' time. However, when conducting archival research, the reliability of an article or source must be considered. To minimize potential bias or false information, our team triangulated sources to find points of agreement and disagreement. To increase confidence in our sources, our team researched the authors, organizations, and sources of publication to gather a well-rounded perspective. Although sources may maintain high reputability, the potential for bias remains a prevalent issue.

For our group, interviews were the largest and most important way information was gathered. We conducted interviews in a semi-structured manner to provide the interviewee with both a guiding structure along with room to share their own narrative. Open-ended questions in our interviews provided crucial insight to the thoughts and opinions of the interviewee, but also enabled our team to ask follow-up questions if more information was necessary. However, interviews can be intrusive, inconvenient, as well as in some cases, triggering to the interviewee (Jamshed, 2014). We remained cognizant and sensitive to ensure the comfortability of the interviewee. Furthermore, interviews provide the opportunity to detect the presentation of misinformation as fact (Jamshed, 2014). The education level as well as belief systems varied between interviewees, which provided data that contrasted between interviews. We highlighted inconsistencies in demographic perspectives to better understand the entire representative population. We compared archival research with the data gathered from the interviews to corroborate our sources.

Our team also conducted observational research, which was particularly important for our team's project. Observational research is conducted by traveling to the subject being researched

(QuestionPro, 2023). We traveled to different sites in Panama and took photographs and videos of climate indicators. The benefit of traveling to the site is we could collect rich and detailed quantitative data in natural settings. However, our information can be biased due to our mistakes in collecting data, which is known as research bias (QuestionPro, 2023). Another con is that observational research can be intrusive (QuestionPro, 2023). Our team collected some sensitive videos from some of our interviewees. In our case, everyone was willing to share media with us.

One effective method we used was ethnographies. Ethnography is a scientific method used to gain qualitative data on a group of people by visiting them in their natural environments (Rees, n.d.). In our case, we had the opportunity to visit the Emberá, as well as visit many places in Panama like Casco Viejo, and Chepo. We visited locations in person to use our senses to gather details. Details allow for a much more interesting and compelling story. One problem with ethnographies is that our visit only captures a specific snapshot of time. Although interviews provided some insight to information our team lacked, we did not observe the events of Panamanian history nor its future. Cultural sensitivity was an important factor that had to be considered when conducting ourselves in a foreign environment. Ethnographies provide room for personal subjectivities and biases that can potentially influence the narrative portrayed in our project. We countered this potential bias by ensuring our team was aware of our privilege in Panamanian society and we conducted research on culture through experienced advisors and reputable sources.

Due to the limitations of each research method, we triangulated all the methods to develop more accurate and compelling information and narratives. By doing so, we mitigate the shortcomings of other research methods, and strengthen our data.

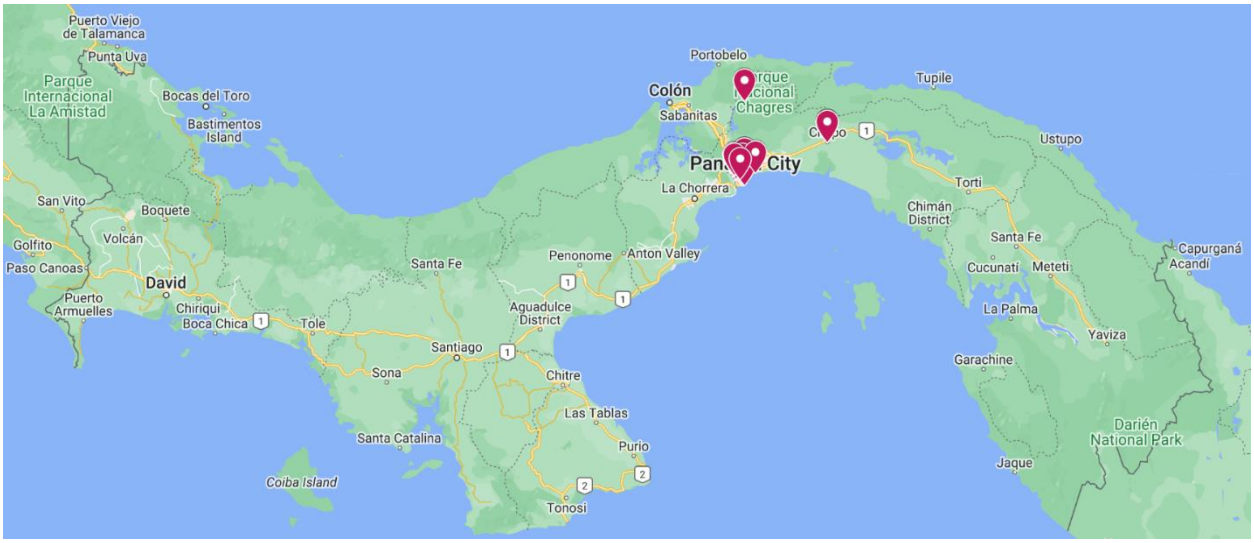
3.9 Selection Bias and Research Limitations

Selection bias is a type of bias or error that can occur when participants are sampled non-randomly (Lustick, 1996). In particular, selection bias is prevalent when a sample of chosen people is not representative of the general population. This bias can occur for several reasons, including non-response bias, interviewer bias, and convenience sampling. Non-response bias is an effect where the subset of participants who agree to participate in a study does not match the general population (Leonard, 2005). This bias could be due to lack of time, interest, or incentive. Interviewer bias occurs when a researcher's actions, words, or non-verbal actions intentionally or unintentionally impact the selection or behavior of participants in a study (Johns, 2023). Convenience sampling is when researchers choose participants primarily based on their availability, accessibility, or willingness to participate, rather than considering their appropriateness or relevance to the study (Nikolopoulou, 2023).

Due to our limited time and resources, our project has inevitably involved a biased group of people. Our sample may be victim to non-response bias, interviewer bias, convenience sampling, and other unnamed or unknown effects. Convenience bias, as shown in Figure 9 and Figure 10, limited the geographical scope of our gathered interviews. Despite this challenge, the goal of our project was to listen and collect stories; while these stories might not represent the general population of Panama, climate change does not affect all demographics equally. We have succeeded at our goal by searching out those who were willing to talk to us about their experience with climate change.

Figure 9

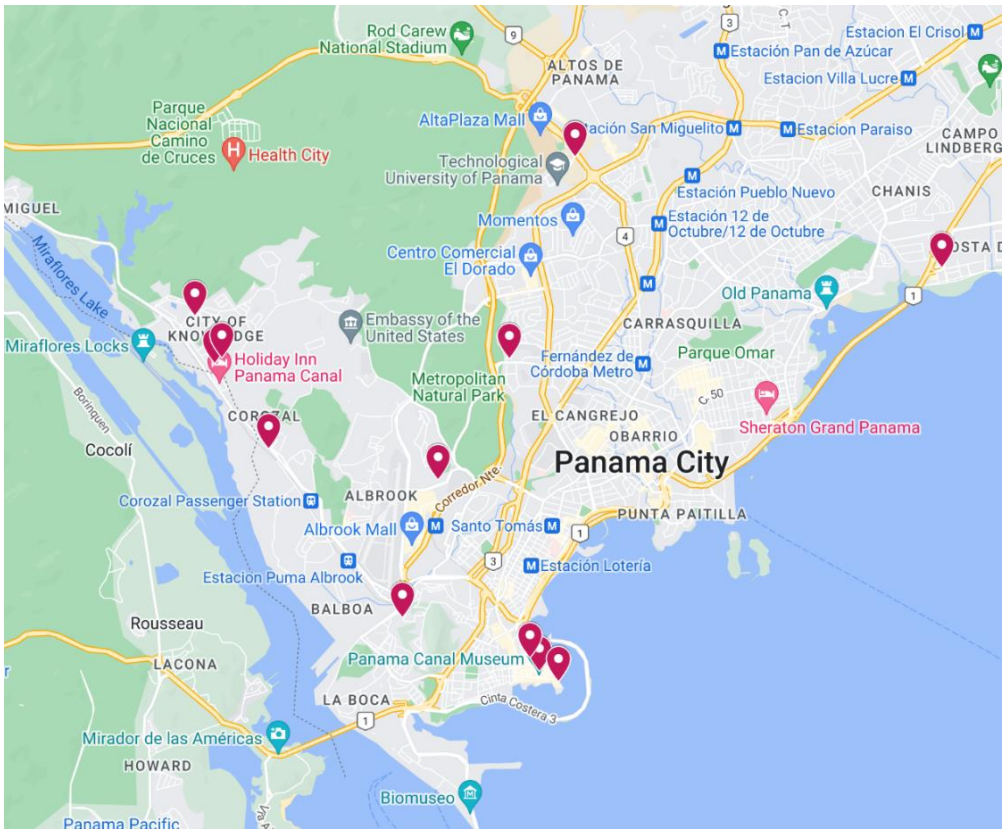
Map of interviewee locations



Note. Map of interviewee locations where most interviews were conducted near each other, which shows there were many areas in Panama where we did not get data.

Figure 10

A zoomed in map of interviewee locations



Note. Map of interviewee locations in Panama City, to better see the distribution of interviews.

3.10 Summary

Our methodology enabled us to thoroughly produce a climate narrative of the people in Panama. We established the individuals and groups of people that represented the diversity in Panama. This method was the basis that helped our project identify the voices that needed to be amplified. We listened to their stories and recorded their experiences to construct the larger narrative. Finally, we compiled and edited this footage to create a deliverable that effectively captured the tone necessary for climate stories. We believe the project successfully demonstrates the perceptions and experiences that Panamanians have felt regarding climate change. Not only does it provide a glimpse into the communities of Panama, but it also contributes to other climate stories that bring awareness to the devastating impacts of climate change.

Findings

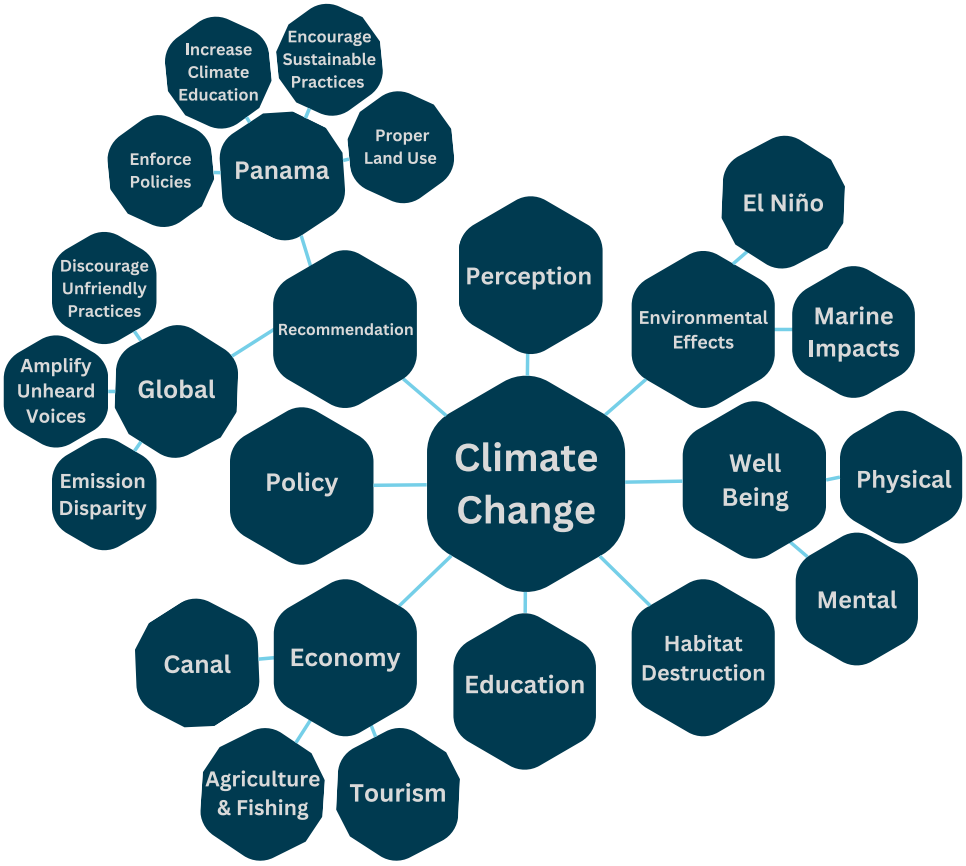
Chapter 4

Chapter 4. Findings

Our team gathered compelling stories from an array of Panamanian individuals, including meteorologists, biologists, policy-makers, activist organizations, teachers, fishermen and street vendors. We collected valuable information from Panamanians regarding not only personal experiences, but also levels of perception and knowledge of climate change. The interviewees' thoughts, feelings, and opinions allowed for a diverse scope and allowed us to capture the Panamanian struggle with climate change. We analyzed our recorded footage, which revealed the trends seen in Figure 11 between the various categorical groups we interviewed.

