

Where's the Justice?

A mixed-method spatial analysis to redefine opportunity index centering environmental justice principles to support organizing, planning, and decision making in the Imperial Valley.

A thesis submitted by

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Abstract

Imperial County, CA is home to environmental justice (EJ) communities, waterways impaired at critical levels, toxic sites that require remediation, and very poor air quality. Environmental justice literature and California planning tools, such as environmental justice case studies, point to a set of conditions that disproportionately impact communities based on their race, like hazardous waste exposure and low access to green spaces. Based on data from a spatial analysis and community survey, a weighted index map shows which communities have the greatest opportunity to implement EJ changes while redefining the traditional opportunity indices. This study explores the power of transparency, data sharing, and empowering communities to address inequities together. From the data, I conclude with a set of qualitative and quantitative recommendations at four different scales, from the county level to individual action. This approach aims to identify whether EJ elements are truly a guiding principle or simply check a policy box.

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The survey would not have reached its wide audience without the support of my partner, friends, family, and peers, and the local organizers and collaborating staff. Thank you to those who supported the translation of my survey to increase access to Spanish-speaking communities present in the Valley. Thank you to everyone who took the time to take my survey and an extra big thank you to those who were also able to share it with their wider networks. Your opinions are all so valuable and I hope to do you justice in this thesis. Everyone shared such beautiful visions of the future, so I hope we can get there together.

Thank you to my partner for supporting me during the complexities of life as a first-generation college student. This work was a reminder that advocacy efforts are not kind to the mind and body. Self-care and leaning on our communities become *essential* for sustaining the contributions and goals we aim to reach.

I want to thank myself for not giving up and give an even bigger thank you to the organizers, activists, and authors who have archived the important events of historically erased or underrepresented communities across the world. I could not have conducted any of this work without those archives.

Change is not easy work, but it is extremely important. I am forever grateful to the creatives who use their craft to make the revolution irresistible. Last, but absolutely far from least, thank you to Helen Snively for editing this paper to clarify my story and analysis.

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List of Abbreviations

Acronym	Full Name
ACS	American Community Survey
ADUs	Accessory Dwelling Units
AHP	Analytic Hierarchy Process
ATP	Active Transportation Plan
CA	California
CalEPA	California Environmental Protection Agency
CDC	Center for Disease Control and Prevention
CV	Coachella Valley
CVAG	Coachella Valley Association of Governments
EJ	Environmental Justice
EYA	Environmental Youth Group Alliance
FEMA	Federal Emergency Management Agency
GHG	Green House Gas
GIS	Geographic Information System
IV	Imperial Valley
LCI	CA Governor's Office of Land Use and Climate Innovation
LUPA	Land Use Planning Awareness
MLK Jr.	Martin Luther King Jr.
NAD	North American Datum
NECAG	North Eastern Community Action Group
OPR	Governor's Office of Planning and Research (changed July 1st, 2024 to LCI)
PCBs	Polychlorinated Biphenyls
PCR	People for Community Recovery
PM	Particulate Matter
RUHS-PH	Riverside University Health System - Public Health
SB	Senate Bill
SDSU	San Diego State University
STEM	Science Technology Engineering Math
US	United States
WGS	World Geodetic System

Part 1: Laying the Foundation

Introduction & Background

Communities of color in California have experienced many instances of racial discrimination in policy and planning practices, ranging from proximity to **hazardous waste sites**¹ all the way to disruption of **cultural practices** and land theft.² The systematic racism dates back well before 1968 when Memphis, along with the world, saw Dr. Martin Luther King Jr. striking for **better wages** and **improved working conditions** for Black garbage workers. The “Boarding School Tragedy” of the mid-1800s³ is still not the very beginning, because stories found in archives are often told from the dominating perspective and erasure is a tool for perpetuating control. The United States went on to witness disputes over waste sites in states like Texas and North Carolina that had been disproportionately placed in communities of color, regardless of the individuals’ household income (Bullard, 2001). Even after statistical studies showed that race was a defining variable in the location of hazardous waste sites, municipalities left the work up to organizers to craft the idea, and eventually the framework, of *Environmental Justice* (Bullard, 2001). After the first *National People of Color Environmental Leadership Summit* in 1991, seventeen “Principles of Environmental Justice” were adopted, and the network of passionate advocates grew. However, environmental racism persists, and many policies and planning documents do not align with these learnings. Zoning, land use, and other tools of urban planning have allowed tactics rooted in white supremacy to continue influencing how communities create space and grow, or in some cases, diminish because of a new highway or landfill. Terminology can also have a large influence; for example “food deserts” downplay the gravity of situations that did not happen by accident⁴. Food apartheid might explain

¹Bullard, “Environmental Justice in the 21st Century.”

²Kimmerer, *Braiding Sweetgrass* | Milkweed Editions.

³“Chapter 3: Boarding Schools | Native Words, Native Warriors”

⁴Cook, “Covering Food Deserts | USC Center for Health Journalism.”

how lack of local access to grocery stores and parks is not a “natural phenomenon,” but instead reflects intentional moves within a racially driven system.⁵

I chose to look further at opportunity indices because they can be used in creating statistical systems to rate complex and difficult-to-measure variables within communities based on their ability to succeed when rated on factors that include the words “economic,” “educational,” and “health.” A traditional opportunity index is a beneficial tool for identifying existing resources and accessing development risk while using a multidimensional approach. However, the detriments far outweigh those benefits. The traditional form of this tool perpetuates inequalities and amplifies stigmas but communicates a biased definition of value to existing places and communities.

This kind of tool can create a positive, or reinforcing, feedback loop. In this thinking, communities who historically received more investment or were given preference are seen as having greater opportunity to successfully implement better levels of such services. On the other hand, communities that historically faced underinvestment or racial discrimination through redlining or other tactics are seen as low opportunity and are rated with lower values for their ability to successfully implement introduced change. If we continue to disregard communities with “low opportunity”, then investors are blatantly missing out on the truest existing opportunity: an opportunity to intervene and create change in these places where real people live.

Although States do not enforce the use of opportunity indices in their planning process, 2018 California lawmakers passed Senate Bill 1000, an act to amend Section 65302 to improve Comprehensive Planning through public engagement, require more detailed acknowledgment of disadvantaged communities and implement an Environmental Justice (EJ) element. This thesis focuses on the communities located within the Imperial Valley of Southern California and how we can utilize a justice index to support the implementation of this newer planning requirement. This

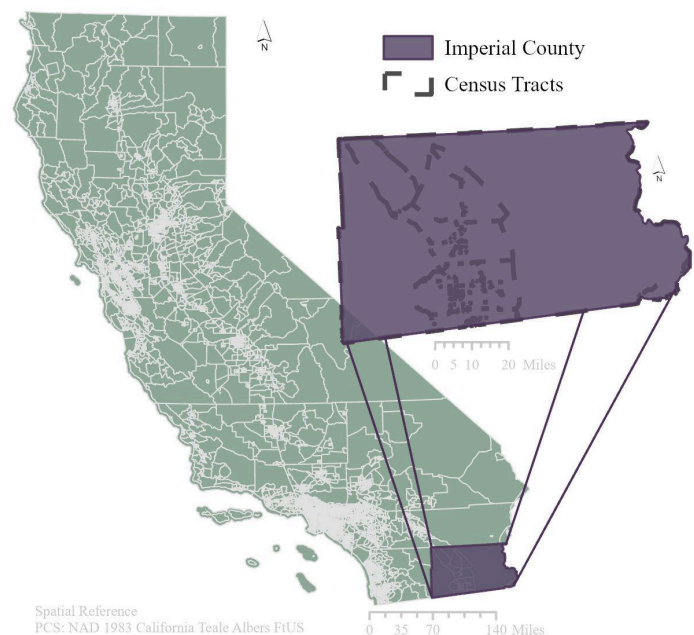
⁵Agyeman, “How Urban Planning and Housing Policy Helped Create ‘Food Apartheid’ in US Cities.”

study uses a literature review, spatial analysis, a review of administrative documents, and a survey, all in an effort to create a template for organizers and planners to produce recommendations to effectively implement environmental justice plans.

The Community

Imperial County, often referred to as the Imperial Valley (IV) or the Valley, was the last county established in California in 1907. According to a feature in *Nature Valley*, “Much of modern Imperial County was ocean floor, as evidenced by the fossilized remains of over 200 different marine invertebrate species unearthed in the Fish Creek area and in the Coyote Mountains.” In 1901, before the Colorado River brought water to the 500,000 acres of fertile clay soils,⁶ It was a desolate space. Today, this county has a Naval Air Facility, seven cities, and eight unincorporated communities. Imperial County is home to approximately 180,000 residents over 4,400 square miles, making it the 10th largest county in California by area⁷ with 93.2% land and 6.8% water⁸. According to the 2024 Census QuickFacts 86.3% of residents are of Hispanic origin.

Figure 1: Imperial County in reference to California



According to 2023 ACS Census data, 36.2% of California residents are high school graduates, and 13.1% have a bachelor’s degree or higher. All but 8.7% of California residents 25 years or older have attained a 9th grade education level. These numbers are different in Imperial County. There, 31% of

⁶ Moss and Van Der Pas, “The Imperial Valley in 1904.”

⁷ Imperial County Administration Center, “Home.”

⁸ ACS 5-Year Estimates, “Social Explorer.”

residents are high school graduates and only 7.9% have a bachelor's degree or higher. The percentage of those with less than 9th grade education aged 25 and older is almost double at 14.6% for Imperial County. Compared to the United States, where only 4.6% of people 25 and older have less than 9th grade education, California has a lot of work to do around **education justice**. Looking at income, the median household income for California is \$95,521 but only \$60,243 for Imperial County. The differences are evident within households and for individuals, but the comparison must also be made at a city and county level.

According to the 2023 ACS 5-year survey, Imperial County has a density of 42.9 residents per square mile, compared to the California state average of 251.8. This mix of suburban and rural development offers great opportunities for future land use planning and preservation. Zooming into some of the cities in the Imperial Valley, we see that for larger cities like El Centro and Calexico the density per square mile is 3,646.6 and 4,544.6 residents, compared to places like Ocotillo with only 17.7 residents.

Between 2010 and 2023, California's population increased by 7% and that in the Imperial Valley by 6.7%. However, looking more deeply, we see that areas like El Centro experienced a 69% population increase during those 13 years while areas like Calipatria-Westmorland saw a 29.4% decrease and Winterhaven-Bard saw almost 47% decrease. Today, 75% of the households in the Imperial County are "Family Households"; 49% of these include a married couple, and 18.4% are female householders with no husband present. California has seen a 76.% increase in "Family Households" while Imperial County has seen a 3.8% decrease. However, when we zoom in to the cities and towns, we see El Centro has seen a 37% increase and Calexico a 10% decrease.

According to the 2023 5-Year ACS survey, the average household size is 3.5 people, with 37% of households having 4 or more people in their home⁹. Comparatively, California has an average of 2.9 people per household with only 28.8% having 4 or more people per household.

It can be very difficult to find recent high-quality data on asthma prevalence in Imperial County. Many studies have shown an association between asthma rates and air quality. Looking more closely at local air quality, a 2025 American Lung Association calculator study gave Imperial County an “F” for Daily and Annual Ozone Particle Pollution levels.¹⁰ The 2019-2020 California Asthma Dashboard data shows that 15.9% of the total population suffer from asthma with more ending up hospitalized or dying compared to overall California rates.¹¹

Given that the area is a valley, conditions such as agricultural burning and the Salton Sea trap toxic chemicals in our air, soil, and waters, disproportionately impacting the health of its residents; meanwhile 90% of US residents get their winter vegetables from this land.

Land in the Imperial Valley, and the surrounding land of San Diego County, was home to the Quechan, Cahuilla, Cocopah, Kumeyaay, and Pai Pai people for many generations before settlers came¹² but their history has not been thoroughly archived, shared, or uplifted.

The History of Planning in the Imperial Valley

General Plans are comprehensive plans required for all municipalities in California. After I reviewed a few, a gap became glaringly evident. First, the environmental justice sections of the plans for larger cities like San Diego and Sacramento are comparably larger, containing over 100 pages of measurable action items with opportunities for evaluation and monitoring. However, in the plans for municipalities in the Imperial Valley, the EJ elements vary from 19 pages to only 2 sentences; some

⁹ACS 5-Year Estimates, “Social Explorer.”

¹⁰American Lung Association, “California: Imperial.”

