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Environmental Health and Policy at the
Tijuana-San Diego Border

A Thesis
Presented to
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Of the University of San Diego

By
Imma Adelpha Honkanen
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Abstract

Immigration at the U.S.-Mexico border, walls and security, and drug trafficking, are among the most deliberated policy issues in the U.S.'s political climate. As a result, policies and international cooperation concerning environmental health impacts at the border are often overlooked, particularly in the Tijuana-San Diego border region. These impacts include contamination and overuse of water by *maquiladoras*, air pollution from concentrated border transit and power plants, and the heightening threat of global warming. However, as climate change worsens and immigration problems grow, this wide range of environmental hazards demand ambitious policy considerations, especially in the Tijuana-San Diego border region. In this project, I analyze environmental health and environmental justice at the Tijuana-San Diego border. I specifically focus on air and water quality and their subsequent health impacts for populations in this region. These populations include permanent residents on both sides of the border, commuters, and groups of migrants forced to stay in temporary camps awaiting asylum processes. I provide an analysis of air and water pollution and the extent to which they cause health problems, as well as how these uniquely affect an increased concentration of migrants during the Trump era. My thesis offers insight on areas for policy improvement and cross-border solutions that encourage and maintain an environmentally just region for all populations.

Introduction

In recent years, issues at the U.S.-Mexico border have dominated media and political discourse. These include the building of a border wall, drug cartels, and migrant caravans arriving from Central America. While these matters are certainly important to discuss and analyze, environmental concerns at the border are often low priorities for both media coverage

and policy discussion. In the wake of global climate change and an influx of migrants seeking asylum in the U.S., it is crucial to not only understand the extent of environmental consequences in the border region, but additionally how they impact the surrounding communities' health and quality of life.

The U.S.-Mexico border is unique. It stretches nearly 2,000 miles long across four U.S. states and six Mexican states, and airsheds and watersheds span states on both sides. Air emissions, water contamination, sewage flow, and hazardous waste are a few of the several environmental concerns the border area faces. Managing these binational environmental systems and various forms of pollution from both sides of the border is complicated due to political, administrative, local, economic, and regulatory differences between the U.S. and Mexico (Quintana et al. 2015). Because of these complications, it can be challenging to unilaterally implement and monitor policies and regulations to control pollution across the international boundary.

Numerous pairs of sister cities plot the border; these range from small city pairs, such as - Matamoros, Mexico- Brownsville, Texas, to large binational metropolises, such as Ciudad Juárez, Mexico-El Paso, Texas. The largest of these is Tijuana, Mexico-San Diego, California and this pair serves as a cross-border economic hub for the United States and Mexico. The total population of the region is approaching five million people and accounts for 40% of the entire U.S.-Mexico border population (Williams et al. 2017). The sister cities share the same regional landscape, climate, and ecology. Even more, they share consequences of their environmental choices. Air pollution, sewage runoff, toxic waste sites, and their effects are not constrained by the international line.

In this thesis, I analyze the extent to which air and water pollution affect the surrounding border communities at the Tijuana-San Diego border and argue that the pollution impacts low-income minority communities on both sides of the border more than other populations. I specifically focus on air emissions and water contamination because these two types of environmental harm impact these communities and their health the most. Finally, I argue three potential policy recommendations that would increase cooperation between the two countries and regulate pollution so the area is healthier for all.

Air

Though there are several forms of pollution that may impact border communities, one of the most prominent in the Tijuana-San Diego border region is air pollution. Tijuana and San Diego share an airshed, meaning the topography and meteorology in the area limit the dispersion of pollutants (Quintana et al. 2015). Due to this, pollution that impacts one side of the border will most likely also impact the other side of the border. The spread of pollutants is unaffected by the political border between the two cities. Close proximity to one of the busiest border crossings in the world and to *maquiladoras* and energy plants dramatically increase the level of air pollution in the area.

Maquiladoras

One of the most prominent sources of air pollution at the Tijuana-San Diego border comes from *maquiladoras*. These are assembly plants that operate without paying Mexican tariffs for exporting their goods. The United States uses *maquiladoras* as one of their main methods for producing goods for export. Although there are myriad countries that own or contract *maquiladoras*, the United States imports more than 90% of the manufactured products

(Sanchez 1990, p. 164). 88% of the *maquiladoras* in Mexico are located along the U.S. border and the rest spread into central Mexico. Out of the roughly 3,000 *maquiladoras* in Mexico, around 700 of them are located in Tijuana (City of San Diego, n.d.). Popular corporations such as BMW, Fisher Price, Hasbro, Hewlett Packard, Honeywell, IBM, and Samsung, are a few that contract or own *maquiladoras* to manufacture some of their products (CorpWatch 1999).

Maquiladoras were originally founded in response to the cancelled U.S. Bracero Program in 1964 that previously allowed millions of Mexican laborers to work in the U.S. The industrialization of Northern Mexico in border towns, through the establishment of assembly plants, gave the recently unemployed braceros a new job and also employed several thousand migrants from within Mexico that were attempting to cross the border into the U.S. (Ebner and Cross 2019). Around the same time, the border began to be militarized and while this did not stop people from attempting to cross the border to find work, this did make workers more vulnerable and decreased their labor value on both sides of the border. As a result, labor at the border was inexpensive and both national governments wanted a stimulating export economy; the Border Industrialization Program was implemented to establish multiple *maquiladoras* (Sparrow 2001). Moreover, in the 1990s, the negotiation of NAFTA (North American Free Trade Agreement) eliminated the majority of tariffs and incentivized the U.S. to move more of their assembly plants across the border to take advantage of the cheaper labor costs (Ebner and Cross 2019). Further, the Mexican peso collapsed in 1994, sending the country into a prolonged depression. Because of these two major events, Mexico became increasingly economically dependent on the dominant U.S and relied on *maquiladoras* to generate foreign revenue (Cooney 2001, p. 55).

Through *maquiladoras*, corporations can dodge strict labor laws, pay their workers less than they would be required to in the U.S., and need only to adhere to Mexico's more lenient environmental regulation and enforcement than the more severe regulations of the U.S. In addition, corporations are able to avoid the costs of disposing waste properly, evade participation in carbon taxes or a cap and trade system, and disregard caution when using local land and its resources. Thus, profit is maximized and there are few consequences these companies face.

One of the major consequences of this lack of environmental responsibility is the air pollutants these factories emit. In the border region, industries are accountable for 17% of sulfur dioxide, 5% of nitrogen oxides, 3% of hydrocarbons, and a large quantity of particulate matter (specifically PM₁₀) (Blackman et al. 2004). These pollutants, among others, are linked to severe health effects, such as asthma, obstructive pulmonary diseases, decreased lung function, exacerbation of Type 2 diabetes, and cancer (Quintana et al. 2018). In other border cities, like Ciudad Juárez in Mexico, these health damages are up to 50 times higher than in areas in the U.S. without *maquiladoras* nearby, and are 10 times higher than the U.S. sister city of El Paso, Texas. The emissions from these factories are intensified in Mexico where people are at the closest proximity and also impacts those who live a few miles away on the other side of the border. For instance, Blackman et al. (2004) found one specific iron foundry to be responsible for one premature mortality, 15 respiratory hospital admissions, 35 emergency room visits, and thousands of asthma attacks each year (Blackman et al. 2004).

In addition, in a more recent study conducted in the sister cities of Reynosa, Mexico and McAllen, Texas, Carrillo et al. (2018) discovered that the level of asthma in children is extremely high when compared to other parts of the U.S. without high air pollution. Though agriculture, vehicle exhaust, and burning trash are a few other factors that cause poor air quality,

maquiladoras are still liable for emitting health dangerous compounds like nitrogen dioxide (NO₂), sulfur dioxide (SO₂), and ozone (O₃) into border communities. Chemicals like formaldehyde, acetaldehyde, hydrochloric acid, and chlorine, which are frequently used in *maquiladoras*, were also found to be more prominent in the sister cities compared to U.S. national averages (Carrillo et al. 2018). As a result of this unsafe air quality, nearly 17% of children aged 14-18 develop asthma, whereas the U.S. national mean is closer to 9%. Respiratory impacts and other health issues are likely to worsen as children get older and are continually exposed to toxins in the air (Carrillo et al. 2018).