Figure 11

Visual guide of Results



Note. Connections stemming from climate change and branching out to the overall trends that the themes emerge from.

Storying Climate Change in Panama 2023 Interviewees

4.1 Panamanian Perceptions of Climate Change

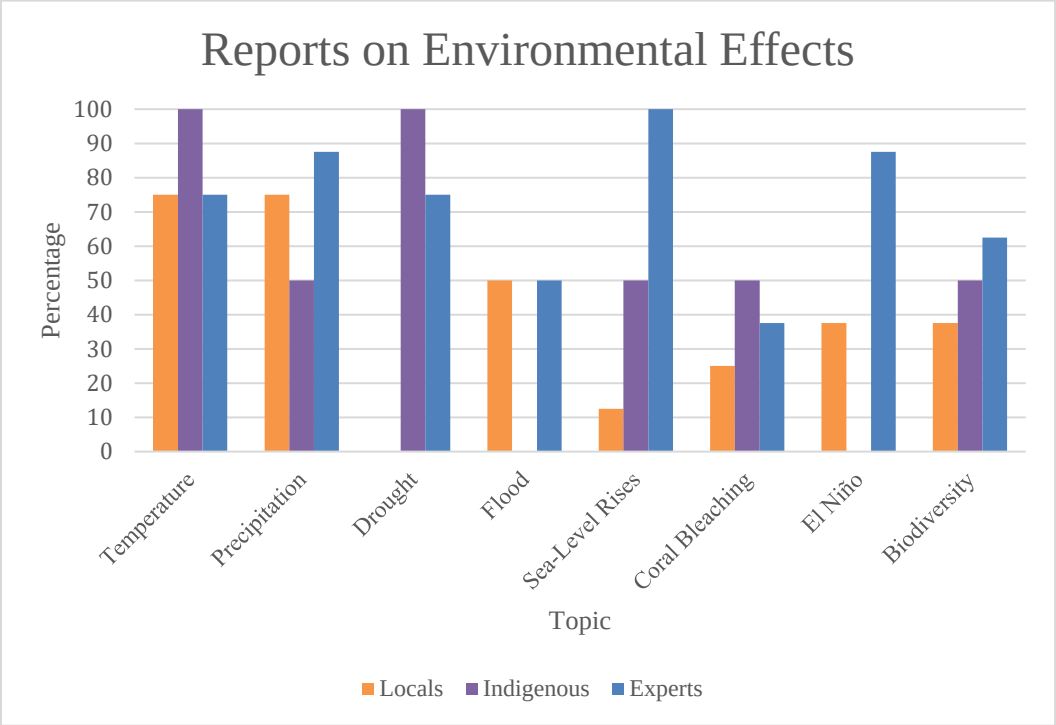
After analyzing our interviews, it became apparent that the Panamanians we interviewed had contrasting views on the definition of climate change and the nature of the phenomenon's extent. A consensus appeared among experts that climate change was a change in weather patterns caused by human intervention with the environment. However, members of the general public that we interviewed had varying perspectives on the definition and causes. One common theme we found through the interview process was religious influence on opinions. Jose Agudo, a *raspado*, or shaved ice vendor, attributed the changes in the environment to natural processes commanded by God. Furthermore, Jorge Clovis, an English Professor from the University of Technology Panama (UTP), stated, "climate change is nature. Nature itself decides what wants to be done and what not to be done. It's something that runs up from our hand, God's nature." Marta Marie, who worked in a flower shop in the province of Paquilla, claimed an excess of cars in Panama has increased the temperature and caused climate change.

4.2 Environmental Effects

While the definition and understanding of climate change varied between interviewees, they all agreed that there have been noticeable changes in their environment explained in Figure 12. This figure illustrates the percentages of how often specific topics were mentioned in interviews among various demographics.

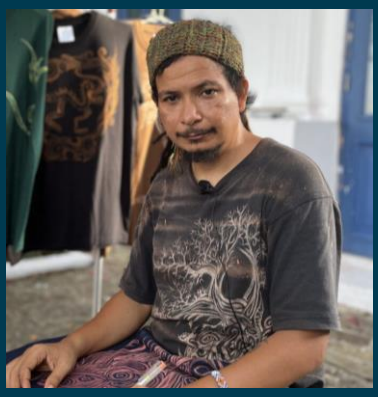
Figure 12

Frequency of interview responses by topic



Note. In order to account for the unproportionate number of interviews from each category, totals were scaled to percentages based.

Interviews reported an increase in temperature the most. Global warming has become synonymous with climate change, and while it is an effect of climate change, this phenomenon is not the extent of issues associated with climate change. Of the twenty people interviewed, thirteen described experiencing hotter weather. César, a shirt vendor, explained that recently the heat has been so unbearable that one vendor was forced to stop working. However, our interview with Steven Paton, the Director of the Physical Monitoring Program at STRI in Panama,



"Well, a friend here once wanted to sell [in an area more open to the sun], and she felt very bad. She couldn't, because of too much heat…"

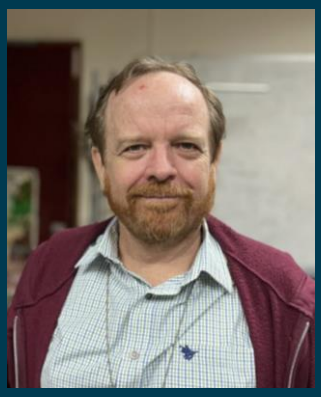
revealed that average temperatures have only increased one degree Celsius. Paton is an expert in monitoring the climate and oceans of the tropics and spoke about the uncertainty pertaining to environmental changes being attributed to climate change, claiming “it's very difficult to attribute a specific observation with a specific cause.” However, while confirmation of the correlation between environmental changes and climate change cannot be definitively stated, Paton stated, “there are lots of things that we've observed, especially in the last 24 years, that are consistent with climate change predictions.” He went on to elaborate that in the area of Central Panama, they have had, “eight of the greatest 10 storms,” and “the three driest years in a row on record.” He claims that 2023 could become, “yet another of the top three driest years.”

The prolonged droughts have had a serious impact on Indigenous communities. Eliecer Ruiz, second chief of Puru Biakiru which is a community of the Emberá people stated, “In 1975, the Chagres River was a very deep river, right? It was one of the very fast-flowing rivers… To where it's not anymore. Why? Because it's moving the scourge of climate change.” This change could have significant consequences relating to their fishing, tourism, and connection with nature explained Ruiz. This finding highlights the importance of climate and environmental justice in Panama. Indigenous groups are located in areas that are particularly prone to climate change impacts and rely more on the land when compared to those that live in cities in Panama. With less ability to mitigate changes, and a lack of resources to be able to adapt, indigenous groups are disproportionately feeling the effects of climate change.

4.2.1 El Niño

Our team visited Panama during an El Niño event, which led to many interviews encompassing effects that are correlated with this weather phenomenon. Increased droughts, floods, and unpredictable rainfall patterns associated with additional frequency and intensity of El Niño were reported during our interviews. Ten of our interviewees mentioned El Niño during

their interviews, with seven out of the ten being experts. Paton confirmed the definition of the El Niño-Southern Oscillation as described in section 2.3.2, further elaborating that “the consequences of that are moving precipitation zones around… During El Niño events, typically, this region suffers severe rainfall deficits.” Jose Brandão, a professor of Agroindustry at UTP, describes this effect in Panama, saying, "in this region, every year we have a drought season that's at least three months that there's no rain. And lately, it has been like six to nine months and is getting out of control." With extended droughts and increased dry season, water levels plummet, causing immense social, economic, and environmental issues. Paton confirms this issue by stating, “once we get into dry season, then the lake level will begin to plummet because it will stop raining almost completely.”



“And once we get into dry season, then the lake level will begin to plummet, because it will stop raining almost completely. It'll be hotter and sunnier so there's more evapotranspiration and the lake level goes down.”

Steve Paton, Researcher at Smithsonian Tropical Research Institute

El Niño events have been increasing in frequency and intensity, occurring only about seven years apart rather than twenty years, which has been historically observed. Panama is currently observing their driest years ever recorded. According to Paton, if this El Niño event behaves similarly to that of 2015-2016, Panama “will lose a major part of our rains in November, which is the rainiest month, and lose all of the rain in December, because our dry season in these big events tends to begin much earlier.”

During interviews locals have reported seeing “rivers dry up,” blaming this issue on less precipitation, but saying, “when it rains, it rains harder.” The unpredictability of rainfall patterns

has caused precipitation to occur in regions that are capable of withstanding changes in frequency and intensity, resulting in flooding of nearby lakes and streams.

Another effect of increased El Niño events is an impact on Panama's biodiversity. Eric Manzané, a biologist and ecologist at UTP, describes the impact that unpredictable rainfall and drought associated with El Niño have on native plant species. He studied, "population[s] of trees that are …less tolerant to drought," looking into "how the population of those trees declined." With "climate getting drier, and not only suddenly drier, but the whole pattern of rainfall hav[ing] changed," El Niño "is affecting how a lot of the species, especially tree species in the forest" adapt to their environment. One of the problems species are facing is in reproduction. Manzané explains how species rely on certain temperature and rainfall conditions to reproduce, and when the cycle is disrupted, there is a significant loss of life and decrease in reproductive input. Additionally, Manzané states, "and now we have seen that some of the species in the Pacific are likely to move toward the north because now we have a heavy drought." Migration patterns of plant species due to climate change will then change entire ecosystems, affecting habitats and accessibility to food sources for both animals and humans. As traditionally dominant species in an environment either migrate or produce less, other species can absorb more resources, potentially "affect[ing] the amount of CO_2 that the forest, the dry forest is

"How they [trees] reproduce, the temperature they used to reproduce have been changing trying to follow up the change on the weather climate, and all this, we know that it has to do with the climate change that we have seen right now.

Eric Manzané, Professor at Technological University of Panama

taking," according to Manzané. Manzané provides an example using the prominence of lianas seen in Figure 13, "woody climbers that actually have to grow over trees to reach the canopy," claiming "they don't invest that much in self-support, but they invest a lot in growing. And because of that, …they can keep growing during the drought season, especially in the Pacific side."