¹¹Health, “California Department of Public Health.”

¹²Scarlet, “Sustaining the Humanities in California’s Imperial Valley.”

have none at all. According to SB 1000 Section 65302, cities and counties with disadvantaged communities must include environmental justice (EJ) policies “either through a separate EJ element or by integrating related goals, policies, and objectives throughout the other elements upon the adoption or next revision of two or more elements concurrently.” (OPR 2020, chap. 4). This amendment is only enforceable to any adoption or revision **of two or more elements on or after January 1st 2018**. This means a city or town is not required to create an EJ element unless they change or create more than one section of their General Plan. This has proven to be a loophole for many municipalities given the lack of requirements to update elements, only patterns and recommendations to update the housing element every 10 to 15 years.

California’s Attorney General is working to comment on municipal plans and is conducting enforcement actions at the local level to promote *effective* and *equitable* environmental justice planning¹³. These comments and actions began in 2018, but to this day, not a single comment has been made on any plan from a city within Imperial County. I find this surprising because, unlike San Diego and Sacramento—which have received comments—the cities within Imperial County do not have over a hundred pages of clearly defined goals and action items. There is no length requirement, but the specific language of the plans for Imperial County municipalities raises further concerns. We see sentences like “Due to the broad and interdisciplinary nature of environmental justice issues, this element directly relates to each of the other General Plan elements.” It is hard to imagine how environmental justice directly relates to housing or transportation in this community with that sentence alone, or what the planners and policy makers suggest doing about it. We also see policy goals like “Distribute public information in a variety of formats to reach a wide range of residents, modifying communication methods as technology and practice changes over time.” The policy does not define “variety of formats”, “wide range”, or “over time”.

¹³“Environmental Justice | State of California - Department of Justice - Office of the Attorney General.”

This variability is the first of many deficiencies that clearly demonstrate the lack of resources and capacity available when drafting Environmental Justice Elements for a city or town's General Plan. Though many of these plans are "compliant", **these documents need to be updated, and they must eliminate arbitrary goals, incorporate evaluation and monitoring, and increase alignment with the 17 environmental justice principles.** The County of San Diego recently released a new Environmental Justice Element (2024), a step that could motivate surrounding counties, like the Imperial Valley, to follow suit.

Personal Statement

This work has a personal connection for me. I grew up as a mixed-race girl, watching fields burn and wondering what was next, knowing the entire field would be covered in a single crop again very soon. We normalized breathing in tiny black combustibles and watched the smoke drift upwards before ultimately going sideways. We normalized the lack of green space, making jokes about the other side of the tracks, our single park, and how it is too hot to play outside anyway. Teachers were upset that students kicked up so much dirt during recess, but dirt was all we had to play in. Grocery stores are not within walking distance, public meetings are rarely accessible, toxic waste exists within our communities, and public transportation is non-existent. I grew up wondering what trees with big shade would feel like, what clear water could teach me, how my skin color might be the reason I have asthma, and wondering who made the decisions to build another big box store in the wake of a lost one. I also grew up ready to leave. I did not want to stay in a homogenous and stagnant community that had one green park, high asthma rates, and virtually no access to quality health care and grocery stores. However, my family continues to find joy in this geographical desert, along with 180,000 others. After becoming a first-generation college graduate, I began to understand how the education system and news outlets created this mirage of a self-sustaining community that "feeds the country". However, we do not create enough space to talk about what is missing, and how we can fix

it. I am passionate about comprehensive planning and states, like California, that require their municipalities to be intentional in their decision-making process – or at least that’s the claim.

According to the California Environmental Protection Agency, “California was one of the first states in the nation to codify environmental justice in statute.”¹⁴ California has made great strides in climate related issues—and continues to—but is it enough to simply pass a statute? I want to focus on the variability evident in the Environmental Justice Plans for the cities within the Imperial Valley in alignment with the 17 principles of Environmental Justice.

The main goal of my work is to face our injustices straight on and acknowledge our mistakes so we can map the best places to take the next step. As residents become more empowered with knowledge and opportunity, they begin to become more aware of the inequities around them. My hope is that this project will allow Imperial County to get ahead of the civil conflicts, by providing site analysis tools, real solutions, and tangible plans.

¹⁴ CalEPA, “Environmental Justice Program | CalEPA,” accessed October 27, 2024

Literature Review

The search began with the keywords below, and continued through articles that cited *Race and Environmental Justice in the United States* by Robert D. Bullard. Through my readings, I continued to explore the references cited in each paper along with those by Laura Pulido, Carl Anthony, Manuel Pastor, Dorceta Taylor, and Naomi Klein. Many of the papers proved helpful as they applied a previous framework to modern ideas and challenges.

First Set of Key Words used in Literature Search

“Environmental Justice”	“GIS method”	“Indigenous”
“Asthma”	“Spatial analysis”	“Natural Planning”
“Community Engagement”	“SB 1000”	“Robert Bullard”
“EJ Communities”	“Public Health”	“General Plan”

Environmental Racism and Justice

Environmental Justice is not a new concept, but it is a newer term that pulls from historical movements in the United States that work for social and environmental justice. It originated among grassroots organizers who created a collective network to advocate for their right to protected environments and economic justice. Robert Bullard has created archives that allow readers to see and understand the earlier conflicts that catapulted the Environmental Justice movement, but the journey started even earlier than that.

Dr. Martin Luther King Jr. went on strike in Memphis in 1968 for the Black garbage workers who demanded equal pay and improved work conditions. The Black community of garbage workers, and allies who stood in solidarity, decided to strike. Unfortunately, Dr. King was assassinated before any of the issues were addressed. In a 1979 Houston case African-American homeowners opposed the

development of a sanitary landfill in their middle-class suburban neighborhood. This effort immediately called out the disparities between races even in middle-income and wealthier neighborhoods. In Houston, the community responded by creating of NECAG, the Northeast Community Action Group, a collection of residents that took the Southwestern Waste Management Incorporation to court. NECAG's attorney, Linda McKeever Bullard, is the wife of the archive creator, Robert Bullard. It would be helpful to know more about the nature of their relationship and potential bias or motivations behind their work. A blog post from the Clean Air Council describes how the Bullards clearly collaborated in the Houston case.

In 1982, residents in Warren County, North Carolina protested against a PCB landfill; this is arguably the one conflict where the Bullards had the most influence. These protests resulted in over 500 arrests, but also led Bullard and others to begin the study on *Siting of Hazardous Waste Landfills and Their Correlation with Racial and Economic Status of Surrounding Communities*. The study was the first to “scientifically” reveal that 75% of hazardous waste landfills were located in communities with large African-American populations, even though African-Americans only made up about 20% of the local population. However, this data has not been enough to change the minds or actions of decision makers today, which leads me to wonder, is this where organizing comes in?

Organizations like the *Black Girl Environmentalist* and *People for Community Recovery* (PCR) continue to highlight powerful contributors to the environmental justice movement, like **Hazel M. Johnson**. Johnson is viewed as “the mother of environmental justice” for identifying “The Toxic Donut” after her husband died from lung cancer. She rapidly identified how her community, like many others with Black residents, was surrounded by high emitting factories and toxic landfills. She began by demanding accountability from the Chicago Housing Authority and major polluters, then increased her efforts at engagement, and started the PCR committee. This collective action brought attention to the movement; ultimately the EPA supported it in getting legislation passed. After he

found her platform and identified the power in advocacy work, she continued to fight to support other communities living in disproportionately polluted spaces. Some of her most powerful efforts include mentoring the next generation. Her contributions equipped youth with the knowledge and tools to become environmental justice advocates—including prominent leaders like “a young Barack Obama”. Hazel Johnson attended “the first National People of Color Environmental Leadership Summit where she was dubbed the ‘Mother of the Environmental Justice Movement.’”¹⁵

...and proof that any person with enough resolve can hold institutions accountable for environmental injustice.

Black Girl Environmentalist Website Accessed January 2025.

Public Health Literature

California communities are not experiencing the same pollution burdens as those in other states (CalEPA 2023). Some communities are experiencing pollution burdens in the 90th percentile, while their populations are only a fraction of those in cities with far lower burdens. Racial disparities are evident here, and several tools and perspectives can help quantify them. First, the CalEnviroScreen tool visually demonstrates these health impacts in a spatial way (Cushing et al. 2015). Second, the new framework of environmental justice offers insights into the intersections of public health and social inequities (Morello-Frosch et al. 2002). Third, air quality is a crucial variable in public health, and climate change continues to exacerbate existing challenges. Anderson et al. (2018) explore the impacts of air pollution sources and climate change mitigation policies on disadvantaged communities¹⁶. Cook, Argenio, and Lovinsky-Desire (2021) found that communities of color and people living in poverty are at higher risk for asthma and other allergic diseases.¹⁷ The Imperial Valley’s economy is predominantly driven by agriculture, and a 2015 journal explores the impacts of

¹⁵People for Community Recovery, “Hazel M. Johnson’s Legacy” Accessed January 9th, 2025

¹⁶Anderson et al., “Climate Change Mitigation, Air Pollution, and Environmental Justice in California.”

¹⁷Cook, Argenio, and Lovinsky-Desir, “The Impact of Environmental Injustice and Social Determinants of Health on the Role of Air Pollution in Asthma and Allergic Disease in the United States.”

pesticide exposure on childhood asthma and the disparities that Mexican-American farmworkers face (Schwartz et al. 2015).

One issue here is hazardous waste sites; approximately 21 million people live within one mile of a Superfund site, and adverse health effects can impact the lives of those who live within a 1.8 mile boundary. Across all US states, Black residents are 75% more likely to be living near or directly next to a hazardous waste site. The toxins released directly impact water, air, and soil quality, with “detrimental community health consequences”.¹⁸ Long-term impacts include irregular menstruation, birth impacts, allergies, diabetes, high blood pressure, and even cancer. Climate change is intensifying and destabilizing waste sites, increasing the risk from exposure.

Looking back in time

Major concerns around health issues can be dated back even before formalized systems of policy and planning in the United States. European settlers introduced diseases and trade that devastated Indigenous populations. Histories of the French and Indian War, along with diaries by the Pilgrims, provide a new perspective on disease and illness as a tool to marginalize, weaken, and disrupt communities. Naomi Klein uses quotes from Pilgrims’ diaries to raise awareness about the prejudice and approach invaders had on existing communities, which we continue to see play out today. Language like “divine gift from God” showed how this new disease “allowed” for the clearing of native people and increased the land available for settlement. However, the spread of smallpox, whether intentional or not, is just a small element of the true disruption to health and cultural practices.

¹⁸Taylor, “Millions of Americans Live Near Toxic Waste Sites. How Does This Affect Their Health?”

Food systems

During the 1600s and 1700s, Native Americans lost not only homes, but also crop fields to forced burning and other destruction by settlers. Entire communities were forced to leave their homes and familiar land and move to places with less access to resources, such as fertile soils and water bodies. Agriculture is still a major concern for rural and communities of color. Unnatural farming techniques, including monoculture, have complex impacts on human health and the environment.¹⁹ A 2015 World Economic publication explores how the lack of diversity in our growing techniques can be disastrous for local ecology and increase the risk of rapidly losing crops or livestock through diseases which can ultimately spread to people through diet and consumption.

Concerns around public health and agriculture continue to rise as studies anticipate that an increase in productivity from 50% to 70% will be required to feed the expected population of 2050.²⁰ A 2024 report exploring Environmental Justice in California General Plans identified policies focused on health through access to resources and exposure to toxins. Healthy foods and water quality were two major factors that contributed to the physical and mental health of residents.²¹ However, Vallejo was the only city to address “food deserts” as a concern priority. Many farmworkers and local wildlife are disproportionately exposed to harmful pesticides in rural or agriculture-dominated communities. Some health policies focus on reducing pesticides and herbicides, sometimes in combination with sustainable alternatives and techniques to protect sensitive land and communities.

Today, we continue to see many ways that public health is disproportionately disrupted for agricultural and low-income communities. According to a 2021 study, livestock can provide mental and physical health benefits from and through sustainable systems, in fact contributing to 12 of the 17 Sustainable Development goals, while enhancing reciprocity between environmental, livestock,

¹⁹Saunders, “How Single-Crop Farming Is Harming Wildlife.”

²⁰Alders et al., “Livestock across the World: Diverse Animal Species with Complex Roles in Human Societies and Ecosystem Services.”