The frequency of *maquiladora* placements near the border in Tijuana cause a large increase in air pollution that can instigate major health effects for the communities around these facilities. Without cooperation from both the U.S. and Mexico, these air emissions and their subsequent health issues may only worsen, especially as climate change continues to exacerbate the effects of environmental hazards.

Energy Plants

Besides *maquiladoras*, energy plants are another major air polluter in the Tijuana-San Diego border region. As the San Diego area in the U.S. continues to grow in population, the need for greater energy supply simultaneously increases. Again, because of the close proximity of cheaper labor costs and less strict environmental regulations, the U.S. takes advantage of contracting energy plants just across the border. In response to market devaluation in the 1990s (around the same time that NAFTA was negotiated and implemented to ease trade across international borders), the U.S. contracted a few major energy plants in Baja California, Mexico and connected them to power distribution networks in San Diego. Currently, over 40% of the energy produced in Baja California is directly distributed to the U.S. (Bolorinos et al. 2018).

Southern California relies heavily on this energy export from Mexico to provide power for its growing population.

The majority of the power plants in the Tijuana area are natural gas combined cycle generation facilities. These facilities emit several air pollutants: greenhouse gases (GHGs) which are measured through levels of methane and CO₂, NO₂, volatile organic compounds (VOCs), and particulate matter (PM₁₀ and PM_{2.5}). VOCs and NO₂ react to create ground-level ozone, and this can generate harmful consequences for surrounding communities, including asthma and other major respiratory issues (Bolorinos et al. 2018).

Electric power plants are the single greatest emitters of toxic air pollutants in all of North America, and plants at the border region contributes to this (Carruthers 2007). Bolorinos et al. (2018) specifically measured two U.S.-contracted plants, La Rosita and Termoeléctrica de Mexicali, to determine the effects of their air pollution. Both of these plants export electricity to San Diego's power distribution networks and are fueled by natural gas. Bolorinos et al. (2018) discovered that GHGs are evenly distributed across both sides of the border. The health impacts of these GHGs are concentrated in the Tijuana-San Diego border region and along the remainder of the California-Mexico border (Bolorinos et al. 2018).

Further, to meet the rapidly increasing energy needs of Southern California in the early 2000s, two major power plants (Intergen and Sempra) were constructed three miles from the border in Mexicali, Mexico. Both are combined-cycle natural gas-fired facilities, and they burn fuel from a pipeline from the U.S. (Blackman et al. 2012). To build these plants, the Department of Energy required both companies to seek approval for presidential permits. This approval process includes an environmental impact assessment. However, both companies were approved for these permits without a rigorous evaluation of the potential health impacts air emissions from

these facilities could produce. Thus, these plants were not founded on a strict obligation to protect people in surrounding communities from these possible harms (Quintero-Núñez et al. 2009).

Specifically, the Intergen plant has a capacity of 1060 MW which can power hundreds of residential homes, companies, and other buildings. Half of this energy is sold to Mexico, while the other half is exported to the U.S. The Sempra plant has a generating capacity of 650 MW and exports all of its energy to the U.S. Both plants attempt to offset some of their NO₂ and CO emissions by employing selective catalytic reduction (SCR) and Sempra further uses oxidizing catalyst units to help prevent high emission levels (Blackman et al. 2012).

Blackman et al. (2012) completed an analysis that measured the health impacts from the remaining air emissions. First, to determine spatial air quality, inputs of polluting emissions from the Intergen and Sempra plants, meteorology, topography, and land use were tested through a chemical-transport air quality modeling system. The outputs from this data were then combined with demography and the base health status of surrounding communities. These were run through the Tracking and Analysis Framework (TAF), which analyzed health impacts for both O₃ and PM_{2.5}. This model outputs estimations of morbidity and mortality rates by plant, country, and pollutant. Finally, the data were run through a valuation TAF model, which assigns monetary values to these potential health impacts (Blackman et al. 2012).

The results of these models indicate interesting results, but none at the level as would be expected. For the Intergen plant, specifically in summer months, plumes of O₃ are blown by strong winds to the neighboring city of Mexicali, but also as far north as the Grand Canyon in Arizona. The same effect occurred for the Sempra plant in the summer months, with plumes blowing into California and Arizona (Blackman et al. 2012). In this study, O₃ emissions did not

produce significant health impacts, such as respiratory hospital admissions, asthma emergency room admissions, and short-term mortality. On the contrary, PM_{2.5} caused consequences that affected work loss days and minor restricted activity days due to health complications, so these effects are not negligible. These impacts are particularly concentrated in California due to strong wind patterns that carry the plumes (Blackman et al. 2012).

It is estimated that the total value of annual health damages from the Sempra and Intergen plants is around \$566,000 (Blackman et al. 2012). This means that, since their opening in the early 2000s, these specific energy plants have caused over \$10 million in health damages. These costs do not burden these plants and the companies that run them, but rather the surrounding communities whose residents may not be able to afford significant health expenses. Without policies that drastically reduce the amount of emissions these plants release into the air, these communities will continue to bear these costs, both physically and financially.

Vehicles and Transportation

Though *maquiladoras* and energy plants do emit harmful pollutants into the air, transportation is the leading cause of air pollution in the border region (Blackman et al. 2004, p. 3). Across the U.S.-Mexico border, there are 43 land ports of entry, but the busiest are at the Tijuana-San Diego border (Galaviz et al. 2014). In specific, the San Ysidro Port of Entry (POE) is one of the busiest land border crossings in the world. 70,000 northbound vehicles and 20,000 pedestrians cross on average each day (U.S. General Services Administration, n.d.). In 2013, this added up to 11.3 million cars and 7.6 million pedestrians crossing (Quintana et al. 2018). Trucks transporting input materials and exports from *maquiladoras* and other commercial vehicles cross at the Otay Mesa POE, located about 10 miles away from the San Ysidro POE. Wait times for both POEs can be anywhere from 15 minutes to multiple hours, so these vehicles idle and release

exhaust during their entire wait time. Not only are pedestrians, drivers, and passengers exposed to these harmful pollutants if they are in line to cross, but the people living in the surrounding communities on both sides of the border are consistently exposed as well.

As aforementioned, air pollutants can have severe health impacts on those that are frequently exposed to these environmental hazards. For those people who are waiting in line to cross in their vehicles, they are exposed to the pollutants other idling cars in line emit. This is only aggravated if these people are daily commuters and are exposed to nearby idling vehicles on an extremely frequent basis. Exposure inside vehicles can be up to 50% of a person's daily exposure to PM (Quintana et al. 2018). Quintana et al. (2018) conducted a study that measured this in-vehicle exposure while crossing the San Ysidro POE in comparison to levels in Tijuana and San Diego, specifically studying the levels of black carbon (BC), carbon monoxide (CO), and ultrafine particulate matter (UFPs, $PM < 100 \text{ nm}$).

Quintana et al. (2018) studied 68 participant trips from Tijuana to San Diego. Participants idled at the border for an average of 51 minutes for each trip. UFPs were found to be the most concentrated at the border at an average of 31,161 particles/ cm^2 in the vehicle, while in Tijuana and San Diego, the means were 26,218 particles/ cm^2 and 22,154 particles/ cm^2 , respectively. The CO levels in the vehicles also peaked at the border, with an average of 3.4 ppm. In contrast, the San Diego average was 1.9 ppm and the Tijuana average was 1.4 ppm. This was not the case for BC; the average levels were highest in Tijuana, then San Diego, then the border. In general, though, idling next to other cars in line at the border proved to cause an increase in pollutants inside the cars themselves. The effects also varied depending on the time of the day. UFP levels and CO levels in the vehicles hit their peaks during morning hours, typically during rush hour (Quintana et al. 2018).