Figure 13

Image of woody climber at Metropolitan Natural Park in Panama City, Panama

The lianas, and other woody climbers, become an issue with the sequestering of carbon because trees, "take the carbon and they fixate in the wood…Lianas, they don't produce too much cell support. They don't produce too much wood." The lianas grow mostly leaves, which have a fast turnover, "thus, the CO_2 that is fixating in the leaf will be released pretty soon. And that will affect the budget of CO_2 in the tropical trees, in the forests, especially in the dry areas," according to Manzané.

4.2.3 Marine Impacts

Climate change not only affects the terrestrial ecosystems in Panama, but also affects marine areas through increases in water temperatures and sea level rises. Paton confirms this claim, saying, “water temperatures in the Caribbean have gone up about 1.2 degrees Celsius,” with sea-levels, “rising in the Caribbean about three and a half millimeters per year, in the Pacific about one and a half millimeters per year.” Paton confirms that these changes are consistent with climate change, saying “sea level rise is one of the things where, yes, that is climate change. There's really no discussion about that.”

El Niño triggers coral bleaching, which is the excretion of algae from coral as water temperatures increase, causing the coral to transform into a white color. While corals can survive these events, they experience stress and are subject to mortality (*NOAA’s National Ocean Service*, 2010). Paton describes past El Niño bleaching events in 1982-83 throughout the Caribbean and eastern tropical Pacific. Through his research at the Smithsonian, Paton was able to reveal, “this year we're getting bleaching again,” claiming there are already bleaching alerts throughout the Caribbean and Eastern Tropical Pacific. He believes this year is, “going to be another major bleaching year.” Coral is not the only species subject to the effects of increased weather.

Vicente Del Cid Mendoza, Manager of Responsible Production and Consumption at Marviva, states that with climate and marine variability, “there has been a significant decrease of a resource.” He claims fishermen have had problems during their daily catch due to, “displacement of important species for fishermen, such as the sierra or macarela, which is a fish that has moved farther and farther away from the coast.” Our team also interviewed Aaron and Charles Henriquez, brothers and owners of MaaGoo’s Fish Tacos, who catch all the fish their

"The [water] temperature got up to 89 degrees the other day in Panama… That's almost never even heard of. 89 degrees that the water went up, then it dropped back down to 82, then to 86…When there's different temperatures like that, the plankton die, and the plankton turn red… it's toxic to the fish."

Charles Henriquez (left) with his father Carlos (middle) and brother Aaron (right), Owners and Fisherman at MaaGoo's Fish Tacos

restaurant serves. Throughout their time fishing in the oceans of Panama, they have witnessed increasing events of oceanic temperature variation. Charles describes one of these events, saying, "the [water] temperature got up to 89 degrees the other day in Panama… That's almost never even heard of. 89 degrees that the water went up, then it dropped back down to 82, then to 86." He goes on to to describe the subsequent Red Tide events, explaining, "when there's different temperatures like that, the plankton die and the plankton turn red. And so, we get Red Tide." Red Tide is typically seen, "when there's a direct increase or decrease in the change of temperature," Charles elaborated. Aaron goes on to explain the detrimental effect Red Tide has on marine life, claiming this phenomenon causes toxicity, killing fish and the birds that consume these fish. Last year, the brothers witnessed a graveyard of pelicans in the ocean following a Red Tide event.

Other reports in interviews include increased extreme weather events, with one local explaining the hurricane that suddenly ravaged a nearby beach, destroying homes and putting lives at risk. Mendoza furthers this point, claiming, "climatic variability in terms of the intensity of climatic events has increased the risk and danger of the activity due to storms." He goes on to explain ground swells, "which are intense swells on the coast and the undertow in the sea as well," and claims these events increase difficulty of the activity of fishermen. He describes how

groundswells break the Panamanian coasts, affecting and increasing the risks of boats in this area, as well as increasing the potential risk for loss of human life. The environmental effects of climate change are seen by every member that our group interviewed and are likely experienced by all Panamanians. These environmental effects impact not only biodiversity in Panama, but also have the potential to destroy property and impact physical and mental well-being.

4.3 Well-Being

The effects of climate change not only modify the environment, but also have detrimental effects on the well-being of the people of Panama. Environmental effects introduce the influence of extreme change into traditional ways of life through the destruction of homes and subsequent impact on physical and mental health. Certain trends identified through interviews regarding the groups of people afflicted most exposes vulnerability patterns that highlight a lack of preparation and adaptation strategies common in Panama.

4.3.1 Physical Well-Being

Our team interviewed two residents from the town of Chepo, a town built east of Panama City and along the Mamoni River. The town experienced an unexpected and devastating flood at the end of August 2023. While the residents were thankful the flood did not result in the loss of human lives, Juan Carlos, a resident of one of Chepo's villages, recounts how challenging floods are. He mentions that people get sick, and they cannot go anywhere. Floods have the capabilities of death, spreading

"When a flood happens, many things happen. There are illnesses, the river floods are very strong, you can't walk, you can't go out, you can't do anything, you just stay static in one place."

Juan Carlos, Teacher

diseases, and mentally impacting those that are hit by such events. Stagnant water can harbor harmful parasites or bacteria, that if ingested, can cause bodily harm. Furthermore, as floods sweep through towns, sources for electrical power can electrify the water, making it impossible to travel or touch the water without bodily harm.

One concern that was mentioned throughout our interviews was access to clean water. Ilya Espino de Marotta, deputy administrator of the Panama Canal, stated that, "55% of the population of Panama take drinking water from either [Gatun or Alajuela] lake." Paton explained that the Panama Canal Authority must guarantee sufficient water for the residents of Panama; however, there are still many complications that arise from this shared water source. Paton recounted that during the 2015-2016 El Niño event, had the country not received a fourteen-centimeter rainfall, they would have run out of water. Meanwhile, Marta Marie, a resident who worked at a flower shop, expressed that the problem had already started. "Yes, we are currently running out of water. Many people don't have their drinking water," said Marta, "we are already seeing that in our houses we are not going to have in fifteen years, the normal [running] water." Paton added that the country will almost certainly have water restrictions. "The water will be turned off and rationed, and it will probably happen beginning in March…," said the expert. Interviewees also mentioned that poor communities will be the first to experience the rationing. Poor and indigenous communities already have limited access to reliable energy and water sources, as mentioned in section 2.3.1, furthering the necessity to climate and environmental justice initiatives in Panama.

Recently, mining expansion projects were proposed by the government, which has also exacerbated the problem of clean drinking water. Aaron Henriquez, a fisherman and entrepreneur, said,

A lot of our Gatun Lake water is going right into the mines and those mines actually have very hot water that once they use that fresh water, they expel it back into the ocean and it's just death. It just kills everything. It's contaminated water and then it's also temperature wise very hot.

The Canal does have plans to add an additional reservoir, a move that would allow more water to be stored and help provide residents with more drinking water explained Ilya Marotta. However, this project would take a minimum of five years to complete. It is evident that more must be done for the residents of Panama to provide them with clean water.

4.3.2 Mental Well-Being

Besides physical harm, the loss of property, stress of dealing with displacement, and other effects of climate change can have harmful impacts on the mental well-being of Panamanians. Juan Carlos Monterrey, Executive Director of activist organization Geoversity, an organization that trains the next generation of policy makers, activists, and leaders with climate change on their agendas, grew up in the town of El Pájaro de Pesé, where his family are farmers. Recently, his family farm has been affected by droughts, causing an unfortunate emotional reaction due to stress. Monterrey explains to our team about growing up on a small farm, with little land to live and grow their crops. However, during the 2015-16 El Niño, their family lost a third

"The impact that the climate crisis is having all over the world is not only economic, it's not only physical, but it also has to do with mental health. And that is one of the things that keeps me fighting and pushing because I can see it on my own dad, I can see it on my own family, and I can see it on my own neighbors, you know, how they are suffering just from the fact that they're losing so much."

Juan Carlos Monterrey, Executive Director of Geoversity

of their cows, meaning they lost, “effectively a third of our wealth.” Monterrey elaborates that his, “dad [went] into an anxious depression phase that [they’re] still dealing with.” Without means of providing for his family, Monterrey’s father struggled to cope. However, in the face of such adversity Monterrey uses the struggles his community faces as motivation to incite change.

Not only does he push for political and governmental involvement, but he also encourages increased education. He remembers growing up where “power outages were frequent, potable water was very limited, and crop failure was basically the norm.” Monterrey states he “grew up facing the impacts of climate change without even knowing what the climate was.” Diwigdi Valiente, a climate change activist and one of the few Indigenous representatives for the Guna people, grew up in a similar way. While growing up, Valiente noticed the changes in his environment without knowledge of its cause. Once Valiente attended a conference for climate justice, he began his activism and passion for climate change education. However, implementing change proved to be a difficult feat. Valiente narrates,

> For many years I was trying to work on something to make awareness of climate change. I started talking to the Minister of Environment, I started talking to some NGOs, and unfortunately at that time, in 2014, no one cared. At that time climate change wasn’t a topic that was on the table. We’re talking almost ten years ago. And I got super depressed, even suicidal, and I didn’t want to talk about climate change for two years.

These mental impacts were extremely harmful to Valiente, but he regained motivation for the cause and “created this group of friends that would go to islands, take pictures, held workshops with the kids of the islands to tell them what climate change was.”

Both activists agree that education is essential in Panama's fight against climate change, but interviews revealed that there are serious mental health implications that could result from this knowledge. Monterrey claims that when the idea that the planet is, "going to crap," is reiterated to school children throughout their lives, "how can [they] not be anxious? And how can [they] not be depressed?" While there is a delicate balance between such pessimistic mindsets that could potentially cause harm, Monterrey reiterates, "that should not be a barrier to further expand the consciousness of what's happening." Through the interviews conducted in our project, the connection between mental health and climate change was one of the most powerful connections.

4.4 Destruction of Human Habitats and Residences

As sea levels continue to rise, there is a threat to the existence of the native inhabitants of Indigenous groups. The San Blas islands are in the Caribbean Sea and a part of the Guna Yala *comarca* (an autonomous sub-province). These islands have been slowly losing exposed land as sea levels continue to rise. Unfortunately, these islands are home to the Guna people, an Indigenous group with a rich history and tradition embedded in Panama. Due to the sinking islands, Guna people have become the first documented case of an Indigenous group that had to move because of climate change. Our team

"My grandkids are not going to be able to see how our ancestors used to live. They're not going to be able to swim in crystal clear water or swim with dolphins or see a jaguar or a macaw or all these species that I have been able to see when I was a kid. And we are risking not only losing all that, but also our culture. I don't want the culture of my grandmother to die."

Diwigdi Valiente, Representative of the Guna

interviewed Valiente, and he detailed the tragic story of his people by elaborating on the impact climate change will have on the Guna. According to Valiente, not only will they be forced to relocate, but they are risking the pertinence of their heritage and culture. When he spoke on reading that, "Guna people are the first climate change refugees in Latin America," he explained that his first thought was how he would explain his culture to his kids and grandkids. He goes on to claim that if, "the people stop living in the islands and stop having our traditional way of living, my kids are not going to be able, my grandkids are not going to be able to see how our ancestors used to live."

While speaking about the Guna Yala with Marisol, the president of FAS Panama, she mentioned that "there is already the plan to move two communities to the tierra firme [mainland]." The displacement of the Guna people will result in the loss of their way of life and occupation, forcing the communities to adapt in an environment that is not equipped to suit their traditional needs.