²¹Brinkley and Wagner, “Who Is Planning for Environmental Justice—and How?”

and human health and well-being.²² Healthy eating is always a priority, but why are we allowing large populations to be impacted by decades old farming practices?

Why does the problem persist?

Inequality is not an economic necessity, it is a design failure.

Kate Raworth, Doughnut Economics

Cross Border Issues

Although this work is focused in California, it is important to think on a broader geographic scale and consider other histories from our neighbors. Right on the southern side of the border, we see Mexico experiencing water flow issues from the Colorado River. Seven US states, 30 tribes, and parts of Northern Mexico are dependent on Colorado River water for their municipal, industrial, agricultural, and ecological uses, among other needs. As of 2022, 1,278 other “named watercourses” make up a combined total of 43,811 miles of streams within the basin area.²³ Starting in the Rocky Mountains National Park, this river stretches over 1,400 miles until it ends in the Gulf of California in Mexico. At least, that’s what should occur naturally. A formal treaty was found in 1944, apportioning 1.5 million acre-feet of water, which was about 10% of the annual flow, but Mexico has never received the agreed upon amount. As of today, less than 1% reaches the end and the river in Mexico, and every year, Mexico experiences unpredictable flows with decreases fluctuating from 2-7% annually. Moreover, Tribal communities who live on the river basin have been left out of the planning and policy conversations.²⁴ This is an example of how policy and human actions in one location can impact those in other areas.

²²Alders et al., “Livestock across the World: Diverse Animal Species with Complex Roles in Human Societies and Ecosystem Services.”

²³Louis Wertz, “The Colorado River Basin, by the Numbers,” August 5, 2022

²⁴Richter et al., “New Water Accounting Reveals Why the Colorado River No Longer Reaches the Sea.”

Power and Takings

Urban planning and regulatory action has been used as a tool to perpetuate white supremacy values like land takings, redlining, racially-driven siting²⁵ and the control of water flow. As the influence of white culture grew, governments implemented additional techniques rooted in prejudice ideals. It started with sending Native children to boarding schools that could erase memories of ancestors, traditions, and languages.²⁶ This was the origin of using citizenship as leverage or a scare tactic. Although governments today are less transparent in their discrimination, redevelopment agencies have a lot of work to undo. Tools like inclusionary zoning can help reverse the racist planning of earlier times, but municipalities need capacity support and explicit language to improve the regulations that allowed discriminatory planning. Environmental equity can exist in city planning, but we need to take a few steps back and to first identify some underlying problems.²⁷

The Free Market and Crises

Another factor that perpetuates injustice is ideologies like Milton Friedman's economic theories and Capitalism. In 2007, Naomi Klein published *The Shock Doctrine: The Rise of Disaster Capitalism*. Her 2009 tour to promote the book is the source of much of the following information. She shared a recently published study that found that "Conservative" people are generally happier because "they are better able to feel fine, when faced with the not fine"(Klein, 2009). The researchers attempted to measure "the ability to rationalize inequality and blatant unfairness". Klein goes on to share 2 real questions the researchers used as "Rationalization measures" to determine happiness levels and rationalization.

Question 1: "It is not really that big a problem if some people have more of a chance than others in life"

Question 2: "This country would be better off if we worry about less about how equal people are"

²⁵Agyeman, "Urban Planning as a Tool of White Supremacy – the Other Lesson from Minneapolis."

²⁶Kimmerer, *Braiding Sweetgrass* | Milkweed Editions.

²⁷Feitelson, "Environmental Equity."

The study raised new thoughts about the free market as a trick to encourage people to “[do] the bidding of the wealthy” while convincing the general public that profits are for everyone. Klein explores how our existing economic models focus on the “limitless quest for growth” without incorporating tools that address ethics, inequality, and impacts to our planet. Many ideologies for a free-market society create an “anti-anxiety remedy for the nagging conscience” or even a “mass tranquilizer” to make determinations of worth and “deserving” a little easier.

Additionally, Klein explores how deceptive tactics have proven to be most successful “in the midst of a crisis, [or] in the aftermath of a shock.” Latin America in the 1970s saw military coups. In the 1980s China experienced a massive debt crisis. Crisis and shock have been seen everywhere from places like Iraq, and Argentina, to New Orleans, and beyond. People have less capacity to argue or question power in the middle of a crisis. It is easier to keep moving and follow the lead of those in power, even if their priorities are on profit over universal health care or affordable housing.

Privatizing Public Amenities

We continue to see broken systems that perpetuate environmental injustice in ways that were originally meant to support communities. One example is private firefighters. Klein explored this in the early 2000s but we saw the impact yet again in the Los Angeles fires of late 2024 into early 2025. Private insurance companies use such services to offer premium rates to receive fire retardant, cleaning member access, and emergency services. Laurel Wamsley from NPR asked an ethics expert about the ability to allow the “rich and powerful to be insulated from what’s happening”. There is “no easy answer”, but it is clear that climate change can impact lives differently based on wealth and knowledge, to which some communities clearly have greater access .

Klein also talks through how New Orleans became a perfect example of public to private in the early 2000s. This city with radical history had “some of the best public housing”, including units that were

left standing after the hurricane. Klein found that in 2009, 5000 affordable housing units, originally occupied predominantly by African Americans, were demolished to rebuild market-rate condos. Not only were homes lost, but many public schools were destroyed and/or converted into a mix of private and public charter schools. Before the hurricane, New Orleans had seven charter schools; when Klein spoke in 2009 there were 40. As of 2020, 83 of the 86 public schools in New Orleans are charter schools. These schools are publicly funded, but run independently from the school boards. Although graduation and learning rates may be increasing, it can be very misleading and result in unethical approaches such as admitting high-testing students and refusing to support low-performing ones.²⁸

The racism, inequities, and privatization can be disguised by using code words like the need for “smaller” and “safer” communities and infrastructure while investing in white neighborhoods, market-rate housing, or privately run schools. Richard Baker, a Republican who was in the House of Representatives for 21 years was heard saying, “We finally cleaned out the public housing in New Orleans. We couldn't do it, but God could”. Ironically, actions like fracking or other impacts to our core can influence environmental disasters that disproportionately harm the communities of color.

Technology and Tools

Advances in technology and access to the internet have contributed to barriers and access in different ways. A 2001 study identified the rapid growth of web-based databases and GIS tools for community mapping, environmental justice, and public analysis. Although our current (2025) administration is removing funding or capacity for EPA tools, programs like Toxic Release Information (TRI) for TRI facilities and National Drinking Water Contaminant Occurrence Databases are forms of web-based mapping applications that generate maps on demand through a warehouse updated by experienced professionals. Accuracy of data has improved over time with new statistical tools to interpolate or increased funding to add more monitoring devices. Interactive online mapping tools can overlay

²⁸Improvement, “Charter Schools in New Orleans – A Byproduct from Hurricane Katrina.”

layers based on local missions and provide access to EPA's spatial information for community members with less knowledge on creating the tool; thus the tool meets an equity agenda. Lui (2001) finds that spatial data is particularly useful when overlaid with ZIP codes or demographic information that make community-based equity analysis useful and informative. Creating maps can transform huge amounts of data into an accessible and *accurate* tool for identifying problems and setting goals at different scales, from federal all the way to block groups or individual parcels.²⁹ Visualizing spatial data as a map with attributes is complex but deep analysis allows developers to make tools such as the Environmental Justice Scorecard. "Scorecard uses risk assessment methodology, which Lui (2001) discusses in Chapter 4 to estimate the potential health risk associated with outdoor exposures to hazardous air pollutants." Evaluation and prevention are two valuable strategies lacking in current EJ policy and planning, so we must utilize what is known of spatial association to identify current and future problems in our EJ communities.

Thinking about Policy and Planning

Ecological degradation is simply the result of degenerative industrial design. This century needs economic thinking that unleashes regenerative design in order to create a circular, not linear, economy, and to restore humans as full participants in earth's cyclic processes of life.
Kate Raworth, Doughnut Economics

To analyze and address the overlap of urban planning and health equity, a useful approach is an intersection framework, one that focuses on social and environmental justice.³⁰ Williams (2023) touches on the importance of collaboration in re-organizing, acknowledging, and committing, but has not explained how existing policies and permitting regulations require, or even create, the needed space for these steps to occur.

Much of the discrimination began and has been perpetuated within policy and planning practices that involve "unjust land use", "intentionally disrupted tribal culture", "dismantled tribes' relationship

²⁹Lui, "Trends and Conclusions."

³⁰Williams et al., "Urban Planning for Health Equity Must Employ an Intersectionality Framework."

with the land”, and much more.³¹ “Capability-promoting policies” respond to urban fragmentation and can support the distribution of opportunities.³²

According to Klein, a broad collective response to unjust action can come directly from a change to policy and technological investments that can change our way of life or “get us off this disastrous course”. An alternative, which we see often, is changing policies and technology to protect individuals from those they have wronged, something we see political office holders doing actively in 2025. Additionally, our response to climate change is currently following this second option and continuing to leave the wrong unchallenged.

Though this knowledge can feel overwhelming and solutions feel intangible, there are options for moving past the history of wrongdoing, and into a policy future that considers communities of color to be valuable members of our society. Existing economic policies and institutions are clearly failing our communities of color or of immigrant origin. Communities can be recentered when their processes allow for accessible community engagement, organizing, and decision making.

Cultural planning, social movements, and activism raise awareness and allow people to make discriminatory and unjust strategies a tactic of the past. Organizers can continue to share strategies about post-disaster rebuilding, collective action, and engagement with governing boards. Both Klein and Kimmerer examine how our language and framing of urgency can be a powerful tool in policy and planning. If communities begin to connect with the planet and build stewardship, then maybe that action can lead communities to better understand how those in power can do disproportionate harm to people of color.

When we can see sweetgrass as a species that needs us to thrive, or carbon emissions as an ecological debt, then the sacred relationship with the natural world can shift towards one of interdependence,

³¹Governor's Office of Planning and Research, “General Plan Guidelines - Chapter 4: Required Elements. 4.8 Environmental Justice Element.”

³²Otto, Walker, and Ziegler, *Capability-Promoting Policies*.

“free from ecological destruction”. As Klein said in 2009, “We have to break this cycle by... We need to refine old narratives”, and that starts with guidelines for how to grow as a city or town.

A 2024 journal article by Catherine Brinkley and Jenny Wagner examined how planning initiatives utilize environmental justice requirements and frameworks to create California General Plan elements. They examined 628 EJ policies across seven unique city plans. Land use is a major factor; its long-lasting outcomes affect social and environmental determinants of health in a spatial way. For example, the siting of hazardous waste sites continue to have impacts on land values, aesthetics, and the health and safety of local residents.³³ “One in six Americans lives within three miles of a toxic waste site...” and the Black residents who live near or directly next to hazardous waste sites are in greatest need of policy changes that decrease or limit future development of these sites.³⁴

Engaging the right people

Davis Schlosberg in 2007 said, “The environmental justice moment can be unified but it cannot be uniform”. Activists like Schlosberg and researchers like Rachel Carson have clearly pointed out that health equity and land use tools can take “multiple forms” without omitting the historic patterns of intentional oppression. Environmental Justice principles influence change in ways that acknowledge past impacts, undo associated harms, and prevent future discrimination or oppression toward communities of color. When these principles were drafted, climate change and multinational corporations were viewed differently than they are today. Brinkley looks at communities who are exposed to extreme weather, like New Orleans, and clearly identifies how environmental justice has moved past issues like hazardous waste siting and social activism into Black communities that have faced devastating floods, wildfires, and more.

³³Brinkley and Wagner, “Who Is Planning for Environmental Justice—and How?”

³⁴Taylor, “Millions of Americans Live Near Toxic Waste Sites. How Does This Affect Their Health?”

Accessible community engagement and design equity become crucial tools for ensuring that disadvantaged communities have power over the process. Brinkley and Wagner (2024) found that a plan's alignment with EJ theory through representation and procedure did not consistently result in an acknowledgement of or respect for difference which can ultimately increase access to environmental decision-making processes. Even communities with a majority BIPOC population prioritize language like “health equity” over explicit reference to race and historical oppression.³⁵ The focus on food systems is one approach to acknowledging disparities through access, hunger, and “diet-related health” that cities and towns can utilize.