Instead of waiting in vehicles to cross through the POE, many people opt to walk across the border. The pedestrian line is 10 feet away from the 24 lanes where cars and busses idle while they wait to cross; however, pedestrians do not have the protection to defend against pollutants that cars can possibly filter out. During peak wait times (2-4 hours), pedestrians are directly exposed to the pollutants that are emitted right next to them the entire time. The pedestrian line is closest to the bus lane in which busses consistently release diesel exhaust (DE) while idling and driving up to the POE (Galaviz et al. 2014).

To determine the extent of these effects, Galaviz et al. (2014) conducted a study that addressed these impacts for pedestrians. 76 participants (56 “Border Commuters” and 15 “Non-Border Commuters”) carried sampling equipment for 24 hours to measure the amount of DE (measured through the amount of 1-nitropyrene [1-NP]) and $PM_{2.5}$ in the air around them. The 56 “Border Commuters” crossed the northbound border during this 24-hour period while the “Non-Border Commuters” stayed in San Diego and had not crossed the border at any time four months prior. At the end of the 24-hour period, there were stark differences in the traffic pollution levels measured between each group. The “Border Commuters” averaged 1.7 $pg. m^{-3}$ of 1-NP, 39 $\mu g m^{-3}$ of $PM_{2.5}$, and 2.8 ppm of CO. In contrast, the “Non-Border Commuters” averaged 0.22 $pg. m^{-3}$ of 1-NP, 21 $\mu g m^{-3}$ of $PM_{2.5}$, and 1.0 ppm of CO (Galaviz et al. 2014). These pollutants are known to cause serious health effects, such as asthma and other respiratory problems. Crossing the border in the pedestrian line and being consistently exposed to these pollutants during the wait is dangerous for pedestrians’ health and is only worsened if this is a frequent occurrence.

On mornings when traffic is heavy and wait times are long, emissions from cars and trucks collect to create a visible smog in the area. This haze blankets San Ysidro and other nearby communities and is primarily composed of UFPs. UFPs are the smallest form of

particulate matter but can be some of the most dangerous pollutants. Because of their small size, UFPs can transcend human defense mechanisms and reach the bloodstream, being redistributed into the lungs, heart, bone marrow, and lymph nodes (Olvera et al. 2013). UFPs are known carcinogens and are correlated with respiratory problems, premature death for people with heart disease, and several other serious health conditions (Environmental Protection Agency 2020; Olvera et al. 2013). The UFPs from vehicles can reach more than a quarter of a mile away from where they were emitted. This, then, impacts pedestrians waiting to cross the border, commuters from both sides idling in their cars, employees who are stationed at POEs, and people who live or work in neighborhoods nearby (Olvera et al. 2013).

Evidently, air pollution from these various sources causes detrimental consequences to the communities surrounding the border. Anyone from residents who live near the POE, communities adjacent to energy plants and *maquiladoras*, workers in these facilities, border employees, and daily commuters are among those harmed by toxic air emissions at the border. The health issues these pollutants can trigger are serious and policies in both the U.S. and Mexico must cooperate to reduce environmental harm and lessen any further potential health risks.

Water

For the past several decades, one of the most complex conflicts between Tijuana and San Diego has been severe water contamination that impacts both sides of the border. During and after rainstorms, a common sight near the border is sewage, trash, and other debris flowing from Tijuana into the Tijuana River Estuary on the U.S. side of the border. The estuary acts as a natural border between San Diego and Tijuana on the west side adjacent to the Pacific Ocean.

Due to the binational nature of the area, it is difficult for the U.S. and Mexico to agree on the best strategy to fund and maintain cleanup of water contamination (Tijuana River National Estuarine Research Reserve, n.d.).

Tijuana is easy to blame for the contamination because the land is at a higher elevation than in San Diego and there are fewer concrete systems to manage urban runoff than in the U.S., so debris flows from Tijuana to San Diego rather than from San Diego to Tijuana. However, the U.S. is still culpable for contributing to this pollution; *maquiladoras* owned by U.S. corporations irresponsibly dispose of toxic waste that seep into the soil in Tijuana and end up in the runoff flow towards San Diego. Further, recent construction to reinforce the border wall near the Pacific Ocean by the U.S. continued to erode the sediment at the top of the border land mass and made it easier for runoff to flow down to the Tijuana River Estuary. Ultimately, this water contamination affects the people who live near the estuary and impacts their ability to enjoy beaches and natural parks in their communities.

Maquiladoras

Along with emitting dangerous pollutants into the air, *maquiladoras* also frequently improperly dispose of hazardous waste that seep into soil and contaminate nearby water supply. The facilities additionally use excessive water in their manufacturing procedures. As aforementioned, a primary reason why U.S. corporations contract and use *maquiladoras* is because they can avoid the responsibility and costs from adhering to stringent environmental regulations. However, when *maquiladoras* were first established, Northern Mexico was unprepared to incorporate hundreds of factories into an already fragile environmental infrastructure. For example, Mexican communities lacked proper sewage systems so, instead, they dumped raw sewage into the Rio Grande River for decades, harming the availability of

clean water for downstream towns. In addition, no local, state, or national planning occurred to support the rapid population and factory growth in the area (Williams and Homedes 2001). This lack of preparation and environmental regulation led to water contamination and other pollution issues that still occur today.

Besides polluting into the air, one of the main ways *maquiladoras* affect surrounding communities is through dumping hazardous waste in uncontrolled sites. Improperly disposing hazardous waste leads to soil and groundwater contamination and is unsafe to live near. Further, the toxins in these sites can be washed away during rainstorms and flow to pollute rivers and other bodies of water, including those where drinking water is sourced (Lemus 1995). Over 98% of all inputs for *maquiladoras* are imported from the U.S., so the majority of hazardous materials are from the U.S. and disposed of in Mexican communities (Sanchez 1990). Thus, Mexican communities largely pay the cost for this negligence.

Hazardous material is primarily composed of three basic categories: a range of solvents (alcohols, freons, cetones, and aromatic hydrocarbons), acids and alkaline substances, and heavy metals. These are all regularly used by *maquiladoras* (Sanchez 1990, p. 173). These materials are used in the industrial process either as direct inputs or auxiliary inputs. Direct inputs are materials that will be a part of the finalized product itself, and auxiliary inputs are materials that are used to treat, prepare, clean, or degrease parts during the manufacturing process (Sanchez 1990, p. 175). Because auxiliary inputs are not part of the finalized products and are often single-use products, they need to be disposed of, and many times this is in an unregulated waste site. Moreover, waste from degreasing and cleaning (solvents and acids) are often mixed with other waste (heavy metals, resin, etc.), and can be dangerous to anyone who is exposed to them, especially factory employees (Sanchez 1990, p. 175).

Mexican legislation requires that these factories export their toxic waste to their country of origin, but they are permitted to treat or dump the waste in Mexico if it is done by an authorized company of the Mexican environmental agency (Sanchez 1990, Lerner 2003). In the early 1990s, only around 20 *maquiladoras* out of over 1,000 shipped their hazardous waste to their country of origin during any given year (Lerner 2003). Therefore, the majority of hazardous is either recycled or dumped in Mexico. There are not many treatment facilities and dump sites that are approved, so several operate without legitimate permits and environmentally safe procedures. In general, *maquiladoras* do not release much information about their waste disposal, so it is difficult to know which facilities are culpable and to what extent in terms of water contamination (Sanchez 1990). However, it is clear that many of these facilities, through bypassing harsh environmental regulations, are responsible for toxins ending up in a variety of water sources.

Toxic effluents (run-off) from *maquiladoras* were found to be as potent as untreated sewage, and toxin levels such as lead, cadmium, and chromium far exceeded EPA standards for safe drinking water. These results were discovered adjacent to residential communities in Northern Mexico (Williams and Homedes 2001, p. 327). Further, in a study by the National Toxic Campaign Fund, in various water sources near *maquiladoras*, chemicals such as petroleum were found to be present at 8.9% above regulatory limits (Lemus 1995). Effects of this water poisoning can include kidney disease and high blood pressure, among other serious health problems (Centers for Disease Control and Prevention 2020).