Increased intensity and frequency of floods has also begun impacting communities throughout Panama. Floods destroy homes and material property and are difficult to predict or resist in areas that are ill-prepared for such events. César Barrilla was one of the residents affected by the floods in Chepo. He described the event as "something that happened unexpectedly, because it rained continuously for more or less six hours. The water level rose higher than normal, and we were quite worried because that didn't happen for a long, long time." César depicts the troubling event, recounting that "neighbors during the flood, they had to leave their houses, they had to leave everything. There were I think four neighbors where the water level went up where the door is." The neighbors were forced to evacuate, and then return to their destroyed homes once water receded. César's neighbor, Kisia, was one of the residents that experienced immense damage from the floods of Chepo, depicted in Figure 14 and Figure 15,

"The water started coming in. It started coming up, it came up extremely fast. So fast that it almost hit us, by the time we realized it, we were already on top of the couches."

Kisia, Housekeeper & Wife of Juan Carlos

describing the frantic actions that they were forced to take. According to Kisia, water suddenly "started coming in. It started coming up, it came up extremely fast. So fast that it almost hit us, by the time we realized it, we were already on top of the couches." Attempting to avoid the hazards of the flood water, while also protecting their belongings, Kisia and her children frantically placed furniture on top of block scaffolding. However, she stated. "some things were damaged." Visibly emotionally distressed from recollection of the event, Kisia goes on to explain the cause of the flood as "overflowing of the river… the main river, when it overflowed, it took hold, it went to the most vulnerable areas, that is to say, the lower parts." Her husband, Juan Carlos, was at work when the tragedy struck, and he was scared for his wife and for their belongings. He remembers the event as "a very sad thing…In the afternoon [his] wife sends [him] a message, videos that the water was rising in the room very quickly, there was almost no time for anything." However, the bond of members in this community was highlighted by neighbors rushing to help those who were affected by the flood. Juan Carlos stated, "neighbors came and helped us at that moment." César concludes, "they had economic damage, material damage, but thank God there was no loss of human beings, loss of life." Besides damage to property and destruction of homes, the effects of climate change can also inflict physical and emotional damage.

Figure 14

Images of Chepo neighborhood

Figure 15

Images of Chepo neighborhood during flood

4.4.1 Most Vulnerable Demographics

The most vulnerable groups of people in society are often under-represented, so it was important for our team to identify these groups and amplify their voices. Climate justice plays a large role in identifying larger, underlying issues that allow these communities to become vulnerable. During the interview process, we asked interviewees to identify the groups who they thought were most vulnerable in Panama. Our interviewees identified three demographics whom they thought were the most vulnerable to climate change: Indigenous, coastal, and poor communities.

As sea levels rise, coastal communities will be affected first. Marisol, president of FAS Panama, identifies coastal communities as one of the most vulnerable groups. She states that "the people that lives on the coast, they are seeing these changes. They saw these changes before us, because we don't live there." The coast has lost some of its natural protection from the ocean due to the loss of mangrove trees. Valiente states that in Panama, mangroves are being chopped to make artificial beaches for tourism or to capture more fish. Marta also noticed that near her business, deforestation had destroyed the mangrove trees. Without mangrove trees, Panama's coast is more susceptible to storms or other climate change events. Those who cannot afford to relocate from the shores will have an even harder time adapting to rising sea levels.

“The place where I had the business… the whole mangrove [forest] was used, just to make a park, where the mangrove [forest] consisted of many trees and now there are no trees. So, they cut down all the trees…”

Marta Marie, Florist

Poor communities lack representation in environmental politics, the community, and healthcare due to limited access to resources and education. Marisol states that one of the reasons why poor communities are especially vulnerable to climate change is "they don't have the infrastructure [or] the phones." The lack of accessibility to resources means that their communities are more prone to damage from climate caused natural disasters like floods or hurricanes. Getting rapid help from government or local organizations can be especially difficult logistically if infrastructure like roadways is poor. Without phones, poor individuals may receive natural disaster warnings too late. As temperatures rise, the heat will have more fatal effects on people. Paton states that “temperatures haven't gotten up high enough where people need to worry yet about the medical implications of excess heat, but that too will come to pass.” He goes on to elaborate, “poor, vulnerable people who don't have air conditioners," will see the most significant implications. When asked specifically which groups of people would be affected the most, Paton stated "it's always the poorest communities, and in Panama that means Indigenous communities.”

The Indigenous communities who utilize tradition and rely on natural resources to survive are vulnerable to climate change, because climate change threatens the lives of plants and animals. Manzané states that "we are actually getting less reproductive input for some plants" and "ones that are less tolerant, they're gonna start to actually get a smaller range." There may be some plants that Indigenous communities are used to utilizing that will be outcompeted by more climate change resilient plants. In the ocean where Indigenous communities fish for food, commercial fishing and warming waters harm the fish populations around Panama. Charlie Henriquez states that "bonita is the main fish on our food chain and they've [commercial fishers] completely wiped out the entire population that we have in Panama Bay.” When they now fish to provide for their restaurant, they, “have to travel 85 miles offshore sometimes to go find quality

fish." Additionally, as discussed in section 2.5, Indigenous peoples are more likely to be left without energy during a shortage. As the demand for energy increases, additional energy sources must be constructed, threatening the protected land that Indigenous groups reside and depend on. Investment in natural resources from third parties on Indigenous territories has increased and endangers ecosystems and people (Garcia, 2018). Since the early 2000s, over 25 hydroelectric dams have been constructed, and as need continues to increase, Indigenous lands are threatened further (Garcia, 2018).

"We are noticing that nature is suffering and there are impacts. And if nature is ending, what does this mean for us, for the Emberá? Oh, well, that is the risk that we are running inside the Chagres National Park…"

Eliecer Ruiz, Second Chief of Puru Biakiru (Emberá)

While visiting the Emberá, we saw directly how climate change was affecting them. When traversing the Chagres River to visit the Puru Biakiru community, there were noticeable parts of the river that were very shallow and hard to boat through. Ruiz, the Second Chief of one community within the Emberá explained that the river used to be much deeper. The river is not the only climate indicator Ruiz noticed. Ruiz talked about how closely the Emberá feels connected with nature. They arrived on the land before any colonizers, they dedicate themselves to agriculture, and they believe in the nature that God left with them. Unfortunately, Ruiz and others feel concerned about what is happening, saying,

> We have different types of trees, we also have very important plants that we have to take care of because they are already in danger of extinction, now we also have ceremonial

> plants that we have and that is why when we talk about mother earth, we take a lot of respect that the spirit is there, she wants us to take care of her.

Ruiz has noticed that biodiversity and agriculture have not been the same. He recalls that in the Darien rainforest, where other Emberá and Indigenous communities live, the past decade has been “unnatural.” Ruiz said that while Indigenous people used to work based on the moon, the moon can no longer help them. Ruiz fears that human greed will exacerbate the problems caused by climate change, and the Emberá will be forced from their homes.

4.5 Education

Throughout our interviews, people expressed their disappointment with the education system, and their contributions to climate change knowledge. One expert claims,

> We don't get educated in anything. Panama has one of the worst educational systems in the world. Our educational law was passed in 1946, and it has not been systematically updated since then, so the Panamanian education system is operating in a wartime educational system. You know, we're talking about the mid-40s when that was designed.

Another expert furthers the argument, expressing their dejection, saying "there's a lot of troubles in the school system in Panama, and probably, sadly, climate change isn't going to be their first priority. I don't expect that happening soon."

Interviewees also claimed accessibility to resources and climate change education in Panama was inhibiting a larger population from gaining the necessary facts. Valiente furthers this claim by stating, "I think we're still needing a lot of work. And especially in public schools, because those ones don't have the same access to information as some of the others." Having grown up on the islands of San Blas on the Guna *Comarca*, Valiente was not informed of data on contributors, such as carbon emissions or unsustainable practices. He describes his first

encounter with climate change, saying, “Well, the first time I heard about climate change and the first time that I realized climate change was affecting my islands was in 2014… I never heard of climate justice before.” He was unaware of the cause of these changes, saying, “I grew up knowing about environmental crisis and pollution, but I didn't link what was happening with climate change and myself and my people.” To him, and many others in Panama, climate change and its causes were not well-known. Valiente explains how this event fueled his motivation to begin taking action against climate change.

Misinformation regarding climate change proves to also be an issue in Panama. This claim can also be seen through the opinions of some interviewees regarding the cause of climate change such as César, who states, "the changes are basically due to pollution and the indiscriminate felling of trees.” While pollution and deforestation are contributors to climate change, it seems as though some Panamanians rely on visual factors to qualify the threat of climate change. Due to lack of visualization of carbon emissions or other greenhouse gases contributing to the problem, this topic is not well-known. Furthermore, with the emergence of uncontrolled distribution of information via social media, deniers of climate change are creating difficulty in spreading factual knowledge. Manzané is attempting to abate deniers by showing them statistical data, but also admits, “I think part of the fault is our fault…because we are not getting the information in an easy way for them to understand.”

We found that many of our interviewees believed that without proper information regarding their environment, people are more likely to make unsustainable choices. Contributing to this narrative, Brandão stated, "I believe that when people are really informed, they make better decisions." However, Monterrey claims that the government is purposefully inhibiting education and progress for climate change awareness to keep power. He explains,

The big economic powers and the big political powers want to keep us ignorant, and they want to keep the entire population ignorant so that they can do with this country whatever they do, and this is something that replicates all over the world.

Without proper knowledge of the potential damage corporations and governments can create for the environment, the public cannot speak out or counter these forces. The Henriquez brothers explained the local fishing practices to our team, saying that many fishermen use large nets to dredge along the bottom of the ocean. However, these nets do not always catch the intended prey, leaving 90% of their catch as byproduct, or product that is discarded. Additionally, discarded, and abandoned nets permeate on the ocean floor, trapping and killing many animals. The brothers went on to tell our team about an experience they had with local authorities that tried to fine them USD 500 for fishing without a net. Although the brothers had a commercial fishing license and were not conducting any illegal behavior, the authorities did not believe they were fishermen due to the lack of nets. Charles goes on to comment, “the people out there that have the control and have the authority and the people that are given the authority, they themselves don't know what's right or wrong.” However, he adds, “it's not their fault. It's because they just simply don't know.”

“We should all be educated on how to take care of climate change because if we damage the home we live, where are we going to go? We are driving ourselves to extinction.”

César Barilla, English & Science Teacher

Our team also found that many of our interviewees believed that furthering youth education pertaining to climate change can help mitigate current issues and facilitate change in Panama. César educates his daughters on topics that are not covered in their schools, implementing sustainable practices such as appropriate waste

management, recycling, and repurposing materials. He goes on to say, “and I think that should start at home and then take it to the schools, to be more resource intensive on climate change because it is the house where we live." Valiente and Monterrey are also prominent contributors in the emergence of young climate change leaders. Valiente travels to various locations in Panama, specifically to *comarcas*, hosting workshops with youth in order to instill sustainable practices into their lifestyle. At the age of 23, Monterrey was the Deputy Lead Climate Negotiator representing Panama at UN climate negotiations. He claims that the youth, “need to be at the center of the conversation, at the center of the discussion, not only because of their determination, but because of the fact that young people see the world with a clarity that obscures with age.” Many interviewees claim the younger generations need to be educated and heard because they are responsible for correcting the mistakes society has made in regard to climate change.

4.6 The Economy

Throughout our interviews, we heard significant evidence about how climate change impacts various parts of the economy in Panama. The impacts range from small-scale, such as shifts in agricultural practices, to large-scale like reducing traffic at the Panama Canal. In addition, we also heard how climate change negatively impacts the communities that depend on ecotourism for their incomes.