Optimizing each General Plan Element

Land use is one element of the California General Plan requirements which must be vertically and horizontally aligned with the other policies, plans, and elements. Only 33 of 77 US cities had sustainability plans, and only five of the 33 actually discuss EJ as a component to sustainability. Reflecting on accountability and review, Brinkley found that only 16 plan evaluations occurred from 1997 to 2007 and still no thorough qualitative coding method or central database has been developed, making future evaluation extremely difficult and time-consuming and allowing plenty of room for error. However, Brinkley did find that the top 20 cities with “EJ content” engaged in EJ networks, showing the impact of larger support systems.

Looking more closely at the actual plans, Brinkley found that the following words were used often in tandem: *health, justice, food, obesity, diabetes, wellness, asthma, hospitalization, nutrition, positional, linguistic, stroke, tobacco, and school based*. Of the 58 counties in California, 13 mention “environmental justice” in their general plans and a sample of those plans showed that 10 of 12 focus on people while 2 focus on place. ***Housing, circulation, and land use make up 51% of the EJ content*** focus, making these elements optimal opportunities for future implementation of the EJ

³⁵Brinkley and Wagner, “Who Is Planning for Environmental Justice—and How?”

principles and framework. Within these elements, additional amenities like parks, childcare, libraries, affordable housing, mixed-use development, open space and access to public facilities were popular. However, they fail to thoroughly acknowledge race as much as they do age and physical vulnerabilities. The one exception, Coachella, explicitly considers non-English speaking groups.

The implementation of mandates, penalties, and incentives that encourage municipalities to incorporate EJ principles has proven to be important for states and counties. The state still does not review these documents or provide adequate funding. This fact, paired with the isolated situation in which each city or town drafts its own elements, is a result of California's "framework where cities can continue to meet EJ requirements without explicitly addressing racial equity,"³⁶

Putting Money in the Right Place

The funding that does exist, like the Active Transportation Program only, requires that 25% of the funding is used to benefit disadvantaged communities—and only 25% of that funding has to be used inside an EJ communities boundary. Over the past few years, Brinkley determined that federal and state policies were increasingly incorporating EJ principles into required plans and assessments, but the 2025 administration is rapidly pulling funding and destroying this momentum.

Major Gaps

Looking at Brinkley and Wagner's work, it can be hard to imagine what impact the federal and state government changes in the current (2025) administration will have on the ability for towns and cities to utilize EJ principles while receiving the funding and technical support they need. Additionally, Brinkley and Wagner focused on a required planning state, California; what does this mean for cities and towns within California with drastically different demographics than the state's average? How

³⁶Brinkley and Wagner, "Who Is Planning for Environmental Justice—and How?"

might they differ in their ability to utilize the suggested recommendations? Moreover, in order to identify resilience and its relationship to Black low-income communities that have been displaced from climate disasters, Brinkley and Wagner (2024) look at social vulnerability and the recovery capability of FEMA communities. However, FEMA utilizes very outdated information and social vulnerability can be a subjective tool that focuses more on income than race, which other studies have shown can have a less significant impact .

Brinkley and Wagners study involved a statistical analysis of plans with the “greatest amount of the EJ topic”. Although they made specific efforts to diversify geographically and remove general terminology not associated with action, the lack of race and random selection increased biases. This study also focused on the intentions and identification of good policies or plans, but did little evaluation or monitoring to explore the outcome of each commitment and the effectiveness of these policies and plans.

It is an intertwining of science, spirit, and story - old stories and new ones that can be medicine for our broken relationship with the earth, a pharmacopeia of healing stories that allow us to imagine a different relationship, in which people and land are good medicine for each other.

Robin Kimmerer, Braiding Sweetgrass Preface

Research Questions

This literature, combined with my understanding of the background and history of the Imperial Valley, led to three research questions.

Main Question: How can Environmental Justice principles be incorporated into an opportunity index to create a spatial tool for planning in the Imperial Valley towns and cities?

Sub-Questions:

- *What factors do EJ literature and the EJ principles say are most relevant to our communities?*

- *What is a meaningful way to determine each factor's weight in a final analysis?*

In this study I aim to create a spatial tool to support cities and towns in writing measurable action-oriented policies that include monitoring and evaluation for their General Plan elements.

Methodology

In this thesis I used a range of methodologies to better answer my research questions. I use a literature review, qualitative document analysis, geospatial analysis, and a survey to understand which of the environmental variables that most impact communities of color can be addressed through comprehensive planning, and how these communities would prioritize finding solutions. These methods result in an opportunity index, or map tool, that is different from indexes of the past.

Qualitative Analysis of Literature Review

This literature review is the base of this study. It lets the reader see the most important issues, including environmental racism and public health, how these issues persist, and what gaps still exist. I use literature from activist authors from communities of Black, Indigenous, and other peoples of color to explore multiple perspectives offered by those who are usually silenced or faced barriers when trying to work with decision-making platforms. In the next pages I review information on the selection of administrative documents and OPR case studies. I also begin the initial list of environmental and social variables that disproportionately impact communities of color.

Qualitative Review of Administrative Documents and OPR Case Studies

I used administrative documents, such as the California General Plan Guidelines, and case studies from the California Governor's Office of Planning and Research (OPR), like the Fresno Food Case Study, to explore the range of tools, resources, and requirements, along with the best practices, challenges, and guidelines that exist today for planners and organizers working with environmental justice communities. I chose the administrative documents based on their relationship to the policy requirements, guiding documents published by the state, or General Plans and elements from

Imperial County, surrounding, or similar CA communities. Case studies were chosen based on their alignment with Imperial Counties community demographics or dominant agricultural industry.

The CA Governor's OPR (now LIC) has guidelines and technical advisories available online to support counties, cities, and towns when they are adopting or revising a general plan element or guideline. This includes tools and resources such as needs assessments and case studies for a selected few large towns with environmental justice communities and active programs or policies to support the implementation of a successful EJ element.

I conducted this analysis to identify tangible tools and techniques that can be a foundation that best uplifts and preserves diversity across California. These tools and techniques include community engagement, collaboration/partnerships, youth workforce development, education, workshops, and stakeholder engagement.

My review of administrative documents, including General Plan guidelines and requirements, allowed me to identify elements that can be used to directly address some of the EJ variables. I identified categories in order to create a list of indicators that can be used in a final EJ opportunity index. The qualitative analysis included the administrative documents, OPR case studies, and other items in the literature review. I began by manually documenting the frequency of the chosen variables, but immediately saw the need to transition to a more efficient tool. NVivo was used to conduct a word frequency analysis. Using PDFs of each document, I removed accessory pages in order to use the word frequency tool to find the top 50 mentioned phrases including stemmed words. I chose the maximum word length of three after my manual analysis showed that terms could vary between one and three words with the same meaning. While I explored the variables listed as most frequent, I highlighted those that could be found in, or joined to, spatial data for a final map analysis. I sorted the variables according to the possibility they would be addressed through that General

Planning element, meanwhile also utilizing the frequency list, literature review, and experience working in or with city governments.

Survey & Central Tendencies

I determined that a survey would be an advantageous form of community engagement that welcomed flexibility in time difference and could accommodate diverse schedules. The ultimate goal of community engagement is to ensure that all residents, especially those who have historically been silenced or neglected, can have a say in the decision making process. A survey is a helpful tool to quickly gather quantitative and qualitative data.

I created five goals for this thesis to guide the community and stakeholder engagement:

1. Gather input to serve as a primary source of information.
2. Collect feedback on relevant variables for spatial analysis.
3. Identify local values related to environmental and public health.
4. Create an accessible and wide-reaching public engagement tool,
5. Determine priority/ weight for the variables in the Environmental Justice Indicator.

The engagement approach that was mostly likely to meet these objectives consists of online surveys in English and Spanish. I made a robust effort to target hard-to-reach residents, including farmers and members of non-English speaking communities. I used an informed-oriented approach which utilized snowball and quota sampling to reach as many people as possible including organizers, students, city staff, farmers, and residents. Qualtrics Data Analysis Reporting and tools allowed me to identify weights for each variable in the final analysis. The Qualtrics' report tool makes it very easy to populate reports with results that include various measurements, such as mean, median, standard deviation, variance, and more. Median is an appropriate measure of central value for residents³⁷ given that it reduces the ability to be influenced or skewed with high and low outliers, so I made the decision to utilize median values when calculating the ranking and other AHP calculator values.

³⁷Central Statistics Office, "Mean vs Median Information Note - Central Statistics Office."

I determined the priorities for the variables through a survey inspired by the Analytic Hierarchy Process (AHP); this survey then utilized percentages to identify final weights. I used median ranking to choose “AHP priorities” and the quotient of these ranked positions determined “How much more?”. The AHP calculator inputs are shown in Figure 2, and the outputs are shown below, in [Part 2: Discussing the Survey Results](#). This calculator produced the priorities weight table shown in

Figure 38. Although the rankings do not look like the survey results for median ranking, one can clearly delineate how #3 to #4 can be very closely ranked and these are the true results of the AHP tool.

Figure 2: AHP inputs for final index weights

	A - wrt AHP priorities - or B?		Equal	How much more?
1	☐ Haz Waste	☒ Air Quality	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
2	☐ Haz Waste	☒ Accessibility / Transportation	☒ 1	☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
3	☐ Haz Waste	☒ Green Space	☒ 1	☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
4	☐ Haz Waste	☒ Impaired Waters	☒ 1	☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
5	☒ Air Quality	☐ Accessibility / Transportation	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
6	☒ Air Quality	☐ Green Space	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
7	☒ Air Quality	☐ Impaired Waters	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
8	☐ Accessibility / Transportation	☒ Green Space	☒ 1	☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
9	☐ Accessibility / Transportation	☒ Impaired Waters	☒ 1	☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
10	☒ Green Space	☐ Impaired Waters	☒ 1	☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

Spatial Data Analysis

Geographic Information System (GIS) is a tool that can conduct analysis on a spatial level to identify and answer location-based questions. Yeager and Gatrell explored the impacts of grocery store closure on food accessibility in a rural community; they found that location plays a crucial role in access. Drawing on their findings, I explored how the lack of public transportation and vehicle access plays an even bigger role.³⁸ Another paper utilized GIS and a case study to identify that race and income become crucial components in access to quality, affordable, adequate, and culturally appropriate foods.³⁹ A study in Italy used GIS to identify accessibility to urban parks through container-based, distance-based, and gravity-based methods.⁴⁰ This work shows the importance of identifying problems, defining the object to be measured, and choosing a unit of observation that does not encapsulate an area that is too large to properly demonstrate the impacts of location on a neighborhood scale.

³⁸Yeager and Gatrell, “Rural Food Accessibility.”

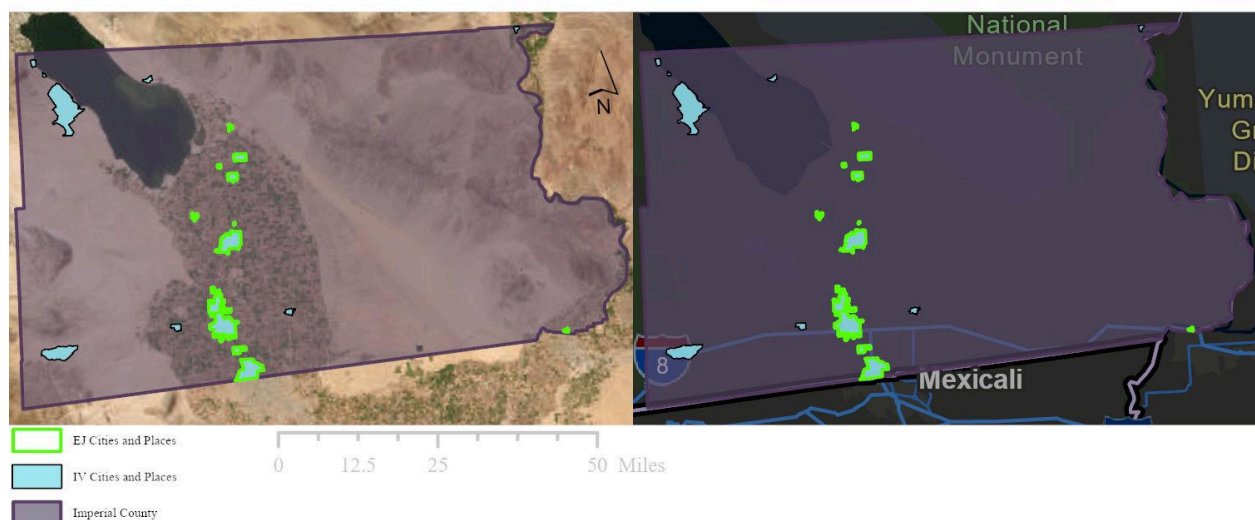
³⁹Raja, Ma, and Yadav, “Beyond Food Deserts.”