Moreover, *maquiladoras* are also responsible for high levels of water withdrawals for their manufacturing needs. This is particularly the case in textile and garment industries, but nearly every facility requires a high amount of water to produce their products (Williams and

Homedes 2001). *Maquiladoras* often withdraw this water from groundwater stored in aquifers. The Tijuana-San Diego shared aquifer is one of 36 along the border and provides a clear example of the negative impacts of sharing this water source (Sanchez and Eckstein 2017). The U.S. pumps this water for farming because it is cheaper, but simultaneously contaminates rivers through the extensive runoff of pesticides, fertilizers, and herbicides (Lemus 1995). Because of this rapid withdrawal from both the U.S. and Mexico, low levels of rainfall in the area, and exploitation of surface water, the aquifers are depleting at a much higher rate than they are replenishing (Lemus 1995). Consequently, combined with contamination from hazardous waste and sewage, the amount of water available for drinking water in Tijuana communities is very low, so many residents rely on water shipped in from other towns for drinking.

Tijuana River

The Tijuana River Watershed (also known as the Tijuana River Valley) is a shared watershed that spans 1,750 square miles across the Tijuana-San Diego border region. 75% of it lies in Mexico and the remainder is in California. Watersheds serve as water drainage basins for rain, snow melt, and urban runoff to flow through creeks and rivers to the ocean. This watershed is one of 12 in Coastal San Diego that connect the mountains to the ocean (Tijuana River National Estuarine Research Reserve, n.d.). Water from the mountains travels dozens of miles from its origin to the ocean, and there are several opportunities for human intervention to contaminate the water before it reaches the sea.

The Tijuana River flows northwest from Tijuana into the U.S., passing through an estuary (where the ocean tide meets the river stream) before flowing into the Pacific Ocean near Imperial Beach. As a result of toxic runoff from *maquiladoras* and untreated sewage, this pollution frequently builds up in this estuary, impacting the quality of the water and the surrounding

communities. Imperial Beach primarily experiences this build-up of sewage and industrial waste, so the beach area regularly closes to the public so they cannot enjoy any recreation activities on the beach. This is a decades-old problem. Pollution has been building up for numerous years, especially increasing with the rise of industrial development after the NAFTA agreement in the 1990s (Lemus 1995). Nearly 30 years after the implementation of NAFTA, this contamination remains a major problem and still impacts communities around the river and estuary on both sides of the border today.

Though it may make sense to blame Tijuana and their lack of proper sewage management systems, the few processing facilities that do exist are overloaded by *maquiladoras*' industrial sewage. The processing facilities are not only forced to attempt to process the high amount of urban waste from the factories, but they also are tasked with processing raw sewage from around Tijuana. Because of this overload, breakdowns are frequent and during heavy rains, this sewage overflows and spills into the Tijuana River (Lemus 1995). The rapid industrialization of the border region after NAFTA's implementation has forced many people to live in unincorporated areas (*colonias*) on the outskirts of Tijuana neighborhoods. As a result, make-shift shelters and houses are not connected to the main city's sewage system, and this sewage is part of what flows to the U.S. through the Tijuana River (Lemus 1995). Approximately 38% of Tijuana and its surrounding areas is not connected to the city's main sewage system (Fernandez 2009).

Along the border, U.S. constructions of border walls and roads for Border Patrol agents affect the natural environment in these areas. Many places along the border are separated by rivers and mountainous terrain, which would make it nearly impossible for migrants to cross the border anyway. By constructing these unnecessary border security measures, this has separated fragile ecosystems (Gaskill 2011). Further, due to the difficulty in building fences along this

terrain, exploding the land to plant the fences has caused sediment erosion and eroded natural boundaries that prevented flooding (Herweck and Nicol, 2018). At the Tijuana-San Diego border in particular, the reinforcement of the border fence in 2007, a result of George W. Bush's 2006 Secure Fence Act, continued the erosion at the top of the border land mass, reducing any natural barriers for flood control of toxic waste during storms (Sierra Club, n.d.). Though the pollution technically originates in Tijuana, the U.S. plays a large role in the amount of waste that ends up in the Tijuana Estuary.

As previously mentioned, there are 12 watersheds that feed into the San Diego coastal region. The Tijuana River Watershed accounts for a relatively small percentage of the runoff that ends up in the Pacific Ocean, but discharges from the Tijuana River Watershed contains the highest concentrations of suspended solids, cadmium, copper, nickel, lead, zinc, and polychlorinated biphenyls (PCBs) among the eight largest rivers and creeks in Southern California (Meyer and Gersberg 1997). Exposure to these metals, especially if in drinking water, can cause brain damage, nervous system issues, and hearing and speech problems (Centers for Disease Control and Prevention 2020).

Moreover, in a study that measured the amount of persistent organic pollutants (POPs) on shorelines along the San Diego coast, Van et al. (2012) determined that Imperial Beach (the beach closest to the Tijuana Estuary) contained the most amount of POPs compared to every other beach. These POPs are attached to plastics (typically <50mm) and comprise 50-80% of all shoreline debris. For example, the average number of plastic pellets in a sample of sand in Imperial Beach was 75 pellets, while the average number in a sample of sand in La Jolla Shores was 43 pellets and in Ocean Beach it was 48 pellets. This result demonstrates the high amount of pollution in an area impacted by Tijuana River pollution in contrast to beaches which are not in

close proximity. A variety of sea life ingest these plastics and these pollutants are ultimately integrated into the overall food chain. In addition, the high level of plastic on the beach means it is less enjoyable and even dangerous for nearby residents to enjoy (Van et al. 2012).

The amount of pollution in the Tijuana Estuary and other parts of the Tijuana River pose serious health risks for residents in San Diego living near this water contamination. These pollutants are unsafe to live around and be exposed to on a consistent basis, especially for those who frequent Imperial Beach and other natural areas where these toxins are present. Because this severe water contamination has existed for multiple decades and worsens as Tijuana continues to grow in population and industrial development, continuous binational government intervention is needed to create safer communities.

Environmental Injustice

Environmental injustice in the U.S. is not a new practice by any means. Proximity to toxic waste sites, air pollution from power plants, contaminated water, and other environmental hazards plague urban and rural communities in the U.S. These hazards disproportionately affect low-income communities and communities of color. On average, three out of every five people of color reside in communities with uncontrolled toxic waste sites (Cole & Foster 2001). Even after controlling for land values, home ownership, education, and other factors, race is still the most statistically significant predictor of exposure to environmental dangers (Cole & Foster 2001; Bullard 2000). White communities see faster action, better results, and harsher regulation than communities where minorities live. This is largely because many people living in majority white communities own their home and therefore possess a seemingly high level of authority when protesting what should be placed in their neighborhoods. In addition, white communities

often enjoy better education and job access which can provide resources, tools, and time to effectively fight these environmental hazards (Cole & Foster 2001; Bullard 2000). Because this environmental injustice overwhelmingly occurs in communities of racial and ethnic minorities, this offers a possible reasoning for why there has been a lack of pollution regulation at the border. It is no accident which communities are impacted the most by border pollution.

Communities in San Diego

Across the U.S., immigrants often congregate in a specific neighborhood or town. This is primarily because shared identities and experiences provide comfort and security in living near one another. Immigrant communities are among some of the most vulnerable populations affected by environmental injustice. Along with these communities already being impacted by environmental racism, they are often also low-income communities. Further, those who are not citizens are not able to vote for people that will represent their interests and defend them, and if they are recent migrants, they may not be familiar with avenues of local advocacy (Logan and Darrah 2012). An example of an immigrant community in the San Diego border is in San Ysidro, the town right next to the border.