4.6.1 The Canal

Our team spoke with Ilya Espino de Marotta, the Deputy Administrator of the Panama Canal Authority, who highlighted the importance of the Canal. “... [The] Panama Canal, it's very good for the government because it's about 10% of their budget,” said Marotta. “It's money that comes out of the country, so it's not a dollar that you recycle in the economy.” She explains the

dynamic of the Canal, saying, “it's just all our customers are foreigners, we don't pass our own ships, we don't have any. It's about 4% of world commerce that comes through here…” When asked if climate change has already affected the Canal, Marotta expressed that it has. She stated how this has been the strongest El Niño year in Panama, citing “that the lake is about seven feet below where it should be normally at this time of the year.” The statement about water levels aligns with our previous research, in which the Canal Administrator, Ricaurte Vasquez, said Gatun lakes water levels were down 2.4 meters, or 7.9 feet (Labrut, 2023). The lower water levels are forcing the Canal authorities to act. For the first time ever, transits have had to be reduced. Normally, 36-38 ships pass through the Canal; now, that number has been reduced to 32 per day. Marotta says this move is necessary to “save enough water for the dry season.” However, the consequences of this move are immense. Given that about 3.5% of Panama's GDP comes from the Panama Canal ("Trade Policy Review Report," 2022), Marotta stated that reductions in transit mean “less revenues to give to the government.”

“I think it’s a wake-up call. If we don't address something soon, the canal could suffer and that's income for the country. It would be non-desirable at all. And drinking water is a must... So, I think it's important that people realize in Panama that they're both very, very important, and we need to work towards both.”

Ilya Espino de Marotta, Deputy Administrator of the Panama Canal Authority

As mentioned earlier, the Panama Canal is also the source of drinking water for over half of the population in Panama. Paton explained how this relationship can strain the Canal and force difficult decisions to be made. He stated, “it causes economic problems, businesses that need the

water can't [get it].” Paton believes the situation is unavoidable, and expressed the unfortunate reality that the Panama Canal Authority’s reputation takes a hit. “They lose millions and millions of dollars,” says Paton. With severe economic impacts at stake, Ilya Marotta acknowledged that previous adaptation methods will not work in the future. Water-saving techniques, such as cross-filling and desalination plants, were some adaptation methods Marotta talked about. She also said the canal is considering implementing a greenhouse emissions fee. However, Marotta explained that an additional reservoir - something that was dismissed in the past - is now necessary. Marotta concluded our interview by stating, “my thoughts are that climate change is here, it hit us very hard this year, and we definitely need to do something different and big to prevent this from happening again. And time is against us.”

4.6.2 Agriculture

Increasing heat, excess rainfall in areas, and droughts are having major impacts on the agricultural sector of Panama’s economy. Despite agriculture contributing to only about 2.4% of GDP in Panama, “around 20% of people...are employed by agriculture,” as said by Brandão, (*Central Intelligence Agency*, 2023). He also added that “maybe [agriculture is] not the most important generator of wealth, but it moves a lot of money…a lot of services [and]… makes people start moving money in other parts of the country.” As 82% of Panama’s GDP is based in the services industry (*Central Intelligence Agency*, 2023), having a functioning agricultural sector is vital for the function of the country since “most people in Panama depend on agriculture.”

With the increasing frequency of extreme weather events, some of our interviewees have stated that it has been more difficult for farmers to sustain themselves and other people with their products. This increased farming difficulty creates “serious problems in terms of food security” in Panama according to Fundación Natura executive director Rosa Montañez. Professor Brandão

also mentions that “if we are unable to grow our crops, we cannot feed the cattle [and] the chickens, and [that] people are starting to sell their agricultural animals” to get an income due to poor farming conditions. Both Montañez and Brandão state that if climate change continues to be ignored and people stop working in agriculture, it will create drastic economic and nutritional challenges in the country. Changes in weather such as increasing temperatures, and unpredictable rainfall periods cause “production to not work…as it used to.”

4.6.3 Fishing

The fishing industry has also taken a toll from changes in weather due to climate change. Warmer waters have been changing the ocean’s ecosystem and diminishing many fish populations, making it incredibly difficult for fishermen to make a living in Panama. After speaking to the owners of a local restaurant called MaaGoo’s Fish Tacos, who catch fish for their restaurant daily, we were told that to catch fish now, they have to go as far as “international waters” to catch fish for their business when they did not need to go out as far into the ocean before. Shortening dry seasons which bring cooler water have also been impacting fishermen’s ability to catch the specific fish that are typically available during this time. As Aaron Henriquez, one of the owners of MaaGoo’s mentioned, many fishermen “count on dry season... for being a good part of [the] fishing season…Normally you'll have three solid months…of cold water…and this last season was one week of it.” Because of this, some fishermen are not able to catch the fish they need to make an income. We also heard in our interviews from fishermen that "over the past few years, [Panama has had] more and more red tide [and]...last year was [a]…really strong red tide [that did not] go away...fast..[killing] a lot” of fish. Increasing water temperatures due to climate change have been killing more plankton and increasing frequency of red tides, thus making waters more toxic. This increasing toxicity further exacerbates the issue of both diminishing food security as well as less income for people in the fishing industry. The

unpredictable weather that comes with climate change has also been putting many fishermen's boats at risk of sinking. Vicente del Cid mentioned how often times, a fisherman's boat is an incredibly large investment that is put at risk during intense storms "because the fisherman generally always [have]...the unanchored [boats] on the coast and these more intense swells damage their equipment, [and] the boats sink..[meaning that] losing this is a significant impact for them."

4.6.4 Tourism

Regarding tourism, there are significant infrastructural flaws in many tourist sites that do not consider planning for climate change. Increased damage due to ineffective climate infrastructural planning, coupled with more intense and unpredictable weather, places many communities at risk. For example, when speaking to Diwigdi Valiente, our group learned that for the sake of bringing in more tourists to specific areas, artificial beaches are being built by cutting down mangroves; however, the building of these beaches strips the land of coastal protection and places tourist sites and the communities that run them at major risk of destruction. In addition, this way of drawing tourists simultaneously reduces the biodiversity in those areas as well as the land's capability to absorb carbon from the atmosphere. Because of the drastically reduced ability of these lands to sequester carbon from the atmosphere, it in turn makes the effects of climate change worse and destroys the coastal land over time, driving away tourists and affecting the people whose sole income is from tourism. In an interview with a local flood victim named Juan Carlos, he mentioned that "there are some tourist places that you [cannot] visit now [and that] there is no economy necessary for [his] community."

As ecotourism becomes a growing part of Panama's economy, many Indigenous communities also depend on its success for their survival. However, unpredictable weather events such as droughts greatly impact the ability of these communities to support themselves as

they gradually lose the parts of nature they need to survive. At the Emberá community of Puru-Biakiru, our group noticed areas of the Chagres River was noticeably shallow. Eliecer Ruiz stated,

> Because here in the Chagres, friends, the only source of us, the Emberá, is tourism. So, if the river dries up with these phenomena, we are not going to be able to have visits from our visitors and that affects who? Our children, right? Our women, and with that we, our day-to-day life.

Moreover, the mining proposals mentioned by Aaron and Charlie Henriquez, would greatly impact Ruiz and the Emberá. "This is a phenomenon that is affecting Panama and that affects us, because the water that the mining company is obtaining is part of the Chagres River, and therefore it affects our business," stated Ruiz. He pointed out that while the government would profit from these expansions, the Indigenous people such as those in his community would not.

In addition to poor infrastructural planning, the increased frequency of drastic weather events damaging tourist sites was another trend we heard from our interviewees. Due to increasing droughts as a result of climate change, it is becoming more difficult to have water to support both a tourist site and the communities who run them. Valiente also mentioned that because of these issues, he has created adaptation projects focused on, "providing these communities with the infrastructure so they could…harvest water and [store] water" to help them prepare for upcoming months with less water so they have enough to support, "not only the tourists, [but also] the community." When speaking to Vicente Del Cid of MarViva, he spoke about how, "because of the intensity of [weather] events, yellow alerts are becoming more and more frequent" from Panama's National Civil Protection System (SINAPROC), meaning that boats, such as ones meant for ecotourism, were not allowed to operate due to safety issues. The

unpredictability of weather conditions has made it especially dangerous for tourists and communities running tourist sites not only along the coast, but also on the ocean.

4.7 Policy

A common theme we have seen in many interviews is minimal implementation of climate laws and plans in place to mitigate and adapt to climate change. Five of the eight people in our experts category, among them being professors from UTP, a representative of the Guna people, a former Ministry of the Environment employee, and representatives from NGOs, agreed that despite Panama's many laws addressing climate change, the country puts in little to no effort to implement these laws. According to the Fragile State Index (FSI), a tool used to determine a country's capability to withstand social, political, and economic pressures (The Fund for Peace, 2017), Panama has an FSI score of 48.7 in 2023 out of a maximum score of 120 (Fragile State Index, 2023). On this scale, a lower score indicates that a country is better equipped to withstand the pressures mentioned above (Fund for Peace, 2017). Within a country's FSI profile, there is data over time indicating how well a country is doing regarding specific social, political, and economic indicators. Panama's trends regarding response to demographic pressures, which include various factors such as public health, environmental laws, resources, as well as food and nutrition, have been going down for the most part since

"If we don't think about anything new, if we just enforce the policies that we have right now effectively, we are going to be great, fine in this country. It's not about creating new policies. It's not about doing something disruptive. If we only do what we already have in place, that will be enough. It doesn't happen."

José Brandão, Professor at Technological University of Panama

2006. However, these trends have started going up since 2020, indicating some sense of societal recovery and stronger policy management in terms of societal welfare (Fragile State Index, 2023).

This statistical data aligns with what many of our experts, who are likely more familiar with climate policy compared to the standard layman, have said about climate change policy. We asked our interviewees whether climate policies were sufficient in Panama. Though some climate laws and plans were mentioned, all of which were created within the past five years, the main consensus among experts, as said by Montañez, was that despite being, "on track to have [policies needed for climate adaptation] ... we are still not in the best situation." Even though Panama is in the process of developing more climate change adaptation and mitigation laws and plans, according to Brandão, "if we only do what we already have in place, that will be enough, but [it] doesn't happen." From what we have heard from many interviewees, implementation of multiple climate change related policies is not prioritized due to short term economic benefits. Much of society seems to lack enough knowledge of the prevalence and danger of climate change which prevents people from following policies regarding practicing sustainability and reducing their carbon footprint since they only see the prompt economic benefits from more conventional unsustainable practices. In addition to this, we learned through our interviews that people often have difficulty accessing climate change adaptation and mitigation tools. For example, one of our interviewees mentioned that a person needed to go to the Ministry of Commerce and Industry and pay 25 dollars to receive the *Guide of Good Practices for Business Sustainability*. Considering that the minimum wage in Panama "ranges from 1.22 to 2.36 Panamanian balboas per hour depending on the region and sector" ("Panama minimum wage rate 2023," 2023), according to an interviewee, "even $25 for some people [is] still a lot of money." This puts into perspective how expensive these climate resilience tools are for the average

Panamanian, especially as economies were recovering after the 2020 COVID-19 pandemic. Though we reached out to various branches of the Panamanian government such as the Ministry of Environment, the Ministry of Education, and the Ministry of Tourism to speak on the implementation of their current policies on climate adaptation, awareness, and mitigation respectively, we did not receive any responses.

4.7.1 Activism and Representation

Another prominent theme we heard through our interviews was the call for young people and other underrepresented communities, namely Indigenous people, to take political action and amplify the voices of unheard climate change victims. Many addressed how younger generations are both learning and seeing the effects of climate change more prominently compared to older generations, and also mentioned how the younger generations are the future for the planet. Monterrey expresses how, "youth need to be at the center of the conversation…because we…are going to suffer the most and we…can see the problem with the most clarity than any other group around."