⁴⁰Semenzato, Costa, and Campagnaro, “Accessibility to Urban Parks.”

The Imperial Valley's predominant land use is agriculture, as shown in Figure 3 below, the satellite image on the left. These center cities and places are the more dense and developed communities of the Imperial Valley. Many farms and land owners have larger property and homes outside the shown cities and places. Throughout this thesis I show many of the maps on three scales. These are first, the entire county (as shown below); second, that map zoomed in to two to three EJ communities; and third, that map zoomed in to show individual neighborhoods within a city. Legends and north arrows can be found throughout.

To provide some visual context, the maps below show the cities and places in blue, and the neon green highlight identifies which city and place has environmental justice communities.

Figure 3: Imperial Valley cities and places on satellite and dark base maps



I used ArcGIS Pro to conduct a suitability analysis to create the final opportunity index. Using the previously described methods, I produced five categories: **Hazardous Waste, Impaired Waters; Mobility/Access; Open/Green Space; and Air Quality**. I took specific steps that were utilized to get situated in ArcGIS Pro. The geodatabase environment was set to have an output coordinate projection system of “NAD 1983 California (Teale) Albers (US Feet). Although much of this work takes place in CA StatePlane 6, much of the data comes from the state of California or the entire US.

This common projection made it easier to translate the data and reduce the error from redefining the projection.

Next, I used Feature Datasets to organize data in the map and geodatabase by variable type. It was important to begin by adding significant spatial boundaries such as the Imperial County, cities and census-designated places, and census tracts. The select-by-attribute tool identified all of the EJ communities in Imperial County for an individual polygon shapefile. Cleaning tables is an important step before adding various shapefiles for each variable, including roads and population data for network analysis. I did this by removing unnecessary columns, converting GEOID to text, calculating new fields, converting to xy points, and joining tables with shared attributes to existing shapefiles. I continued to document the process, using journals, ArcGIS toolboxes, and ModelBuilder; this allowed me to keep track of all the data alterations so I could identify points of bias and error. After I had cleaned and properly displayed the variables on ArcGIS Pro contents/map, the analysis began one variable at a time.

Each layer that utilizes the variable “walking distance” incorporated at a distance of 0.25 mile, given this as a common and accessible distance. More recent studies have explored common distances greater than the 0.25 mile distance for walking⁴¹, but given the health concerns in our specific communities, along with the poor air quality and extreme heat, I decided it would not be either reasonable or appropriate to consider any distance over 0.25 mile as accessible for the most vulnerable of residents.

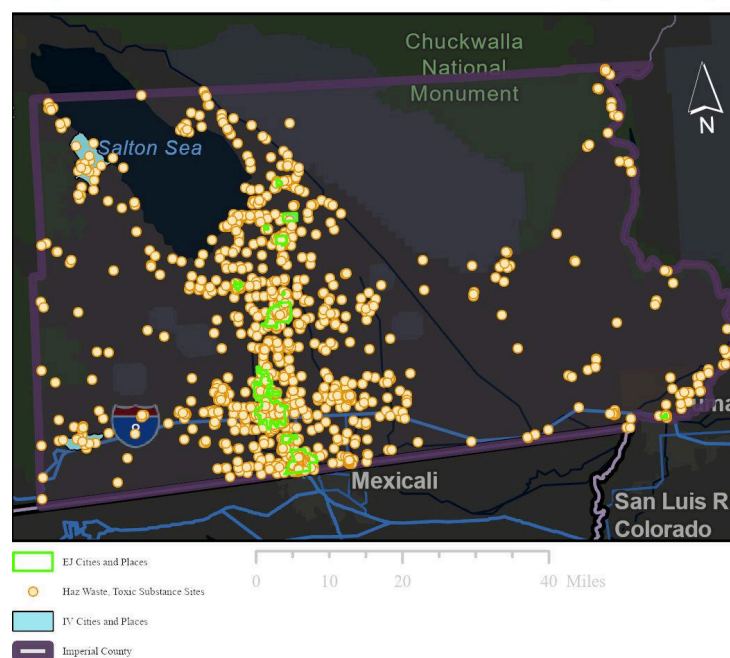
Below, in [Part 2](#), I explore how I used the associated weights for each variable in the opportunity index using an analysis of the case studies, environmental justice literature, and a survey.

⁴¹Yang and Diez-Roux, “Walking Distance by Trip Purpose and Population Subgroups.”

In the next few pages I describe how I approached each variable; the results and further discussion are in Part 2, Section: Getting Started and Using Model Builder.

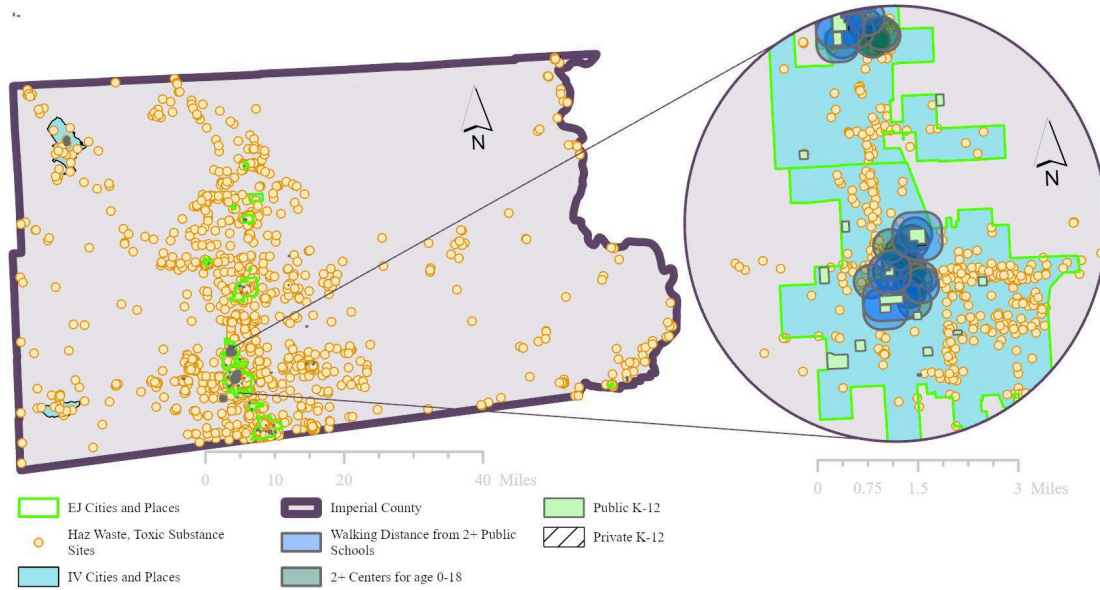
Hazardous Waste Sites: This layer is a comprehensive list of hazardous waste and materials, state and federal cleanup sites, and toxic release sites, all from the California Environmental Protection Agency. I began my analysis with the 0.25 mile, or 5-minute, walking distance buffers around the CalEPA hazardous waste and substances sites located throughout Imperial County. The neon green coloring in Figure 4 highlights the city and towns with EJ communities.

Figure 4: Hazardous waste and toxic substance sites in the Imperial Valley



The next step was to determine the areas in which a person can be expected to have high exposure to regulated sites during a walking route. A new layer was created to show walking distance polygon buffers around public schools, non-public K-12 schools, community colleges, and centers that provide care for children ages 0-5. After creating these buffers, I could identify the overlap between public schools and then create a new layer to show which areas put the most children at risk today.

Figure 5: High levels of hazardous waste and toxic substance exposure to youth in the Imperial Valley



The final step for this variable was to identify point density and convert polygons to a raster in order to reclassify them on an opportunity scale of 1-10 and combine the variables through the raster calculator tool. This allowed me to create a single clean layer that I could utilize in the final index.

The “variables” in this section include: *Haz sites within walking distance of 2 or more schools*, *hazardous sites within EJ communities*, *areas that are within walking distance of 2 or more hazardous sites*, and *walking distance from the sites that do not fall into any of these categories*.

Two are site specific and two are focused on land use or resident exposure. Given that some of these are seen as higher priority than others, Figure 6 shows the AHP calculator inputs used to determine weight.

Figure 6: AHP Inputs for the Hazardous Waste indicator

	A - wrt AHP priorities - or B?		Equal	How much more?
1	☒ 2+ Schools	☐ EJ Communities	☐ 1	☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
2	☒ 2+ Schools	☐ 2+ Walking Dist	☐ 1	☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
3	☒ 2+ Schools	☐ All Other	☐ 1	☐ 2 ☐ 3 ☒ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
4	☒ EJ Communities	☐ 2+ Walking Dist	☐ 1	☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
5	☒ EJ Communities	☐ All Other	☐ 1	☐ 2 ☐ 3 ☒ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
6	☒ 2+ Walking Dist	☐ All Other	☐ 1	☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
CR = 5.3% OK				

Those results were used in the final raster calculator, seen in Figure 7. That figure also shows the ModelBuilder used for the analysis. The results and discussion of these methods are Part 2, below.

The screenshot displays a QGIS Processing Toolbox workflow for land cover classification and extraction. The workflow consists of the following steps:

- Inputs:** Five input rasters are shown: *Haz_WalkBuffOV*, *HazEJ_PointDense*, *HazWasteWalkB...*, *HazOverlap_Poi...*, and *NLCD23_LndCov*.
- Reclassification:** Each of the four hazard-related input rasters is processed by a *Reclassify* tool (with parameters 2, 4, and 3 respectively) to produce intermediate classified rasters: *Reclass_HazWalk...*, *Reclass_HazEJ*, *Reclass_HazAllOT...*, and *Reclass_Haz2Plus...*.
- Raster Calculator:** These four reclassified rasters, along with the *NLCD23_LndCov* raster, are combined in a *Raster Calculator* tool to produce the *RstCalc_Haz* raster.
- Extraction:** The *RstCalc_Haz* raster is used in an *Extract by Mask* tool, along with the *NLCD23_LndCov* raster, to produce the final output: *RstCalc_Haz_Clip*.

The **Map Algebra expression** window is open, showing the following formula:

```
Con( IsNull("%Reclass_HazAllOther%",0), "%Reclass_HazAllOther%" * 0.077) + ( Con( %Reclass_HazAllOther%',0), '%Reclass_HazAllOther%' * 0.077)
```

Figure 8: Add Location inputs for grocery service area map

Add Locations

Input Network Analysis Layer
Service Area

This layer's network data source is **Service Area**, limits, such as on the number of inputs that can be used, are defined in the layer's properties.

Sub Layer
Facilities

Input Locations
Grocery Stores

Field Mappings

Property	Field
Name	Field Name:
CurbApproach	Address
Attr_Minutes	Default Value:
Attr_TimeAtt1KPH	
Attr_TravelTime	

☒ Append to Existing Locations

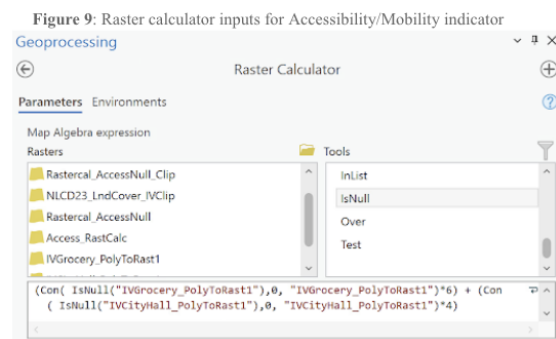
Advanced

Apply OK

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I then created a service area map using grocery stores and city halls as facilities in separate maps. I visualized them using a dissolved blend for 5-, 10-, and 15-minute driving distances. In a second layer I used the same facilities, but shifted the mode of transportation to walking distances of 5 and 10 minutes, which can range anywhere from 0.10 - 0.50 miles depending on the person's health and ability, and the weather. Again, results and discussion can be found in [Part 2](#).

The final step was to identify areas within a given city or place that are **not** within walking distance of a grocery store or city hall. After I converted the polygons to a raster, they were reclassified on an opportunity scale of 1-10. I then combined the maps for non-service areas using the raster calculator tool, weighing the grocery stores at 0.60 and city hall at 0.40, as shown in **Figure 9**. This created a final layer that is utilized in the "Mobility" indicator in the final EJ index. Again, the results are in [Part 2](#).