	San Ysidro	San Diego
% of population that are Latinx	93%	30.1%
Median income	\$35,993	\$75,456

Source: U.S. Census Bureau 2010; SANDAG 2015

According to the above table, there is a large disparity for both percentages of the population that are Latinx and median income, marking San Ysidro as a majority-minority low-income community, especially in comparison to the greater San Diego area. Because of low incomes and other factors, it may be difficult for these residents to be able to afford to live anywhere else, away from the border and its pollution. And, these residents may not wish to live elsewhere due

to close relationships made with other migrants. Though air and water pollution affect many communities around the Tijuana-San Diego border region, one of the most highly impacted is the San Ysidro community.

Concerning air pollution, in Southern California, exposure to heavy traffic has been found to be substantially higher in low socioeconomic status and minority neighborhoods. Due to its close proximity to the San Ysidro POE and the amount of idling vehicles waiting to cross the border, the community of San Ysidro is concerned about the potential health effects the air pollutants may cause. These adverse effects are a top concern of local environmental justice community groups (Quintana et al. 2014). As aforementioned, being in close proximity to heavy traffic is linked to negative health outcomes, such as asthma, reduced respiratory function, birth defects, and cardiovascular disease. People who live, work, attend school, or pass through areas with high traffic density are exposed to high levels of traffic-related pollutants (Quintana et al. 2014). Thus, for the people who live in San Ysidro, just a mile or two away from the POE, they are constantly exposed to these hazards.

The level of how much these individuals are exposed to traffic emissions depends on distance from major roads, wind speed and direction, humidity, solar radiation, and temperature (Quintana et al. 2014). In order to determine how much residents in San Ysidro are impacted by traffic pollutants, Quintana et al. (2014) measured UFPs and BC from four rooftop sites at varying distances from the San Ysidro POE. BC and UFPs were consistently higher at the three rooftop locations in the San Ysidro community than the control rooftop location at the Tijuana Estuary. Winds from the POE had significantly higher BC and UFP concentrations than winds from the ocean (Quintana et al. 2014). This was especially true during low wind speeds, which is consistent with other research that shows higher traffic-related pollution concentrations during

low wind speeds. Around 12% of daytime winds were from the POE, rather than from the ocean, so San Ysidro was exposed to an elevated concentration of these toxins when the wind was blowing from the POE. Further, correlations between BC pollutant concentrations and border wait times indicate that concentrations are higher when border wait times are higher. This may be impacted by other major highways, the city of Tijuana, and other road pollution, but the correlation suggests that the POE does have a significant effect on the quality of air around San Ysidro (Quintana et al. 2014). Subsequent health issues from these air pollutants therefore impact the community of San Ysidro. Living in such close proximity to this continuous air pollution contributes to explaining why there is an 18% higher rate of asthma in San Ysidro compared to the rest of San Diego County as a whole (San Diego Association of Governments 2015).

Besides low-income and racial and ethnic minority communities, air pollution particularly harms other vulnerable groups: those with preexisting health conditions, the elderly, pregnant women, and children. In a case study conducted in Hidalgo County, Texas (the county in which Brownsville, Texas, is located within), Askariyeh et al. (2019) measured the amount of $PM_{2.5}$ that 17 pregnant women in their third semester encountered on a daily basis for three days using a GPS system. Hidalgo County receives the greatest share of food stamps in Texas and it is considered a low-income county. Askariyeh et al. (2019) determined that the amount of $PM_{2.5}$ was the most elevated when the women were commuting near the border, and when traffic levels at the border were the highest (Askariyeh et al. 2019). This is especially concerning because pollutants like $PM_{2.5}$ are known to cause adverse birth defects, among other aforementioned health problems. If pregnant women are consistently exposed to traffic-related air emissions in border towns, this is dangerous for them and their unborn children.

Concerning children, in a binational study determining the effects of urban air pollution on asthmatic children, Sarnat et al. (2012) discovered striking findings. Children who had already been diagnosed with asthma were found to have positive associations between airway inflammation and PM_{2.5} and NO₂. Children are already more likely to develop asthma if they are living in border towns with close proximity to air emissions, but these pollutants can additionally exacerbate the severity of asthma symptoms (Sarnat et al. 2012). It is evident air pollution in the border region impacts vulnerable populations, racial and ethnic minorities, and low-income communities the most.

In regards to the Tijuana Estuary contamination as previously discussed, the most impacted populations are those who live near Imperial Beach. These are also the people who would use the beach for recreation activities the most due to close proximity, so any beach closures from water contamination and pollution buildup from urban runoff affects the health and quality of life of these community members. Imperial Beach is located just eight miles down the coast from Coronado Island, a town known for pristine beaches, fancy hotels, and rich neighborhoods. However, Imperial Beach is harmed by severe pollution and its beaches have been closed multiple days a year for decades due to this increased hazard.

Comparable to the differences in median income and percentage of the population that is a racial or ethnic minority between San Diego and San Ysidro, Coronado Island and Imperial Beach also have drastic disparities. The percentage of the population that is Latinx in Imperial Beach is 52.3%, while on Coronado Island, the percentage is 15.6%. The median income in Imperial Beach is \$51,383, while on Coronado Island, the median income is \$101,520 (U.S. Census Bureau, 2010). These large differences may explain the environmental injustice that Imperial Beach residents experience. Very little action has occurred in the past 30-plus years to

protect Imperial Beach from hazardous water contamination and the raw sewage runoff from Tijuana. Perhaps if this pollution was happening in a place like Coronado Island, the richer, whiter residents would have the resources and political sway to ensure the government was working towards maintaining and preventing the pollution.

Many people are harmed by air and water pollution at the border, such as commuters passing through the border crossing, employees working at the POE, and tourists visiting beaches and natural parks near the Tijuana Estuary. However, it is clear that the people living in San Ysidro and Imperial Beach are some of the most harmed populations, due to constant exposure to these pollutants and often an inability to relocate to a safer environment. In addition, due to the majority-minority and low-income status of these communities, it may be more difficult to receive government interference and resources to reduce pollution and mitigate any potential negative health effects.

Communities in Tijuana

Not only are marginalized communities affected by pollution on the U.S. side of the border, but these communities are especially harmed on the Mexico side as well. The majority of people living in Tijuana make less than \$15,000 a year, which would be below the poverty line in California (Villa-Caballero et al. 2006). In addition, several neighborhoods in the Tijuana area are considered to be slums. These consist of houses without good infrastructure, proper plumbing and sewage systems, and lack of access to clean drinking water (Cruz 2006). The previously mentioned effects of *maquiladoras* and their air and hazardous waste pollution specifically harm these low-income neighborhoods.

Two neighborhoods in Tijuana experience negative pollution effects at a high rate: Colonia Chilpancingo and Campestre Murúa. They are adjacent to Tijuana's largest industrial

complex and experience a variety of problems frequently found in low-income communities of color: substandard housing, low-paying jobs, over-crowded schools, industrial truck traffic, close proximity to polluting industries, and severe air pollution (Environmental Health Coalition, n.d.). 67% of the homes have dirt floors, 65% of the homes do not have piped water systems, and 33% of the homes are not connected to a sewer system. If two adults are employed full-time in the *maquiladora* industry, their wages only cover around two-thirds of the basic needs of a family of four (Environmental Health Coalition, n.d.).

One of the largest uncontrolled toxic waste sites in Tijuana is the Metales y Derivados site. It is adjacent to the Colonia Chilpancingo community. The site is a former battery and lead waste recycling facility that was abandoned in 1995 by its U.S. owner, Jose Kahn. When Kahn was implicated by Mexican environment officials for not complying to regulations, he fled the country and left thousands of tons of waste and contaminated soil with lead and other toxic heavy metals (Yang 2005). Still today, uncontrolled piles of lead slag and barrels and sacks of waste remain at the waste site. This dangerous waste seeps into the soil and impacts the quality of the groundwater and chemicals runoff into the Tijuana River to pollute other water sites. The site is relatively unprotected; children and other people can easily enter the property by climbing over the walls or squeezing between the two-stranded barbed wire (Yang 2005). The close proximity of this unregulated site to low-income neighborhoods is a clear indicator of the environmental injustice that Tijuana experiences.