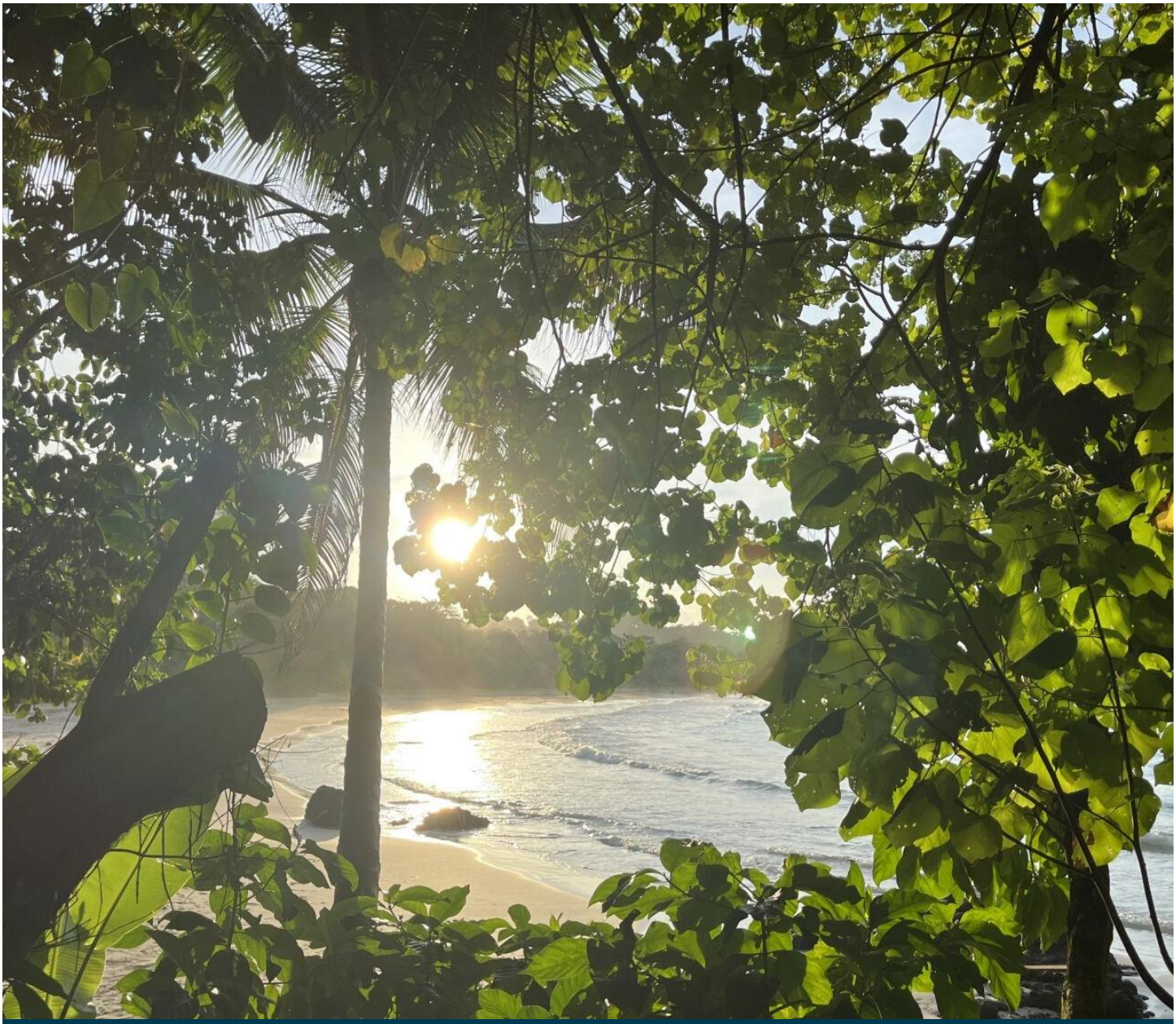
In addition to this trend, our interviews have highlighted that Indigenous people are both part of the least included in climate conversations, and one of the largest underrepresented groups in policy making. Valiente, made points of how, "sad [it is] that sometimes Indigenous people are left out of the buildings," after traveling incredibly far to attend United Nations conferences and COP events. With Indigenous populations such as the Guna being the most vulnerable to climate change in Panama, especially with their increasing status as climate refugees, Valiente states that more Indigenous people, "need a platform," for effective climate change conversations and the policies that come out of them to be truly inclusive.

4.8 Relation to Past Climate Stories Projects

Our findings are consistent with many of the previous climate stories projects. One prominent theme is a disconnect between local residents and experts in the climate field. From our observations, this theme appears to stem from a lack of awareness and education provided to the residents. For instance, every expert that we interviewed was able to attribute at least some causes of climate change due to recent human activity or a rise in greenhouse gas emissions. While some residents concurred with this belief, others shared vastly different beliefs. Religion and "mother nature" were some trends that the group heard locals attribute to climate change. Experts like Monterrey believe that the public is not aware of the threat of climate change, nor does the country have enforceable policies that can help with adaptation and mitigation. Like past projects, residents were able to identify climate indicators. For example, César, an artist we encountered selling his decorative bleached shirts in a tourist area, was very cognizant of the hotter temperatures in recent years. Jorge Clovis, an English Professor, recognized that weather patterns have been more unpredictable lately. These trends show that people are already being affected by climate change and can feel the changes in their environment.

While many of our findings are comparable to past climate stories projects, they also provide unique perspectives that have not been shared yet. One of the greatest findings is that some Indigenous communities, like the Guna Yala, already are preparing to relocate within the next year. While other climate stories have talked about migration from rural to urban areas, they have never addressed forced climate migration due to rising sea levels. Additionally, the Canal made Panama a distinctive location to investigate. Hearing stories from Ilya Espino de Marotta, the deputy administration at the Panama Canal Authority, provided our team with remarkable insight into how climate change is affecting the Canal. It was interesting for our team to provide

the climate stories collection with the first stories in Latin America. Although the people in Panama shared many similar themes as past projects, the stories they told were authentic and revealed the challenges that their communities have faced and will have to face if action is not taken. These diverse perspectives have made it aware how important it is to amplify voices that are not always heard and the significance of addressing climate change on a local and global level.



Conclusions

Chapter 5

Chapter 5. Conclusions

In completing this project, our team found it important to develop recommendations that stem from our experiences in Panama and our conversations with residents. We divided recommendations into three different categories: for future teams, for Panamanians, and for global populations. Overall, these recommendations highlight the need for action from individuals, communities, governments, and industries.

5.1 Recommendations for Future Teams

Although our team succeeded in many areas when completing this project, we faced some difficulties that would be helpful for future teams to consider. Through our experience, we adapted and learned the most accepted ways to approach people in Panama. Unlike the United States, the people in Panama were generally much more informal regarding paper-signed consent, even when conducting professional interviews. The team was warned of customs regarding consent, in which some people may find it offensive or become wary if presented with a formal document to sign. To oppose this potential threat and remain within IRB approval, our team opted for verbal consent scripts, which were video recorded and filed in appropriate team folders. Furthermore, the team was diligent in abiding by the customs and cultural norms of Panama, acknowledging information learned during archival research, as well as from field work. While these methods may differ for countries with varying traditions and cultural practices, it is essential to be as educated and sensitive as possible in a foreign environment.

An additional factor that limited the scope of our project was the difficulty of including the public in the sample population interviewed. Both a language barrier and lack of reliable transportation inhibited our team from contacting locals. Many of our interviews at the beginning of our project took place because our team researched various organizations and sent emails to

about 50 different experts. In emails, our team was able to utilize online translation applications that enabled seamless communication and scheduling with our contacts. However, most of the public does not have a website or easily accessible email address. To include their vital stories and experiences in the project, our team typically used a method of approaching locals on the street and attempting to communicate with them. This method proved to yield minimal success as it was difficult to ascertain whether a person would be inconvenienced by our dialogue as well as their willingness to participate. Instead, our team found favorable outcomes by using the snowball sampling technique. After interviewing with various people, they helped us connect with other people willing to do an interview with us. This method ensured our interview would be both convenient for and welcomed by the interviewee. However, interviews with people who preferred to communicate in Spanish were only made possible by our project advisors acting as translators.

If provided with additional time and resources, our team believes the project would have benefitted from supplementary interviews from a more expansive scope. Panama contains a diverse geological landscape, enabling various types of livelihoods based on location. Displaying representation of mountain farmers in the east or islanders to the north, for example, would have given our project another perspective to fully understand the impacts climate change has on the residents of Panama. The extent of our interview location ranged across the provinces of Panama, which includes Panama City, Casco Viejo, and Chepo, as well as Bocas Del Toro, islands to the northwest of the country. This limited geological scope not only inhibited interviews from people of varying occupations, but also excluded ethnic and racial groups. Extending the scope of sample populations ensures the diversification of voices amplified by this project and others like it.

Producing quality audio is one of the most important parts in producing an aesthetic documentary. Background noise from overhead fans, people talking, glassing clinking, and other distractions can drastically lower the quality of a documentary. With the rise of AI, we now have a host of new tools that can aid in this sometimes-tedious process. After trial and error, we discovered a site called cleanvoice.ai, which uses AI technology to process audio in various ways. We mainly used it to remove background noise and generate transcripts for our interviews. It is important to note that this is a paid service and will cost a small amount to use (about $10 for five hours of audio). For Spanish interviews, we additionally used a website called cockatoo.com to transcribe the audio. After trying various tools, it seemed like Cockatoo provided better Spanish translation then its competitors. Again, this is a paid service and will cost a small amount to use (about $30 for 10,000 minutes of audio).

5.2 Recommendations for Panamanians

Our analysis of the data collected through our interviews allowed our team to gather essential information regarding vulnerability to and perceptions of climate change in Panama. Addressing issues that inhibit protection from the effects of climate change could greatly reduce the chances of quality of life, livelihoods, and biodiversity from diminishing in Panama. Based on analysis of the stories told by Panamanians, the team has developed strategies against climate change for Panama in the following recommendations:

1. **Enforce Current Policies**
2. **Increase Climate Change Education**
3. **Review and Implement Proper Land Use**
4. **Encourage Sustainable Practices**

5.2.1 Enforce Current Policies

Despite the many climate policies and climate adaptation plans in Panama, there are multiple reasons why they are not being implemented to the point of being fully effective. Through our data collection, we found that to properly enforce current climate policies, the government needs to have proper fund allocation towards departments such as the Ministry of Environment. Some people in our "Experts" category, such as former Ministry employees, have suggested that more funding can and needs to be put towards climate policies to drastically decrease susceptibility to climate change in Panama. As said by our interviewees, one of the largest reasons why climate adaptation and mitigation projects are being implemented slowly is because of the minimal resources that the Ministry of Environment has.

It is crucial that this department gets increased funding, especially since many laws that they create work in conjunction with other government departments to implement climate protection, adaptation, and mitigation projects. For example, the Ministry of Environment has worked closely with the Ministry of Tourism to set various sustainable ecotourism standards with laws such as the Sustainable Tourism Master Plan 2020-2025. Because many of the laws of the Ministry of Environment are interconnected with policies from other branches of government, increasing resources for this branch will allow the country to properly adhere to their Nationally Determined Contributions to the United Nations Framework Convention on Climate Change.