Impaired Waters: The impaired waters layer looks like a road system but it is actually all the rivers, streams, and lakes that are contaminated, with a majority at the level of serious health hazard. I created a walking distance buffer from the lakes and polygons to produce a shapefile layer showing which communities have exposure to impaired surface waters. The result shows clearly that the ponds and lakes of highest concern are outside of the EJ communities, but we must remember that in fact many of these communities do not have ponds or lakes within them. I decided to remove the canals and focus on the ponds and lakes. Given that this desert has few spaces with natural surface waters, we see that many of the rivers and streams are actually canals carrying water from the American River and the Colorado River through the Imperial Valley for irrigation.

The final step was to identify the areas of concern using a weighted overlay for the accumulated distance from the source of both critical and grey bodies of water to ensure a focus on those within the closest proximity to the exposed source. After I converted the lines and polygons to a raster, I used the euclidean distance tool to represent distance from the source regardless of pathways and topology. These areas are impacted similarly, regardless of a person's ability to drive or walk directly to the source. I reclassified all four raster layers on an opportunity scale of 1-10 and then added them into the raster calculator with conditions and weights. Again, results are in [Part 2](#).

Access to Green Spaces: For this variable layer I manually reclassified a combination of data from the National Land Cover Data set. Reclassifying this layer required fewer steps, but much more attention to detail and a lot of generalizing. If better data had been available, I would not have had to use this approach. For example, preferred data would include existing parks, parking lots, trees, and community spaces. There are no NLCD land cover classifications of 12, 41, 43, 51, 72, 73, or 74 in the Imperial Valley so these will not be seen in the final reclassification.

Given that 0.000% of the area is evergreen forest and none of it is within a designated city or place, I ranked this type of land area a 1 on the opportunity scale.

Cultivated crops and pasture/hay cover 17.4% of the Imperial County NLCD raster file and contribute to local concerns around pesticides, particulate matter, burn residue, and water usage, but this study focuses on spaces with the greatest opportunity for immediate intervention, and we do not want to disrupt the culture and economic development of the community by removing or altering agricultural land from the data analysis. For that reason, I placed cultivated crops and pasture/hay at a 4 on the EJ scale, giving them one point for each major concern.

Results from the zonal histogram tool showed no presence, or fewer than 0.000%, for the following NLCD land cover classifications within a designated city or place: 42, 71, 81, 90, and 95. Thus, I ranked these between 1 and 5 on the opportunity scale, depending on their contributions to social and ecological health and wellbeing and any disproportionate impacts by race.

Seven areas were in the main focus for the opportunity scale; I ranked these between 5 and 10. They are: 11 - *Open Water*; 21 - *Developed, Open Space*; 22 - *Developed, Low Intensity*; 23 - *Developed, Medium Intensity*; 24 - *Developed, High Intensity*; 31 - *Barren Land*; and 52 - *Shrub/Scrub*.

Here are my reasons for each ranking. I ranked 11 - Open waters at 5, considering the benefits of access to blue spaces and their critically impaired quality. The categories of barren lands (31) and shrubs/scrub (52) primarily include dirt lots; these raise concerns over particulate matter and offer great opportunities to implement change with little disruption so I ranked them at 7.

The closest category to “green space” and open space is 21 - Developed, Open Space. This included large open areas like parks and empty permeable land. Given the quality of the existing structures in the areas classified as 21 and the fact that they would cause the least disruption to existing communities, I ranked them at 8. I did not give them a higher ranking because some of these parks are of great use to the existing community, even if much of the area is dry dirt. At the category 22 - Developed, Low Intensity, we see some of the empty dry lots or vacant spaces near the open space. I ranked them at 9 because they offer an opportunity to implement change with little disruption to existing communities. Given that areas classified as 23 and 24 largely represent massive parking lots, roads, and high traffic areas for communities, I ranked both at 10,

Figure 10: Reclassify inputs for Green Space indicator

Value	New
11	5
21	8
22	9
23	10
24	10
31	7
42	1
52	7
71	2
81	4
82	4
90	1
95	1
NODATA	NODATA

even if any change could disrupt existing structures, because these massive parking lots are impervious surfaces with very little green space and very intense heat island effects. Some of these inputs are seen in **Figure 10**. The results and discussion of this reclassification can be found in [Part 2](#).

Air Quality: I began working with this final variable by mapping asthma prevalence in Imperial County. This layer shows Asthma percentile overlaid with the schools in this zoomed-in area. For spatial reference, please see the yellow square in the mid upper right area which represents the Imperial Valley Community College. Interestingly, we see that a large percentage of the schools in El Centro, the middle neon green city, are highlighted. Given that these areas have vulnerable populations, they especially deserve to be prioritized.

The CalEnviroScreen 4.0 data dashboard includes a pollution burden score. Using it, I created a pollution variable scaled with a range of 0-10 which was very convenient and easy to use. After changing the polygon to a raster, I reclassified the layer on the opportunity scale of 1-10. The results are in [Part 2](#).

The EJ Opportunity Index: After exploring the indicator as individual multidimensional variables, I reclassified each layer on a scale of 1-10, with one meaning 'Very low opportunity', five 'Moderate', and 10 'Very high'. After the reclassifications, each layer was combined using a raster calculator to find the sum with the associated weights determined from the surveys (see **Fig 11**). The calculator output was reclassified on the opportunity scale from 1-10.

Figure 11: Raster calculator inputs for final EJ Index

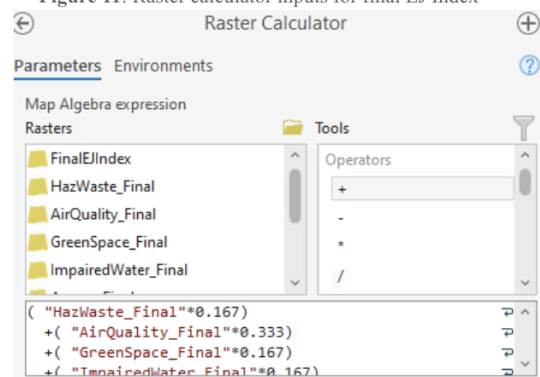
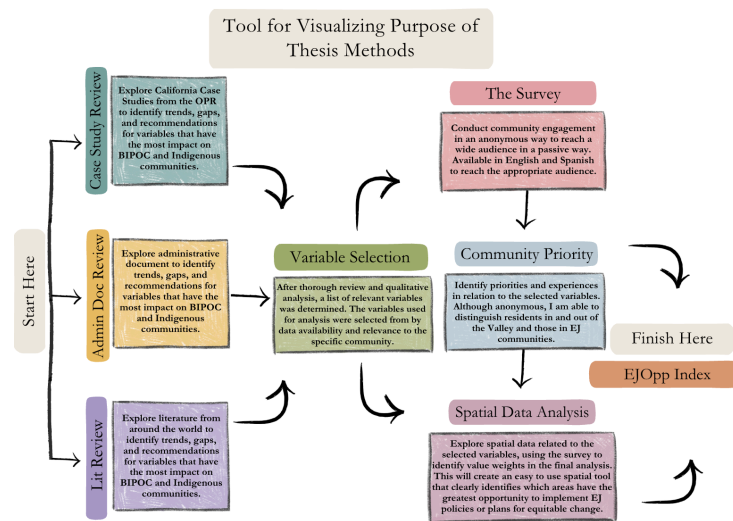


Figure 12 is a visual map of the described methods, showing their purpose and relation to the research questions.

Figure 12: Mind map to understand the purpose of each method



More inspiration came from the author, policy expert, and marine biologist, Ayana Elizabeth Johnson. Her 2024 book, “What If We Get it Right?: Visions of Climate Futures” demonstrates what true love and passion for climate solutions can do when we take a mixed-methods approach to identify challenges that persist today, and solutions that real people are working on. Quantitative data is valuable but does not always represent people’s unique experiences and the individual level impact. The ability to incorporate qualitative data through methods such as interviews and surveys allows researchers to consider ways to represent such experiences and increase the opportunity to model and conduct community engagement. Environmental justice is far more than just problems. It also includes solutions, but until we transition to a “we” mindset, it can be hard to imagine a future of successfully implemented solutions.⁴²

Sources of Data

In this thesis I primarily used secondary data gathered from public sources. Secondary data is not ideal, given the difficulty in accessing specific variables and dates of collection. However, through this study I

⁴²Johnson, *What If We Get It Right?*

hope to show others the benefit of releasing data to the public for individual and personalized analysis.

Much of this data came in the form of PDFs, shapefiles, or csvs.

The primary qualitative data that I collected for this study came in the form of community engagement through an anonymous survey I created, asking participants to rank the five variables in order of priority to help determine each one's weight in my spatial analysis.

Table 1: Data sources that were used for two or more methods [full data list can be found in Appendix 10]

Data	Type	Connection to Method	Source
CalEnviroScreen Dictionary	PDF	Spatial, Survey	COEHHA
CalGEM Orphan Well Screening	Shapefile, points	Spatial, Survey	ArcGIS
Food to Share as Healthy Community and Environmental Justice Case Study	PDF	Admin Docs / Case Study, Survey	OPR
IVAN	Website	Spatial, Survey	County Org
Jurupa Valley - The 2nd California Environmental Justice Element	PDF	Admin Docs / Case Study, Survey	OPR
Land Use Planning Awareness Project	PDF	Admin Docs / Case Study, Survey	OPR
Los Angeles Countywide Parks Needs Assessment	PDF	Admin Docs / Case Study, Survey	LAC
National City's Health and Environmental Justice Element	PDF	Admin Docs / Case Study, Survey	CEJA
National transit roads	Shapefile	Spatial, Survey	GEOData Gov
OEHHA	Shapefile, csv	Spatial, Survey	CA Gov
School data by county	excel	Spatial, Survey	Ed Data
Social Explorer (lots of data) for state, county, place/remainder, and other counties for reference	csv	Spatial, Survey	ACS 5-year

Part 2: Choosing the Variables and Determining Priorities

The Earth was new then, when it welcomed the first human. It's old now, and some suspect that we have worn out our welcome by casting the **Original Instructions** aside.

Robin Kimmerer, Braiding Sweetgrass pg. 8

In this section I address my first subquestion: What factors do the EJ literature and the EJ principles say are most relevant to our communities?

In the section below I show the selected Seventeen Environmental Justice Principles drafted and adopted at the First National People of Color Environmental Leadership Summit in 1991. I have removed some principles that do not fit within the scope of this thesis because they are too difficult/complex to measure or solve through a planning initiative or spatial tool. **Bold** represents potential variables for analysis.

- 1) Environmental Justice affirms the sacredness of Mother Earth, ecological unity and the interdependence of all species, and the right to be **free from ecological destruction**.
- 2) Environmental Justice demands that public policy be based on mutual respect and justice for all peoples, **free from any form of discrimination or bias**.
- 3) Environmental Justice mandates the right to ethical, balanced and **responsible uses of land and renewable resources** in the interest of a **sustainable planet** for humans and other living things.
- 4) Environmental Justice calls for universal protection from nuclear **testing, extraction, production** and **disposal of toxic/hazardous wastes** and poisons and nuclear testing that threaten the **fundamental right to clean air, land, water, and food**.
- 6) Environmental Justice demands the **cessation of the production of all toxins, hazardous wastes, and radioactive materials**, and that all past and current producers be held strictly accountable to the people for detoxification and the containment at the point of production.
- 7) Environmental Justice demands the **right to participate as equal partners** at every level of decision making, including needs assessment, planning, implementation, enforcement and evaluation.
- 8) Environmental Justice affirms the right of all workers to a safe and **healthy work environment** without being forced to choose between an unsafe livelihood and unemployment. It also affirms the right of those who work at **home to be free from environmental hazards**.

9) Environmental Justice protects the right of victims of environmental injustice to receive full compensation and reparations for damages as well as **quality health care**.

12) Environmental Justice affirms the need for urban and rural ecological policies to **clean up and rebuild our cities and rural areas** in balance with nature, honoring the **cultural integrity** of all our communities, and providing **fair access for all to the full range of resources**.

15) Environmental Justice opposes military occupation, repression and **exploitation of lands, peoples and cultures, and other life forms**.

16) Environmental Justice calls for the **education** of present and future generations which emphasizes **social and environmental issues**, based on our experience and an appreciation of our **diverse cultural perspectives**.