Many of the low-income communities in Tijuana welcome the short-term economic gains that *maquiladoras* can provide, but this comes with the major costs of the negative environmental consequences tied to this. In one example, Grineski et al. (2015) conducted a study to measure the extent of the correlation between low socioeconomic status and proximity

to *maquiladora* density in Tijuana. Grineski et al. (2015) used mean education level as the main class status variable, along with proportion of the population under 12, proportion of female-headed households, proportion of recent migrants, and proportion of formal development.

Formal development is measured as the combination of the percent of homes in a neighborhood with a strong roof, percent of homes with strong walls, percent of homes with floor, percent of homes with public sewer lines, percent of homes with indoor piping, and percent of homes with hot water heaters. These variables were all analyzed with the density of industrial park hazards in each specific neighborhood (Grineski et al. 2015).

As a result, higher proportions of migrants, female-headed households, and children under 12 were all statistically significantly correlated to a higher density of *maquiladoras* in their neighborhoods. However, close proximity does not always mean more vulnerable. The most vulnerable are those who are both close to a high density of *maquiladoras*, but also those who are unable to engage in self-protective measures. These measures, a function of more money, time, and education, include using air conditioners so windows do not have to be open on ‘bad air days,’ or owning a car that can readily escape potential industrial accidents. Further, those who are more vulnerable to environmental effects may not be equipped to protest or fight for equitable environmental outcomes (Grineski et al. 2015).

In addition, air pollution particularly impacts Tijuana and its residents more than San Diego as a whole. Past studies conducted in sister city pairs along the border indicate that the levels of air emissions are consistently worse on the Mexico side of the border. For instance, in Mexicali, Mexico, BC was approximately 1.5 times greater than just across the border in Calexico, California. Further, in Ciudad Juarez, Mexico, BC was approximately 3.8 times greater than in its sister city, El Paso, Texas. One of the reasons for this is that the average age of cars is

older in Mexico than in the U.S., so these vehicles produce more toxic pollutants than newer cars (Shores et al. 2013). In Tijuana-San Diego, these disparities across the border are similar. BC concentrations were more than two times higher than in San Diego. U.S. concentrations averaged $0.8 \mu\text{g m}^{-3}$, while Mexican concentrations averaged $1.95 \mu\text{g m}^{-3}$ (Shores et al. 2013). Though the two areas share the same airshed, Tijuana is still impacted more than San Diego by air pollutants.

Moreover, in the same neighborhoods as mentioned, Colonia Chilpancingo and Campestre Murúa, diesel emissions (like BC) have caused respiratory problems for school children. Trucks from the nearby *maquiladora* plants take shortcuts through the neighborhoods and pass three schools, exposing 2,000 children and everyone else who lives and works in the area to diesel exhaust. Diesel emissions are considered a carcinogen according to the World Health Organization and are associated with asthma, cancer, and heart disease. Only in recent years has signage been placed on the streets with schools to prevent trucks from driving down them (Environmental Health Coalition, n.d.).

It is clear that environmental racism and injustice at the Tijuana-San Diego border region not only greatly harms marginalized groups within San Diego, but also marginalized groups in Tijuana. These populations are the most likely to develop health issues due to nearness to environmental dangers. They are not adequately protected by either nation's governments in preventing the pollution from occurring at all or mitigating any potential harmful effects.

Migrants

Recently, one of the major themes in media discourse concerning the border has been an influx of Central American migrants fleeing their homes and travelling to the U.S. border in hopes of seeking a better life for themselves and their families. Due to U.S. immigration policy, it is nearly impossible for these migrants from Central America to immigrate through the regular

process in a timely manner. The Hart-Celler Act of 1965 (which is currently still in place) established annual country quotas around 25,000 for each country and does not take into account population size, proximity to the U.S., and conditions in the country (Ngai 2004). This law impacts Mexico and Central America the most because it does not acknowledge the desperation migrants feel in escaping dangerous situations to travel to the closest country that could offer them opportunities for a more stable life. Because wait times are nearly 20 years to enter the U.S. from these countries, seeking asylum is the most viable option for many migrants (U.S. Citizenship and Immigration Services, n.d.).

The Trump administration recently introduced new immigration enforcements for asylum-seekers. Slowing visa processing and narrowing eligibility restrictions (especially domestic abuse and gang violence, which are often the main reasons migrants from Central America flee) are among a few new practices (Pierce et al. 2018). Remain In Mexico is a new policy that concerns asylum seekers; it began implementation at the San Ysidro POE in 2018. The rationale of the policy is that migrants are deterred from attempting to come to the U.S. for fear of being forced to stay in Mexico for long periods of time (Chishti and Bolter 2020).

When a migrant arrives at the border to seek asylum, they now must wait 45 days to formally file an application to seek asylum. A judge then assigns them a court hearing date which is typically at least 45 days out. During each period of waiting, migrants must stay in Mexico, instead of the U.S. To add to this, Customs and Border Protection use a practice called ‘metering,’ which limits the number of migrants allowed to request asylum per day (Fredrick 2019). To deal with metering and maintain order, migrant communities in Tijuana and other border cities uphold an unofficial list of migrants waiting to seek asylum. These lists are

hundreds or thousands of people long in each border city. If they are lucky, around 100 people will be allotted to seek asylum each day (Hootsen 2018).

These long periods of waiting imposed by Trump's policies pose several challenges, especially concerning exposure to environmental harms. Most migrants are not from Tijuana or Northern Mexico in general, so they are not familiar with the area and often do not have a safe place to stay. As a result, hundreds of migrants are forced to sleep in shelters in abandoned nightclubs or tent cities on soccer fields (Silva 2019). Due to close proximity to the POE in these makeshift camps, migrants are heavily impacted by border pollution, and perhaps even more so because of the lack of infrastructure.

Like many houses in Tijuana, migrant shelters and tent cities do not always have access to the central sewage system or trash disposals, so people are consistently exposed to raw sewage and bacteria. Further, migrants in these shelters do not always have access to clean drinking water or water for bathing and cleaning clothes. Consequently, many migrants are forced to use surface water that is contaminated by the urban runoff from *maquiladora*'s toxic waste sites (Narea 2019). They are exposed to heavy metals and other health dangerous toxins. On top of these circumstances, because migrants are often within a few miles of the border, they are also exposed to the aforementioned air emissions from cars and trucks that greatly impact residents around the border. However, migrants do not always have homes/buildings that can potentially shield them from pollutants. If migrants are staying in tent cities, they are exposed to these harms all the time because of the lack of protection and shelter, and this can inevitably cause negative health issues in combination with unsanitary living conditions.

Because a variety of marginalized populations experience pollution at the border at exacerbated rates, it is crucial to address it through binational policies that ensure enforcement

and sanctions for violations. If policies are not implemented and regulated, this pollution will continue to create adverse health effects for these communities in combination with the worsening effects of climate change. Though policies exist in both the U.S. and Mexico to regulate pollution and enforce these rules, there is still a lack of binational cooperation. Ultimately, to ensure a safer environment for all these marginalized communities on both sides of the border, several policies will need to be implemented to tackle all types of pollution.

Policy Recommendations

Current Binational Management and Policy

In general, the U.S. and the Environmental Protection Agency (EPA) mandate strict air emission regulations. These can be even stricter in states with high concentrations of air pollution, like California. For instance, in California, ambient air quality standards exist to protect vulnerable populations from traffic and facility pollution. They limit the amount of pollutants that can be in the air for a specific period of time without harming sensitive populations. The standards apply to pollutants such as PM_{2.5}, PM₁₀, O₃, NO₂, sulfate, CO, lead, and Visibility Reducing Particles (which are similar to several of the pollutants mentioned before that cause severe health risks). These are often more stringent than national regulations (California Air Resources Board, n.d.). Further, through the federal Clean Air Act established by the EPA, state and local regulatory partners participate in compliance monitoring and inspect and enforce air emission restrictions. Regulations apply to companies that pollute into the air and also individuals who own cars, trucks, and other vehicles. (Environmental Protection Agency, 2019). Because corporations are typically held accountable for any emissions violations, this provides an apparent incentive to place facilities on the Mexico side of the border.