5.2.2 Increase Climate Change Education

Since a lack of sufficient educational systems in Panama was a recurring theme in our interviews, an important issue to address is the implementation of curriculums detailing scientific facts and data about carbon emissions and other contributors to climate change. Education can

teach students about the impacts of the current climate and environmental crises, which allows people to address these concerns. Empowering Panamanians with the resources needed to incite change enables their voices to be amplified. Recent studies have shown higher levels of education were correlated with the belief that climate change is a major threat to our planet (Angrist et al., 2023). Additionally, people with more education typically voted for policies that promoted the use of renewable energy and resources (Angrist et al., 2023). Increasing education will allow the people of Panama to better prepare and adapt to a changing world, which is essential to the survival of many communities that are now facing the effects of climate change. Although some of our interviewees and other passionate activists in Panama are hosting workshops and educational programs to enhance knowledge of communities on sustainable practices, our team believes the best way to improve this lack of education is to allocate more funds to these activists and organizations so that they may continue their work on a broader scale.

5.2.3 Review and Implement Proper Land Use

Proper land use practices and cautionary urbanization methods are essential in limiting the effects of climate change on Panamanians. Potentially improper land use, such as factories, agriculture, and deforestation, contribute to the global cycle of greenhouse gases, and disruption of natural processes can produce increased emissions. However, proper use of land, such as forests and meadows, can contribute to the removal of these gases from the atmosphere (UNFCCC, n.d.). In 2018, land allocation in Panama was 30.5% agricultural, 20.7% of permanent pasture, 43.6% forest, 2.5% of permanent crops, 7.3% of arable land, and 25.9% of other uses (“Panama,” 2023-a).

Arable land is land that grows using a system of crop rotation and is regularly worked (“Glossary: Arable Land,” 2023). It was revealed through our interviews that Panama is facing

battles in mitigating land use between economic opportunities. Cattle ranching and mining are threatening deforestation, which will subsequently influence traditional CO_2 offsets and stores, as explained by the sponge effect. Panama, through their support of the article 5 of the Paris Agreement, emphasizes the importance of land use as climate change mitigation. Land use is then stated to be vital for stability between removals of sinks of greenhouse gases and anthropogenic emissions (UNFCCC, n.d.). However, as many Panamanians contribute to anthropogenic emissions on a much smaller scale when compared to major industrial producers such as the United States, and rely on the economic opportunities the ranches, mines, and other pursuits produce, environmental protection is often overshadowed.

Furthermore, proper land use and urban planning is needed in order to protect Panamanians against extreme weather events and rising sea levels. As seen in communities prone to flooding, such as the Township of Juan Diaz, explained in section 2.5.3, and Chepo, people's lives and homes are put at risk when they are placed in locations that do not protect against such events. Placing sea walls and protecting mangroves to reduce the risk of flooding during extreme weather events is essential for the coastal communities of Panama. Currently, Panama has many regulations and policies governing their urban planning system, but due to pre-existing habitual residences and lack of enforcement, some communities are still at risk ("Panama," n.d.).

Protection of Indigenous owned land and existing *comarcas* is also essential in protecting not only Indigenous communities, but also in preventing further contributions to climate change. Within the protected areas of the world, there are 27% of the net forest carbon sinks (Harris & Gibbs, 2021). The maintenance of land and forests under Indigenous communities is explored through our interviews where the connection and respect for nature that Indigenous groups have is explained. This point is further proved through finding in Brazil, where forests in reserves owned by the Menkragnoti people absorb about 10 million metric tons of CO_2 more than they

emit every year. In areas that surround this reserve, land has been cleared due to mining, pastures, and soy production, transforming the area into a net carbon source (Harris & Gibbs, 2021). Advocating and allowing traditions and cultures of indigenous groups to be amplified contributes to climate and environmental justice, limiting the disproportionate effects climate change has on minorities and underrepresented groups. Enforcing and acknowledging the rights to the land of Indigenous groups should be top priority for law makers in Panama to mitigate the effects of climate change.

5.2.4 Encourage Sustainable Practices

While it is necessary for businesses and corporations to reduce their carbon footprints, it is just as important for individual people to do the same to prevent the worsening of climate change. A major way people can do this is by reducing their energy consumption through recycling, saving water, electricity, gas, and other forms of energy. Because fossil fuels produce almost 90% of carbon dioxide emissions, and global energy production runs primarily on fossil fuels, reducing energy consumption can significantly help reduce the effects of climate change by minimizing the need for more fossil fuels (United Nations, n.d.-b).

Through our interviews, the lack of recycling capabilities in Panama was often mentioned. Despite some effort to recycle in Panama through the minimal recycling centers scattered throughout the country, the importance of recycling needs to continue to be emphasized in schools and among general society. According to the Resilient Cities Network, out of 34,000 tons of waste, only two percent is recycled in Panama City (“From marine plastic to public living rooms, Panama City is recycling with resilience,” 2023). The minimal recycling in Panama is, aside from leaving a large carbon footprint on the country, contributing to health and sanitary issues as well.

In 2021, Panama City's only landfill became a major health hazard when it overflowed after a major landslide in the area. This landslide not only contaminated a nearby river, but also damaged a nearby treatment and incineration plant ("From marine plastic to public living rooms, Panama City is recycling with resilience," 2023). A trend we noticed in our interviews was that even though many people want to recycle, they are not able to due to the lack of recycling bins and waste separation resources. Some interviewees also stated how difficult it is to get to recycling centers near them, which often drives people away from recycling. Considering that plastic produces over 500 million tons of CO_2 per year, the situations above that many other locals face further emphasizes the need to promote recycling importance among society and make waste separation resources such as recycling bins more accessible to the public (Kilgore, 2023).

5.3 Recommendations for Global Populations

Climate Change is an issue that will have impacts on every country, so it is important to recognize that everyone has an important role in mitigating climate change. We have developed the following three recommendations:

1. **Acknowledge the Disparity in Global Emissions**
2. **Discourage Environmentally Unfriendly Practices**
3. **Amplify Unheard and Vulnerable Voices**

5.3.1 Acknowledge the Disparity in Global Emission

The first recommendation we have for the general public is to acknowledge the disparity in global emissions. This recommendation establishes the reason it is necessary for our audience outside of Panama to be included in our project. While some interviewees were skeptical about the claim that Panama is carbon-positive, evidence shows that regardless, there is a global carbon

inequality. Panama's greenhouse gas emissions make up less than 0.05% of the global greenhouse gasses (Climate and Clean Air Coalition, n.d.). Despite this fact, both quantitative data from the World Bank Group and qualitative data from our interviewees demonstrate that Panama is extremely vulnerable to the effects of climate change (World Bank Climate Change Knowledge Portal, 2021). Meanwhile, the Pew Research Center states, "The U.S. is the second-largest carbon dioxide emitter, contributing about 13.5% of the global total." (Tyson et al., 2023, para. 32). These statistics demonstrate that the United States and other large carbon emitters have a greater responsibility to reduce their emissions. It would be unjust to shift the burden of mitigating climate change on to Panama when the largest emitters, like the United States, are causing far greater damage to the environment.

5.3.2 Discourage Environmentally Unfriendly Practices

The next recommendation we have for everyone is to discourage environmentally unfriendly practices in businesses, so it is vital that everyone can recognize unsustainable practices. One of the most detrimental practices is the over-use of fossil fuels, especially when alternatives exist. Fossil fuels, which contribute significantly to the greenhouse effect, are often used as a cheap energy source. Another bad practice is mass deforestation. When companies deforest without reforesting, they destroy massive carbon sinks. Not only that, but the stored carbon dioxide eventually returns to the atmosphere. Forests also shelter countless species of plants and animals. Disrupting this balance can weaken ecosystems and make them more susceptible to climate change. Many people and groups, such as Indigenous communities, forest-dependent industries, and rural populations, rely on natural resources from forests.

The last unsustainable practice to point out is unsustainable fishing which comes in many forms. One of the most harmful fishing practices we heard about in Panama was dredge fishing. Dredge fishing, which is a form of trawling, is a fishing technique where large nets are dragged

along the seafloor by ships to capture sea-creatures. Dredging and trawling have detrimental effects to the seafloor (Ferdinand, et al., 2016). Trawling is a practice that negatively impacts the seafloor, as well as the plants and animals that reside there. This practice rototills the seabed, tearing roots systems and habitats, as well as causing a change in the chemistry and nutrient balance of the water when the sediment is lifted from the floor (Ferdinand, et al., 2016). In Panama, our group learned that the dredging that is done here is incredibly unsustainable due to the massive amount of bycatch that is caught by dredging. According to the three family members of the Henriquez family we interviewed, who are all fishers and owners of the restaurant, MaaGoo's Fish Tacos, 90% of the animals caught by dredging are bycatch and are often killed and discarded back into the ocean.

Some companies, which may appear to be eco-friendly, are not actually sustainable businesses. These companies can deceive consumers through a process called greenwashing, which is a practice in which businesses claim that their services, products, or initiatives are sustainable. However, these businesses are actually operating in a manner that is not environmentally friendly (Kendrick, 2023). Some examples of greenwashing are certifications received from non-reputable sources, cherry picking data in reports/portfolios, and misleading packages/claims. Misleading packages/claims can include terms like "natural" and "green" without much evidence to back up these terms.

5.3.3 Amplify Unheard and Vulnerable Voices

The final recommendation we have that should not be overlooked is to amplify unheard and vulnerable voices. This recommendation is the fundamental goal of our project and others that contribute to Professor Shockey's "Climate Stories" collection. Climate change is a data-heavy topic that is dominated by experts (I. Shockey, personal communication, September 27, 2023). As a result, voices from people most affected often go unheard. Incorporating climate and

environmental justice into discussions and decision-making regarding climate change will allow for these unheard voices to be amplified and just practices to persist. Our team believes it is essential for people to be aware of this reality and to help prevent this trend from continuing. Hearing the climate stories of people from around the world helps provide unique perspectives and insight into a crucial global issue. It humanizes the problem, making it more emotionally engaging and motivating the reader to take more action against the threat of climate change. The stories gathered in this project have helped make progress in the right direction. It is essential to continue advocating for the voices that have not been heard in the fight against climate change.

5.4 Concluding Thoughts

Our project culminated in several trends and themes found across the eighteen interviews our team conducted, pertaining to experiences and thoughts on climate change. Through the analysis of phrases and codes identified in interviews, our team was able to gain insight into the opinions of these individual residents of Panama and display these results in a documentary. The goal of this compilation of video storytelling was to empower and amplify the voices of Panamanians, as well as provide a compelling narrative to humanize the effects of climate change.

Gaining this perspective has allowed our team to glimpse into the plight faced by Panamanians due to climate change, however, with so many more untold stories, we have just begun comprehending the threat climate change has on Panama. We hope this project is able to spread awareness, as well as highlight the importance of the individual when discussing climate change.

"The climate crisis, to begin with, is not an environmental crisis. And this is something that everyone needs to get out of their head. It is not an environmental crisis. It's a total crisis. It's an everything crisis. Because climate change permeates into every single walk of life, every single business, every single policy, every single everything that we are and that we do as a society. So it is of paramount importance that young professionals, that seasoned professionals, that leaders at all levels, start waking up to this reality."

Juan Carlos Monterrey, Executive Director of Geoversity

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Appendices

Appendix A: Consent Forms

Long consent form in English:

Informed Consent Agreement for Participation

Investigator: James Chiarelli
Co-Investigator: Grant Burrier
Student Investigators: Benjamin Brooks, Jayson Caissie, Jewel Pauly, Elliot Trilling and Olivia Vogel

Contact Information:

Email: gr-ClimateStoriesPanamaA23@wpi.edu
Faculty Advisors: jachiarelli@wpi.edu and gburrier@wpi.edu
Title of Research Study: Climate Stories
Sponsor: Ingrid Shockey

You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study and the procedures to be followed. This form presents information about the study so that you may make a fully informed decision regarding your participation.