Identifying Key Factors

In this section I describe how I began my analysis of selected administrative documents and CA OPR case studies. As mentioned in the methods section, the CA OPR produced a set of tools and resources created through case studies of communities that have successfully implemented an EJ plan or program in their city. The plans chosen for analysis all have EJ communities and are either near Imperial County, and have a similar community structure, and/or similar land use (such as predominantly agricultural towns and largely Hispanic communities).

California's Earlier Environmental Justice Element

In 2011, a development project failed to consider its impacts on a local Hispanic neighborhood; this failure inspired the lawsuit that resulted in the preparation and implementation of California's second ever Environmental Justice chapter, or element, for a CA General Plan. Funding from the City of Jurupa Valley, in combination with collaborative efforts from consulting staff and the Center for Community Action and Environmental Justice (CCA EJ), began the process for creating an intentional and personalized environmental justice element for the community's General Plan.

After a history of low public involvement in the decision-making process, it became clear that extensive outreach and community engagement would help CCAEJ identify environmental equity concerns. Residents shared input related to language barriers and the need for buffers between recent industrial developments and community spaces. Projects included efforts in English and Spanish to increase residents' understanding of the issues and their familiarity with the public process.

After relying on existing tools and extensive research on community demographics, health, and environmental burdens, the city was able to identify specific health issues and worked to address them clearly and directly through policies and plans in the Environmental Justice Element published in 2014. The city has seen an increase in public involvement in the decision-making process and reviews all new developments for compliance with the General Plan elements. These plans have promoted the use of mapping tools and land use compatibility studies, and have inspired/informed additional elements focused on community health and the elimination of cultural and language barriers in the citizen planning process. This has proven to be successful because it aligns with Jurupa's philosophy, city staff are cooperating, and stakeholders are engaged to ensure all parties are seen, heard, and aligned when a decision is made.

Solutions and Tools

Many initiatives have contributed to environmental justice efforts throughout the history of California. An example of personalized effort includes the EJ Task Force created in 2013. This group identifies target goals and partners to better understand issues on a local level. Six *Initiative Reports* are featured on their website, one specifically for the Imperial Valley. However, the only map in the entire document only shows census tracts that are above the 80th percentile for proximity to solid waste sites and facilities, and no updated data has been explored since 2018.

Community Engagement and Partnerships

Engaging Local Youth

The ***Land Use Planning Awareness (LUPA)*** project was “conceived” by The Riverside University Health System Public Health (RUHS-PH) in 2014. The group engaged with local youth in the Coachella Valley including 3 high school and after-school groups.

The Nova Academy youth group took time to learn and discuss the project **before** initiating planning efforts. After identifying issues and ideas, they decided to look at one specific project and gather data through a health impact assessment with the Coachella Valley Association of Governments (CVAG) and RUHS-PH. They collaborated in the production of materials with the LUPA team and a local youth group to produce a PhotoVoice Project. Programs like PhotoVoice, and the willingness of local organizations to support, involve, and document the youth’s efforts culminated in a successful campaign to raise awareness around trail access and environmental health impacts.

The Environmental Youth Group Alliance (EYA) also focuses on a single topic: affordable housing. After visiting sites and interviewing residents, they produced a blog to raise awareness of the issues.

The Coachella Valley High School chose to engage with LUPA through a visual arts path by forming “CV Artisans,” an art collaborative. This method explored “tapping into their curiosity, imagination and critical thinking” to raise awareness around the importance of engaging in local community planning. This collective met with other youth partners to engage in learning and shared discussion before communicating their findings through a “mobile public art installation”.

LUPA engaged in other youth collaborative projects to continue educating the population on local issues such as heat exposure and transportation / mobility. Receiving state funding and using data from larger organizations and studies proved to be successful tools in this project. Challenges still

existed, like the lack of reliable transportation and a need for more funding, but this project shows how valuable community engagement and partnerships are to exposing youth to the profession of planning and raising awareness among residents on local issues. This project was recognized with two American Planning Association awards, was included in an accreditation portfolio for RUHS-PH, and inspired local youth to pursue planning degrees at the University of California, Davis.

Educational Meetings and Stakeholder Engagement

As **Fresno** was producing its **Active Transportation Plan (ATP)**, a local organization, and now non-profit, called Cultiva La Salud, partnered with a regional leadership and justice council to gather, inform, and empower residents to engage with their local decision makers to make their needs heard and create change in their community. This community suffers from high rates of obesity and clear disparities in infrastructure and policies that prioritize minoritized neighborhoods. After engaging, residents quickly realized and communicated the lack of parks, bike lanes, walking paths, and other projects that promote healthy and active lifestyles in their neighborhoods. The educational meetings included elected officials to openly discuss challenges and goals for the ATP.

The process of engagement started with community workshops to inform residents about the ATP and how it could impact their day-to-day lives. Cultiva and the Leadership Council facilitated conversations around disparities and ways to address the inequities seen throughout their communities and the ATP. The use of storytelling helped increase access to information and engagement opportunities for the residents. Through collaboration with city staff and data-driven decision making, this non-profit was able to inform planners and empower residents to take action. The residents wrote a response to the city discussing the need to remove barriers in the plan that would increase the problems around increasing community spaces for disadvantaged communities.

This led to community-led events and meetings that residents also utilized to collect data about active transportation and resident input on infrastructure improvements. The events included culturally relevant and accessible activities like community bike rides and walks that also included traditional Cumbia music. This shared space allowed residents to build trust as they made observations and collected data together.

According to the Governor's Office of Planning and Research in California, it was the residents' "strong community engagement" that encouraged the Fresno City Council to adopt Fresno's Active Transportation Plan (ATP) and incorporate an Equity Rubric. Without local advocates and community leadership, it is uncertain if the equity rubric would have been developed in Fresno today. It was the community input that informed and personalized the rubric priorities to meet local needs, such as safe routes to school and high-density pedestrian traffic areas.

The community's demographics, health concerns, and lack of investment was a perfect match for funding from the Center for Disease Control and Prevention (CDC) , but both funding and staff capacity continue to be concerns for this program, and for others trying to replicate it. However, the strong partnerships, stakeholder education, and empowered community members produced an excellent tool to evaluate how equity is addressed in projects like the ATP.

Sorting the Variables

In the following section I describe a combination of variables taken from a range of case studies. They are Active Transportation Fresno Case Study; Fresno Food Justice Case Study; Land Use Planning Coachella Valley Case Study - Fact Sheet; Jurupa Valley Case Study, General Plan Guidelines, Chapter 4: Required Elements; and Envision Cambridge, along with other Environmental Justice literature.

Figure 13: Poll Everywhere word cloud

A 2022 study on the prevalence of environmental justice concerns in planning documents identified *Land Use, Air Quality, Circulation, and Health* as elements that could be easily adapted in order to include and address environmental justice in environmental justice communities. I conducted another Word Frequency analysis on the OPR documents for those elements, in addition to *Safety, Equitable Resilient Communities, Community Engagement, Community Outreach, Environmental Justice, and Models for Environmental Justice Policies*. The Methods section includes more information on how I sorted the variables. A full list of Nvivo results can be found in Appendices 3, 4 and 5.

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Table 2: Most popular variables from the literature categorized by comprehensive elements or potential indicators

Indicator	Variable	Description	Have Data
Land Use	Hazardous waste sites	The locations of hazardous waste dumps, spills, or exposures designated by CA EPA. This This aligns with EJ Principle 4, 6, 15	☒
	Agricultural Land	Area for growing crops or caring for livestock.	☐
	Open Space	Areas for community gathering in safe and fulfilling places outside.	☒
	Renewable Energy	Energy sources that are powered by systems that naturally replenish when used at a sustainable rate.	☐
	<i>Recreational facilities</i>	Public areas where residents can gather and engage in activities.	☐
Air Quality	<i>PM 2.5</i>	Particulate Matter at 2.5 microns. This aligns with EJ Principle 1	☐
	GHG	Greenhouse gas emissions. This aligns with EJ Principle 1	☐
	<i>Trees</i>	A woody plant with deep roots that provides shade.	☐
	<i>Asthma</i>	A condition in the airways causing difficulty breathing, mucus, and coughing.	☐
Circulation	Vehicle Access	Personal ownership of a working vehicle. This aligns with EJ Principle 12	☒
	Bike Lanes	Areas in public streets and pathways soley for bike use.	☐
	Sidewalks	Areas in public streets and pathways soley for pedestrian use.	☐
	Transportation routes	The path taken by public buses when in service.	☒
	Public utilities and facilities	Public services, offices, and resources. This aligns with EJ Principle 7, 12	☐
Housing	Affordable	Housing that is 30% or less of a person's monthly income.	☐
	<i>Diverse Perspective Schools</i>	Create space for social and environmental issues through diverse perspectives. This This aligns with EJ Principle 16	☐
	<i>Green Space</i>	Public areas outside that have natural plants, biodiversity, and greenery.	☐
	Grocery Stores	Formal businesses that primarily sell produce and food products.	☒
	ADUs	Accessory Dwelling Units	☐
Health	Race and Ethnicity	Race and Ethnicity. This aligns with EJ principle 2	☐
	<i>Quality health care</i>	Health care that is affordable, reliable, accessible, and meets the needs of the residents. This aligns with EJ Principle 9	☐
	Cancer	Abnormal cell growth in the body. This aligns with EJ Principle 9	☐
	Obesity	Weight conditions that impact health, mobility, and quality of life. This aligns with EJ Principle 9	☐
	Impaired Waters	Water contaminated by pollutants beyond acceptable thresholds. This aligns with EJ Principle 1, 3, 4	☒

Towns in the Imperial Valley are not compact or walkable so the primary mode of travel is by car, for those who have access to a personal or shared vehicle. Some towns may have walkable main streets, but given our extreme heat and air quality, it becomes difficult for people, especially sensitive populations, to navigate their community. Active lifestyles encourage healthy habits and can reduce pressing concerns existing communities face like obesity, hypertension, and diabetes. In order to ensure safety, increase comfort, and reduce barriers to access, it will become vital to implement more routes for public transport, whether that be by bus, bike, or walking.

To create an Environmental Justice Map, I chose the following five variables because they best aligned with the principles and local concerns; data availability weighed heavily in my decision.

1. Hazardous Waste Sites
2. Impaired Waters
3. Circulation / Mobility (or Accessibility / Transportation)
4. Green space
5. Air Quality

Community Feedback - The Survey

This section answers the following sub-question: What is a meaningful way to determine each factor's weight in a final analysis?

One of the greatest challenges during this project was working remotely—across the country— from the community of interest. The inability to conduct in-person community engagement goes against true environmental justice efforts, but I was able to address this concern through a survey that allowed residents to provide anonymous feedback on how to prioritize the selected variables.

Discussing Survey Results

As of April 8th 2025, a total of 145 respondents had completed the survey with 117 providing full responses applicable for further analysis. Of those respondents, 49 were from the Valley **and** residents of an EJ community, 35 were from IV but not a resident of an EJ community, and 33 were located outside of IV, or our “general public” group. Given that information on exact location was not included, there is no conclusive data to show statistical significance in representation, but it was concluded that the survey was shared predominantly by residents of California and Massachusetts communities, along with their LinkedIn networks, and their extended networks.

Certain variables were chosen as controls, to identify causes of bias, and to paint a holistic picture of participating community members. The survey was tailored to identify information that would have an influence on perception of, and engagement with, environmental justice communities. Figure 14 and tables 3 through 5 show information on respondents’ employment industry, and most importantly, race.

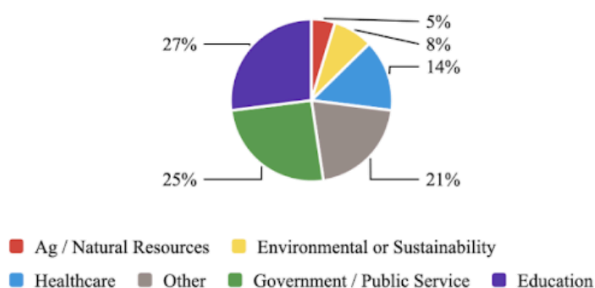
Figure 14 shows the industries employing the respondents who are residents of EJ communities in the Valley. Of these residents, 79% are employed in

an industry that influences or makes decisions over environmental justice issues of a city or town. It is very important to ensure that people in

non-government positions are included to increase

the representation in the decision making room. Failing to include a wide range of residents makes it less possible to ensure equitable decisions which consider diverse experiences, goals, and values. The following figures show results of a multi-select race and ethnicity question from the survey pulled on April 8th, 2025 after a total of 49 EJ residents, 35 Non-EJ IV residents, and 33 General Public, or outside of the Imperial Valley. Although the tables may show different information, only 2% of the

Figure 14: Pie chart of EJ employment industries



Imperial Valley population are of Asian identity, so much of the racial analysis and comparisons moving forward will be focused on **Hispanic, White, and Black or African** identities.