Mexico is popularly known for less strict environmental regulations than the U.S., especially concerning air. As of late, emissions standards in Mexico are not too far beneath U.S. emissions requirements. However, Mexico is not always able to effectively enforce their emissions standards like the U.S. is. The U.S. has developed an enforcement infrastructure through the above mentioned policies that connect federal, state, and local enforcement bodies to attempt to ensure the compliance of these standards. In Mexico, local governments may not necessarily have the resources or infrastructure to guarantee that various facilities and individuals are complying to regulations (Burguete-Stanek 1994). Further, Mexico's policies for air regulation are able to be bypassed through loopholes. For instance, in Mexico City (a city with high vehicle emission regulations), 9.6% of car owners circumvent smog test regulations by paying the equivalent of \$20 USD to bribe test centers into giving them stickers that confirm their passage of the smog test, even if they would not pass the test regularly. Eliminating this form of cheating alone would reduce emissions by 3,708 tons per year (Oliva 2015). Though the U.S. contributes to the pollution at the Tijuana-San Diego border, the lack of enforcement that the Mexican government often provides leads to an increased concentration of emissions in the area.

In terms of binational water management, there are several differences between the U.S. and Mexico and their water governing bodies. For Mexico, groundwater management is controlled by the Comisión Nacional del Agua, or the National Commission of Water. So, any groundwater in the Tijuana-San Diego aquifer is controlled by the federal government. Surface water is controlled by less centralized Basin Councils that correspond to hydrological basins (Sanchez and Eckstein 2017). However, the sewage that flows into the U.S. is primarily under the management of Tijuana's municipal utilities department, or Comisión Estatal de Servicios

Públicos de Tijuana. It is estimated that nearly \$400 million in repairs are needed for the system to avoid future sewage releases (San Diego Regional Water Quality Control Board, n.d.).

On the contrary, water management is not centralized in the U.S. Instead, the U.S. delegates the majority of its water management to individual states, which can further delegate this authority to county and local managerial bodies. In the case of the Tijuana Estuary, the majority of its management is controlled by county and local officials rather than the state. Therefore, the amount of funds the City of San Diego and other local departments can allocate is very little compared to the amount the federal government could potentially provide.

The major body that serves as the liaison of binational cooperation is the International Boundary and Water Commission (IBWC), established in 1889. Both the U.S. and Mexico are active members of this commission. Past efforts of the U.S. and Mexico pursuant to the IBWC include construction of diversion structures, pump stations, and treatment plants to attempt to reduce the levels of transboundary sewage flow (San Diego Regional Water Quality Control Board, n.d.). The IBWC is able to regulate transboundary water sources, but still lacks some authority in enforcing regulations. The IBWC is not necessarily that effective because of the amount of water contamination that still continually plagues border communities. The City of San Diego and environmental justice groups have recently sued the IBWC for this exact reason (City News Service, 2019).

In response to recent increasing pollution and community activism in Imperial Beach, \$300 million was allocated to clean up this area in the United States-Mexico-Canada Trade Deal. The deal was set to be implemented in July 2020. Previously, federal budgets only allocated up to \$30 million to aid this crisis. The majority of the money will be used to expand and upgrade the International Wastewater Treatment Plant in South Bay, San Diego (City News Service,

2019). This plant is operated by the IBWC and is located two miles west of the San Ysidro POE. It treats sewage flowing from Tijuana and discharges it to the Pacific Ocean (IBWC, n.d.). Evidently, this plant does not treat all the sewage that originates in Tijuana, as the Tijuana Estuary and Imperial Beach areas still frequently experience heavy sewage pollution. This \$300 million will certainly help create a safer environment for residents of Imperial Beach, but it would not necessarily address the underlying sewage issues in Tijuana that cause this pollution in the first place. Further, any of the sewage issues that affect Tijuana residents would not be addressed either.

Recommendations

To remedy some of the negative consequences of air and water pollution and build on current binational solutions, these few policy recommendations may help mitigate these impacts and prevent future environmental harm if implemented. To begin, emissions standards for U.S.-owned polluting facilities should be raised and enforcement should be strictly enforced in border communities. This would include both *maquiladoras* and energy plants contracted by the U.S. These emissions standards do not necessarily have to exactly match U.S. regulations, but they should be raised to reduce the air pollution in the area and protect employees and nearby communities. Moreover, without proper enforcement, this policy would not produce its intended effects so local enforcement systems would need improvement.

Because one of the primary reasons U.S. companies choose to place their manufacturing plants in Mexico is to avoid stricter environmental regulations, this policy may cause corporations to withdraw their contracts or prevent more from using *maquiladoras* or energy plants in the future. However, the pollution these facilities produce, as aforementioned, cause severe health issues in employees. These health issues may cause employees to be unable to

work in the facility and reduce overall productivity. With economic gains in mind, that is why these standards would not need to match the U.S., but be raised enough to limit pollution in the area and target these potential productivity issues. Ultimately, the goal of this policy would be to balance potential productivity loss due to ongoing health problems with emission reduction in the area.

To enforce this, a few methods can be employed. First, in order for Mexican energy plants to be contracted by the U.S., they often need to apply for presidential permits from the U.S. government for the use of cross-national transmission lines (Blackman et al. 2012). Department of Energy regulations in approving these permits can become stricter to ensure that facilities would actually adhere to these higher environmental standards before being granted the permit. Second, local Mexican authorities would need incentives to enforce the higher regulations and allocate consequences if need be. These incentives could include grants from the U.S. derived from the taxes the corporations pay or fees that their trucks would have to pay to cross the border to transport the goods manufactured in *maquiladoras*. Ideally, these officials would conduct annual inspections and if the facility fails to meet regulations, they can be fined. If infractions occur for three years in a row, operations at the facility can be suspended until they meet emission regulations. In general, this policy would reduce overall air pollution in the area and especially protect people who work in and live near *maquiladoras* and energy plants.

Next, to reduce some of the air pollution due to vehicles at the POE, a recent smog check can be required for vehicles to cross the border from the Mexico side to the U.S. side at the San Ysidro POE. Smog checks are required biannually in several counties across California if an owner's car is older than 1975 or runs on diesel. If owners do not submit documentation that they received a smog check, they will not receive their vehicle registration or registration stickers

(California Department of Motor Vehicles, n.d.). This in itself can cause a ticket fine if a vehicle does not have updated registration stickers. However, this practice is not universal in San Diego County. Because many cars in Tijuana and South San Diego are older and produce more toxic emissions than newer or electric cars, a smog check requirement at the border can reduce the amount of pollutants in the surrounding air.

Further, to create a larger impact and specifically protect people who frequent the border or nearby residents in San Ysidro, smog checks would need to be annually conducted for any car from 2000 or older. Once a smog emissions test is completed and passed, the testing center can provide windshield stickers that visibly indicate a vehicle has passed their most recent test. Each time vehicles cross the border, employees can check their windshield for the sticker to ensure the car is not producing heavily toxic fumes. Because there are several people that only cross the border a few times a year, their vehicle pollution is likely not a major culprit in area air pollution, and it may not make sense to get a smog emissions test done if they have no intent of crossing the border multiple times a year. In addition, tourists or local residents from further away may not be aware of the smog inspection rules, so it would be ineffective to fine them if they are only crossing one or two times that year. So, windshield stickers indicating smog emission test passage would only be required if a vehicle crosses the northbound border crossing more than five times each year. After vehicles cross for their fifth time in a calendar year, the windshield sticker would be required to cross any additional times that year. This specifically would target commuters and other frequent border crossers who collectively produce the most air pollution in the area. If a vehicle crossing that requires a smog inspection does not have the windshield sticker, they can either accept a fine to cross the border or turn around. In Mexico City, for

example, the fee for cars without a smog inspection sticker can be up to 3,500 pesos, or around \$175 USD, so a similar amount fine can be implemented at the border (Oliva 2015).