The purpose of this study is to conduct and record a series of interviews to capture the stories of Panamanian residents regarding their experiences with climate change. These provide a qualitative viewpoint on climate change to add to the existing quantitative scientific research, while spreading awareness of the effect of climate change on a personal level.

The procedure for this study is to conduct a short interview of approximately 15 to 20 minutes, recording the participant. After asking introduction questions pertaining to basic identifying information, the participant will be asked to provide a narrative on their experiences, which will then be compiled into a publicly available documentary. We don't see any foreseeable risks to the participants throughout this study. If hesitant of the interviews being recorded and posted online, the participant is encouraged to ask for clarification or further information.

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit. You do not give up any of your legal rights by signing this statement.

Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators, the sponsor or its designee and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you unless you have given prior consent to be identified.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. By signing below, you agree to the use of your name and other specific identifying information, to publicly quote you, with your pre-approval for each quote in the interview, and to record this interview. You also agree to the recording and interview content to be publicly available. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

_____ Date: _____
Study Participant Signature

_____
Study Participant Name (Please print)

_____ Date: _____
Signature of Person who explained this study

For more information about this research or about the rights of research participants, or in case of research-related injury, contact gr-ClimateStoriesPanamaA23@wpi.edu. You may also contact our faculty advisors from Worcester Polytechnic Institute (WPI) at jachiarelli@wpi.edu or gburrier@wpi.edu. You may also contact the IRB manager, Ruth McKeogh, at Tel: +1 508 831-6699 and email: irb@wpi.edu, or the Human Protection Administrator, Gabriel Johnson, at Tel: +1 508 831-4989 and email: gjohnson@wpi.edu.

Long consent form in Spanish:

Acuerdo de consentimiento informado para la participación

Investigador: James Chiarelli
Co-investigador: Grant Burrier
Estudiantes investigadores: Benjamin Brooks, Jayson Caissie, Jewel Pauly, Elliot Trilling y Olivia Vogel

Información del contacto:

Correo electrónico: gr-ClimateStoriesPanamaA23@wpi.edu
Consejeros docentes: jachiarelli@wpi.edu y gburrier@wpi.edu
Título del estudio de investigación: Historias climáticas
Patrocinador: Ingrid Shockey

Se le está pidiendo que participe en un estudio de investigación. Sin embargo, antes de aceptar, debe estar completamente informado sobre el propósito del estudio y los procedimientos a seguir. Este formulario presenta información sobre el estudio para que pueda tomar una decisión completamente informada con respecto a su participación.

El propósito de este estudio es realizar y grabar una serie de entrevistas para capturar las historias de los residentes panameños sobre sus experiencias con el cambio climático. Estos proporcionan un punto de vista cualitativo sobre el cambio climático para agregar a la investigación científica cuantitativa existente, al mismo tiempo que se difunde la conciencia sobre el efecto del cambio climático a nivel personal.

El procedimiento para este estudio es realizar una breve entrevista de aproximadamente 15 a 20 minutos, grabando al participante. Después de hacer preguntas de introducción relacionadas con la información de identificación básica, se le pedirá al participante que brinde una narración sobre sus experiencias, que luego se compilará en un documental disponible públicamente. No vemos ningún riesgo previsible para los participantes a lo largo de este estudio. Si duda de que las entrevistas se graben y publiquen en línea, se alienta al participante a solicitar aclaraciones o más información.

Su participación en esta investigación es voluntaria. Su negativa a participar no dará lugar a ninguna sanción para usted ni a la pérdida de los beneficios a los que de otro modo podría tener derecho. Puede decidir dejar de participar en la investigación en cualquier momento sin penalización ni pérdida de otros beneficios. Los investigadores del proyecto se reservan el derecho de cancelar o posponer los procedimientos experimentales en cualquier momento que lo

consideren oportuno. Usted no renuncia a ninguno de sus derechos legales al firmar esta declaración.

Los registros de su participación en este estudio se mantendrán confidenciales hasta donde lo permita la ley. Sin embargo, los investigadores del estudio, el patrocinador o su designado y, bajo ciertas circunstancias, la Junta de Revisión Institucional del Instituto Politécnico de Worcester (WPI IRB) podrán inspeccionar y tener acceso a datos confidenciales que lo identifiquen por su nombre. Cualquier publicación o presentación de los datos no lo identificará a menos que haya dado su consentimiento previo para ser identificado.

Al firmar a continuación, usted reconoce que ha sido informado y da su consentimiento para ser un participante en el estudio descrito anteriormente. Al firmar a continuación, acepta el uso de su nombre y otra información de identificación específica, para citarlo públicamente, con su aprobación previa para cada cita en la entrevista, y para grabar esta entrevista. También acepta que el contenido de la grabación y la entrevista esté disponible públicamente. Asegúrese de que sus preguntas sean respondidas a su satisfacción antes de firmar. Tiene derecho a conservar una copia de este acuerdo de consentimiento.

_____ Fecha: _____
Firma del participante del estudio

_____
Nombre del participante del estudio (letra de imprenta)

_____ Fecha: _____
Firma de la persona que explicó este estudio

Para obtener más información sobre esta investigación o sobre los derechos de los participantes de la investigación, o en caso de lesiones relacionadas con la investigación, comuníquese con gr-ClimateStoriesPanamaA23@wpi.edu. También puede comunicarse con nuestros asesores docentes del Instituto Politécnico de Worcester (WPI) en jachiarelli@wpi.edu o gburrier@wpi.edu. También puede comunicarse con la gerente del IRB, Ruth McKeogh, al Tel: +1 508 831-6699 y correo electrónico: irb@wpi.edu, o al Administrador de Protección Humana, Gabriel Johnson, al Tel: +1 508 831-4989 y correo electrónico: gjohnson@wpi.edu.

Short consent form in English:

Informed Consent Agreement for Participation

The purpose of this study is to conduct and record a series of interviews to capture the stories of Panamanian residents regarding their experiences with climate change. The procedure for this study is to conduct a short interview of approximately 15 to 20 minutes, recording the participant. After asking introduction questions pertaining to basic identifying information, the participant will be asked to provide a narrative on their experiences, which will then be compiled into a publicly available documentary. We don't see any foreseeable risks to the participants throughout this study. Your participation in this research is voluntary, and you may withdraw at any time for any reason. Your answers will be kept anonymous and confidential unless you permit otherwise. The participant is encouraged to ask for clarification or further information and is entitled to retain a copy of this consent agreement.

Do we have your permission to include your name and other specific identifying information?	Yes ☐	No ☐
Do we have your permission to take notes, and publicly quote you, with your pre-approval for each quote, in this interview?	Yes ☐	No ☐
Do we have your permission to record this interview?	Yes ☐	No ☐

_____ Date: _____

Study Participant Signature

Short consent form in Spanish:

Acuerdo de consentimiento informado para la participación

El propósito de este estudio es realizar y grabar una serie de entrevistas para capturar las historias de los residentes panameños sobre sus experiencias con el cambio climático. El procedimiento para este estudio es realizar una breve entrevista de aproximadamente 15 a 20 minutos, grabando al participante. Después de hacer preguntas de introducción relacionadas con la información de identificación básica, se le pedirá al participante que brinde una narración sobre sus experiencias, que luego se compilará en un documental disponible públicamente. No vemos ningún riesgo previsible para los participantes a lo largo de este estudio. Su participación en esta investigación es voluntaria y puede retirarse en cualquier momento y por cualquier motivo. Sus respuestas se mantendrán anónimas y confidenciales a menos que usted permita lo contrario. Se alienta al participante a solicitar aclaraciones o más información y tiene derecho a conservar una copia de este acuerdo de consentimiento.

¿Tenemos su permiso para incluir su nombre y otra información de identificación específica?	Sí ☐	No ☐
¿Tenemos su permiso para tomar notas, y citarlo públicamente, con su aprobación previa para cada cita, en esta entrevista?	Sí ☐	No ☐
¿Tenemos su permiso para grabar esta entrevista?	Sí ☐	No ☐

_____ Fecha: _____

Firma del participante del estudio

Appendix B: Interview Questions

Interview Questions for General Populations

Introduction Questions

1. What is your name?
2. How long have you lived in Panama?
3. What have you done for a living?

General Questions

1. Have you noticed any changes in the weather or the environment over the course of your life?
2. What do you believe the cause of changes in your environment is?
3. Have changes in your environment impacted your livelihood, community, culture, or recreational activities?
4. Do you know of any climate change government policies or restrictions activity followed?
5. What are your thoughts on these changes, and do you think they will affect your life in the future?

Post-Interview

1. Are you aware of any people that could have been affected by climate change? If so, could we contact them?

Supplemental Agriculture Specific Questions

1. Have changes in climate affected your crop or livestock?
2. Has crop production changed over the years?
3. How has climate change affected your business?

Supplemental Fishing Specific Questions

1. Has the amount of fish you catch on a daily basis changed throughout your career?
2. Have the locations that you typically fish changed?
3. Have you experienced any unusually frequent weather events while fishing?
4. How has climate change affected your business?

Supplemental Logging Specific Questions

1. Approximately how much land do you clear per year?
2. How has climate change affected your business?

Interview Questions for Indigenous Peoples

Introduction Questions

1. What is your name?
2. How long have you lived in Panama?
3. What have you done for a living?
4. How did you learn about this land from your family?

General Questions

1. Have you noticed any changes in the weather or the environment over the course of your life?
2. What do you believe the cause of changes in your environment is?
3. Has climate change affected your culture or traditions?
4. What are your thoughts on these changes, and do you think they will affect your life in the future?

Post-Interview

1. Are you aware of any people that could have been affected by climate change? If so, could we contact them?

Interview Questions for Experts

Introduction Questions

1. What is your name?
2. How long have you lived in Panama?
3. What have you done for a living?

General Questions

1. What is your view on the threat of climate change?
2. What do you believe the main cause of climate change is?
3. Do you believe there are sufficient policies that aim to improve the effects of climate change in place in Panama?
4. What have you had to do to adapt to climate change?
5. Are you in touch with adaptation procedures?
6. Do you believe that the school system educates youth on issues regarding climate change sufficiently?
7. What group of people do you think climate change affects the most?

Post-Interview

1. Do you know of anyone that could be beneficial for us to talk to for our project?

Appendix C: Interviewee Demographics

Name	Occupation	Category
Jose Agudo	Ice vendor	Locals
César	Bleach shirt vendor	
Juan Carlos	Teacher	
Marta Marie	Florist	
Kisia	Housekeeper	
César Barilla	Teacher	
Jorge Clovis	English Professor	
Aaron Henriquez	Fisherman and Entrepreneur	
Charlie Henriquez	Fisherman and Entrepreneur	
Carlos Henriquez	Fisherman and Entrepreneur	
Diwigdi Valiente	Indigenous Representative (Guna Yala)	Indigenous
Eliecer Ruiz	Second Chief of Puru Biakiru (Emberá)	
Marisol Landau	President of Social Action Foundation for Panama (FAS)	Experts
José Brandão	Professor at Technological University of Panama (UTP)	
Eric Manzané	Professor at Technological University of Panama (UTP)	
Steve Paton	Researcher at Smithsonian Tropical Research Institute (STRI)	
Vicente Del Cid	Researcher at MarViva	
Rosa Montañez	Executive Director at Natura Foundation	
Ilya Espino de Marotta	Deputy Administrator of the Panama Canal Authority (ACP)	
Juan Carlos Monterrey	Executive Director of Geoversity	

Appendix D: Link to Documentary

Link to YouTube playlist containing documentary:
https://www.youtube.com/playlist?list=PLLp2Ec88EnEEE_zqmfH6o-Ex2uTtOboNC