A potential issue that arises from this policy would be excluding people with low incomes who may not be able to afford annual smog checks (and new cars/electric cars long-term). The average cost of a smog inspection is around \$30, but this fee can be up to \$70 depending on the type of car and the area the smog test is conducted (Smog Tips, n.d.). In order to remedy these negative impacts on these already vulnerable populations, a few programs can be implemented to alleviate the costs of these tests. For example, the DMV in California offers low-income repair assistance if vehicles fail the smog test (California Department of Motor Vehicles, n.d.). A similar program could be implemented to subsidize any significant hardships as a result of failing a smog test. In addition, in Mexico City, every other smog inspection is free, so if this were introduced and subsidized by the government, people with low-incomes may be able to better afford the annual tests to cross the border (Oliva 2015).

This would, again, require binational cooperation, but a possible fund that could be allocated to subsidizing these costs could come from SENTRI (Secure Electronic Network for Travelers Rapid Inspection) card application fees. These are cards that allow holders to bypass long lines at the border crossing and shorten wait times. In order to receive a SENTRI card, there is no requirement for U.S. citizenship. As a result, several Mexican citizens who work in the U.S. apply for and use this card to shorten their commute times. To apply for this card, it costs a total of \$122.25 per person (U.S. Customs and Border Protection, n.d.). Because the U.S. collects the fees from both U.S. citizens/residents and Mexican citizens/residents for SENTRI cards, a portion of this money can be allocated to subsidizing smog emissions costs for people with low incomes on both sides of the border. In general, by ensuring vehicles that frequent the POE are

producing as clean air as possible, this can reduce dangerous pollution for all people at the border and potentially lessen health impacts.

Finally, to address water contamination on both sides of the border, a binational fund could be created and used to identify, prioritize, and fund specific water management projects (Blackman et al. 2012). Blackman et al. (2012) refer to this solution as one that would work best with air quality management projects, but I argue that this same recommendation can also apply to water management. Adding to the \$300 million that will be allocated by the U.S.-Mexico-Canada Trade Deal, this fund can help projects that address cleaning up the pollution in the Tijuana Estuary and Imperial Beach and preventing it from happening at all. Specifically, this fund can be used for projects that specifically target improving the sewage system on the Tijuana side of the border and preventing the pollution from harming Tijuana residents. By focusing on prevention, this will allow people in both Tijuana and San Diego to have a better quality of life, instead of only focusing on the U.S. side of the border as the Trade Deal does.

In order to collect the funds that would sponsor this type of project support, this would require cooperation from both the U.S. and Mexico. For instance, funding can be acquired from direct appropriations from each federal government's legislatures, cross-border commuter fees, or taxes on energy plants or *maquiladoras* who are culpable for much of the water contamination. Implementing this type of large-scale policy would likely take several years, but particularly focusing on cleaning up and preventing the water pollution will reduce public health hazards and allow Imperial Beach residents to enjoy their neighborhood beaches and natural parks.

Ultimately, policies like these mentioned and a variety of others will all contribute to reducing air emissions and water contamination in the Tijuana-San Diego border area. Not only

will policies help encourage a cleaner environment in general, but it will further improve the quality of life for people heavily impacted by this pollution. Though this may take multiple decades for these effects to be reduced and health impacts to be lessened, it is crucial to implement multiple policies as soon as possible to stop this pollution from worsening.

Conclusion and Policy Recommendations

The Tijuana-San Diego border is one of the most unique binational areas in the world. With similar geography and topography separated only by a man-made border, Tijuana and San Diego share the same airshed and watershed. Thus, environmental hazards produced on one side of the border often impacts communities on the other side of the border. Specifically, air emissions and water contamination contribute to some of the most harmful environmental health issues in the region.

A major source of air pollution in the border region is emissions from *maquiladoras* (factories) and energy plants on the Mexico side of the border. The majority of these facilities are contracted by companies from the U.S. and other countries because they can avoid strict labor laws and environmental regulations. As a result, *maquiladoras* and energy plants produce emissions that contain ozone, sulfur dioxide, nitrogen oxides, and particulate matter, all of which can cause harmful respiratory problems or other severe health impacts. People working in these facilities and neighborhoods around these facilities are the most impacted by these air emissions, but the pollution can travel far distances within the border region.

Another significant source of air pollution comes from the San Ysidro Port of Entry (POE), where 11.3 million vehicles and 7.6 million pedestrians cross through the POE each year (Quintana et al. 2018). While waiting to cross, these cars can wait up to multiple hours, idling

and emitting toxins such as black carbon, carbon monoxide, and particulate matter. Prolonged exposure to these pollutants can cause health consequences like asthma, other respiratory issues, and cancer. This air pollution impacts people in cars waiting to cross the border for a daily commute, pedestrians waiting for several hours in an adjacent line to the traffic, border employees, and the nearby community of San Ysidro in San Diego.

Besides air emissions, water contamination in the area additionally causes adverse environmental health outcomes. *Maquiladoras* in Tijuana often improperly dispose of hazardous waste which includes heavy metals and other dangerous toxic materials. During rainstorms, this waste flows into nearby neighborhoods and ends up in the Tijuana River. In addition, many households in Tijuana are not properly connected to the central sewage system, so untreated sewage flows into the river. The Tijuana River flows northwest so the majority of the hazardous waste and raw sewage culminates in the Tijuana River Estuary across the border and produces environmental health hazards in recreational parks and beaches.

Air pollution and water contamination in the Tijuana-San Diego border area specifically impact low-income communities and communities of color. The air pollution from the POE affects the nearby community of San Ysidro the most. San Ysidro is highly majority-minority and the median income is nearly half that of the rest of San Diego. Many residents may not have the means to move somewhere further away from the POE or the tools to advocate politically for better conditions. Further, the Tijuana River Estuary is directly next to the community of Imperial Beach, who are often unable to use beaches and parks because of heavy water contamination. This community is also majority-minority and has half the median income of the nearby neighborhood of Coronado. In Tijuana, the lowest income neighborhoods are also the closest neighborhoods to *maquiladoras* and their uncontrolled toxic waste sites, and the

communities most likely to not be connected to the main sewage system. Finally, migrants who are forced to stay in makeshift tent cities and shelters while they await seeking asylum in the U.S. are among the most vulnerable and most exposed to these negative environmental consequences.

Though I discussed many of the impacts of pollution in the Tijuana-San Diego area, there is still more research to be done. In the future, potential research frontiers could include studies on how climate change is exacerbating environmental health problems in the Tijuana-San Diego border region; how the environmental injustice experienced by the communities in this area is similar or different across the rest of the border region; and, how this pollution impacts temporary migrants in the long-term.

To mitigate the negative impacts of air and water pollution in the area, I offer three policy recommendations that could prevent and reduce the pollution in the area. First, air emissions standards for *maquiladoras* and energy plants in Mexico should be raised. These restrictions would not need to match the U.S., but be balanced between the costs in productivity due to employee health problems from emissions and the economic losses stricter emissions standards would produce. This would help reduce the amount of air emissions in the area and prevent health problems for nearby communities. Second, requiring smog checks for vehicles passing through the San Ysidro POE would ensure they are emitting as clean air as possible while idling and waiting to cross. These smog checks would be specifically required for cars older than 2000 that cross the border more than five times a year. Finally, creating a binational fund to identify and financially support various water management organizations would lessen the amount of pollutants in the water (Blackman et al. 2012). These organizations would ideally prioritize cleaning the Tijuana River Estuary and the surrounding beaches and parks and support fixing the

sewage system on the Mexico side of the border. The binational fund would assist in reducing the amount of water contamination and prevent future contamination from occurring.

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