Table 3: Race of EJ residents		Table 4: Race of non-EJ residents		Table 5: Race of General Public (outside the IV)	
Field	Percentage of Responses	Field	Percentage of Responses	Field	Percentage of Responses
American Indian or Alaska Native	0%	American Indian or Alaska Native	2%	American Indian or Alaska Native	2%
Asian	1%	Asian	13%	Asian	12%
Black, African, or African American	6%	Black, African, or African American	11%	Black, African, or African American	12%
Native Hawaiian or Other Pacific Islander	0%	Native Hawaiian or Other Pacific Islander	0%	Native Hawaiian or Other Pacific Islander	0%
White	16%	White	47%	White	50%
Hispanic or Latino	87%	Hispanic or Latino	45%	Hispanic or Latino	42%
Other (please specify)	1%	Other (please specify)	2%	Other (please specify)	2%

The *EJ IV Residents* (Table 3) shows the responses from residents of a city or town in the Imperial Valley that have environmental justice communities in them. Table 4, *Non-EJ IV Residents* shows those in the Imperial Valley but not located in an area with EJ communities. It becomes immediately noticeable that the percentage of Hispanic/Latino representation drops almost in half from EJ residents to not EJ residents. Additionally, we see the Asian population increase by 12 percentage points and the percentage of White residents almost triples in non-EJ communities. It was surprising to see the increased numbers of non-EJ residents who are Black and American Indian or Alaska Native; this is important to remember in the spatial analysis I describe in the next section.

It was not surprising to see that 87% of the respondents from the Imperial Valley were Hispanic, given that 86% of the total residents are of Hispanic origin.⁴³ As Table 5 shows, only 42% of the “general public” are of Hispanic origin. According to the US Census 2024 fact sheet, only 9% of the White population in Imperial County is NOT of Hispanic origin.⁴⁴ Another important note is that the “Asian” population dropped to only 1% in EJ communities, while they are 13% and 12% of the non-EJ and general public groups. Much of the literature on environmental justice in the United

⁴³“U.S. Census Bureau QuickFacts.”

⁴⁴“U.S. Census Bureau QuickFacts.”

States shows that race has a negative impact for Black, Hispanic, and Indigenous communities; meanwhile White and Asian communities tend to live in better environmental conditions and have more access to decision-making tools or spaces.

Tables 6, 7, and 8 show the April 8th survey results for the question asking participants to rank the five variables by dragging them between 1 and 5. Mean and median were significant considerations for the final variable ranking given their direct ability to communicate average community voice.

Field	Mean	Median	Standard Deviation	Variance	Responses	Sum
Hazardous waste sites	3.57	4.00	1.32	1.76	49	175.00
Impaired waters (bad quality, low flow)	3.12	3.00	1.30	1.70	49	153.00
Accessibility / Transportation	3.37	4.00	1.41	1.99	49	165.00
Green spaces (such as parks)	2.90	3.00	1.25	1.56	49	142.00
Air quality	2.04	2.00	1.26	1.59	49	100.00

Table 6: Data from ranking of variables from residents of an EJ community in the Imperial Valley

Field	Mean	Median	Standard Deviation	Variance	Responses	Sum
Hazardous waste sites	3.77	4.00	1.29	1.66	35	132.00
Impaired waters (bad quality, low flow)	2.89	3.00	1.24	1.53	35	101.00
Accessibility / Transportation	2.54	2.00	1.57	2.48	35	89.00
Green spaces (such as parks)	2.97	3.00	1.28	1.63	35	104.00
Air quality	2.83	3.00	1.36	1.86	35	99.00

Table 7: Data from ranking of variables for residents of the Imperial Valley but non-EJ community

Field	Mean	Median	Standard Deviation	Variance	Responses	Sum
Hazardous waste sites	3.88	4.00	1.22	1.50	33	128.00
Impaired waters (bad quality, low flow)	2.94	3.00	1.25	1.57	33	97.00
Accessibility / Transportation	2.48	2.00	1.60	2.55	33	82.00
Green spaces (such as parks)	2.88	2.00	1.25	1.56	33	95.00
Air quality	2.82	3.00	1.31	1.72	33	93.00

Table 8: Data from ranking of variables for residents of the general public (outside the IV)

Although the general public is represented in Table 8 below, their responses do NOT impact the final decision, given that this study focuses on the Imperial Valley. Data on the general public is used to

identify trends and differences between this community and others. In any study that replicates this research for another community, further populations must be sampled.

Air quality is an issue commonly discussed in California for several reasons: high winds in the valley, forest fires, the industrial past, and the practice of agricultural burnings. Additional concerns local to the Imperial Valley include lithium mining in the Salton Sea and high levels of particulate matter or other toxic airborne chemicals. Together these factors result in almost 16% of the population living with asthma; a UCSD study showed that 140 children per 10,000 residents are hospitalized annually for severe asthma symptoms.

It was interesting to see that very few people in any community ranked Hazardous Waste as a high priority. Of the over 2000 toxic sites in the region, 100 are on walking routes that children and other vulnerable populations encounter multiple times on their way to school. This number is multiplied when we consider routes to grocery stores, city halls, places of work, and more. When I considered how I had used the AHP calculator to determine the weight of prioritization based on the community feedback, it became clear, and easy to determine, that hazardous waste would be ranked last.

It is important to note that all residents of the Imperial Valley ranked green space and impaired waters as having equal median values, though the general public did not. Environmental justice has expanded from hazardous waste to these more general issues: access to green spaces is important for the residents of this desert community. Personal experience, literature, and the short response survey question reflect similar concerns: people yearn for green spaces, trees, or relief from the extreme heat this desert area faces annually. With average summer highs of 106 to 115 degrees, any additional opportunity to experience cool air shifts from a luxury to an absolute necessity, especially for young/developing⁴⁵, diverse, and aging bodies.

⁴⁵Early Childhood Scientific Council on Equity and the Environment, “Extreme Heat Affects Early Childhood Development and Health”

On the issue of cleaner waters, residents share similar experiences and needs. People living in these cities and rural areas are quite familiar with water restrictions; for example, lawn watering is limited to certain days of the week depending on one's neighborhood and location. Water is stored in, and primarily travels through, canals and piped systems across the entire county, and beyond, and has multiple uses: flood or atmospheric irrigation after applying pesticides, single cropped fields, and grasses for livestock. It may spread ashes remaining from large-scale burning and other toxic pollutants. For some residents, a "lawn" can even be considered additional parking spots or a place to play on the occasional day off. It does not mean big lush green spaces for show or for aesthetic purposes as it does in other communities or wealthier neighborhoods. Historically, residents' need for access to blue spaces was ignored just as much as it was for green spaces, but today we see both types of spaces being included in the work of environmental justice communities and because of equity concerns. It is important to note that I have disregarded the population outside of the IV in order to conduct my analysis on a local level so I can best align my findings with the specific community, resources, and shared missions that uplift communities historically left out of the conversation and forced to live with harmful exposure.

At first glance, it would seem that EJ communities rank these values much differently from non-EJ residents. While EJ residents consistently rank Air Quality as a number 1 priority, non-EJ residents rank Accessibility/ Transportation as a number 1 priority. It would make sense, especially for residents in more rural parts of the Imperial Valley, and non-EJ communities, to have less access to public transportation (which is also mostly non-existent for city residents). These rural residents may also have less access to grocery stores, childcare services, and city hall amenities or opportunities. I used median rankings to identify how EJ Communities stated their priorities. The following ranking was determined and used in the AHP model for part A vs B, setting Impaired Waters and Green Space equal to one another:

1. Air Quality
2. Impaired Waters AND Green Space (tied for ranking at #2)
3. Accessibility / Transportation AND Hazardous Waste Sites (tied for ranking at #3)

The ranking would look much different if we were looking at the non-EJ residents:

1. Accessibility / Transportation
2. Air Quality, Impaired Water, and Green Space (tied for ranking at #2)
3. Hazardous Waste

Although we still see hazardous waste at the bottom, there is a drastic difference in the ways they prioritize Accessibility and Transportation. This is a crucial finding when considering the power of representation in decision making and community engagement. If we were to focus on the residents with lower burdens, then we might aim to fix issues that are not a priority to those disproportionately experiencing the impact. Given that the sample sizes are on the smaller end, that there were more EJ respondents, and that the AHP calculator does not include

decimal points, the scores for ALL residents provided the same results as the EJ community ranking. More information about the calculator inputs can be found in the Methods section. Calculator outputs are shown in Figure 15.

Figure 15: AHP calculator results for final index

Cat		Priority	Rank	(+)	(-)
1	Haz Waste	16.7%	2	0.0%	0.0%
2	Air Quality	33.3%	1	0.0%	0.0%
3	Accessibility / Transportation	16.7%	2	0.0%	0.0%
4	Green Space	16.7%	2	0.0%	0.0%
5	Impaired Waters	16.7%	2	0.0%	0.0%

The calculator produced a weighted ranking where Air Quality is at number one, with 33.3% of the priority weight. Although these AHP rankings do not look like the survey median ranking results, it is clear that the items ranked #3, #4, and #5 got identical rankings. These are the true results of the math and AHP tool. An increase in sample size might allow for clearer distinction in priority. The survey will remain open till May 31st, 2025 and will be updated in June. This date is outside the thesis timeline, but I intend it to be an accurate and inclusive tool, allowing input from the community past this arbitrary deadline. I used these results in the final spatial analysis tool that combines the individual factors into the Environmental Justice indicator.

In the rest of this paper I will address the main research question: How can Environmental Justice principles be incorporated into an opportunity index to create a spatial tool for planning in the Imperial Valley towns and cities?

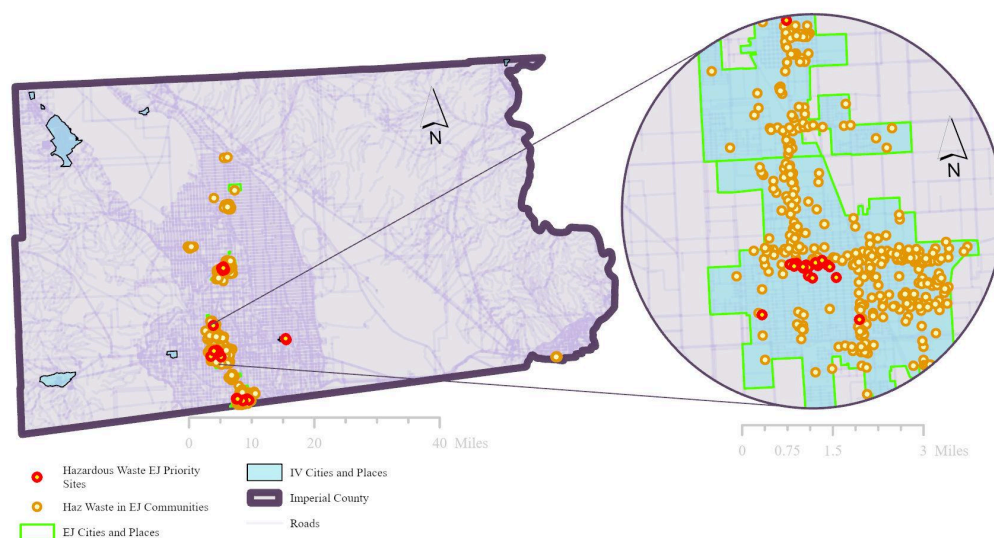
Indicators and Results

More information on how I set the environments and how I began the spatial analysis can be found in Part 1: Spatial Data Analysis section in the Methodology.

Hazardous Waste Sites

I first approached this layer by identifying large overlaps of exposure, in other words , priority communities, or those with the **highest opportunity for reducing impact and increasing the quality of life** through removing hazardous wastes or passing further regulations to protect the local residents. Figure 16 shows hazardous waste sites within the overlap in red and the hazardous waste sites in EJ communities in orange. This map helped to clearly identify the 53 hazardous site locations that public school children pass frequently on their way to and from their campuses, along with the 878 located within EJ communities.

Figure 16: Priority hazardous and toxic waste sites for remediation



Given the EJ focus, of course I overlay the findings with racial data, as shown below:

Figure 17: Map of hazardous sites and percent of population by race



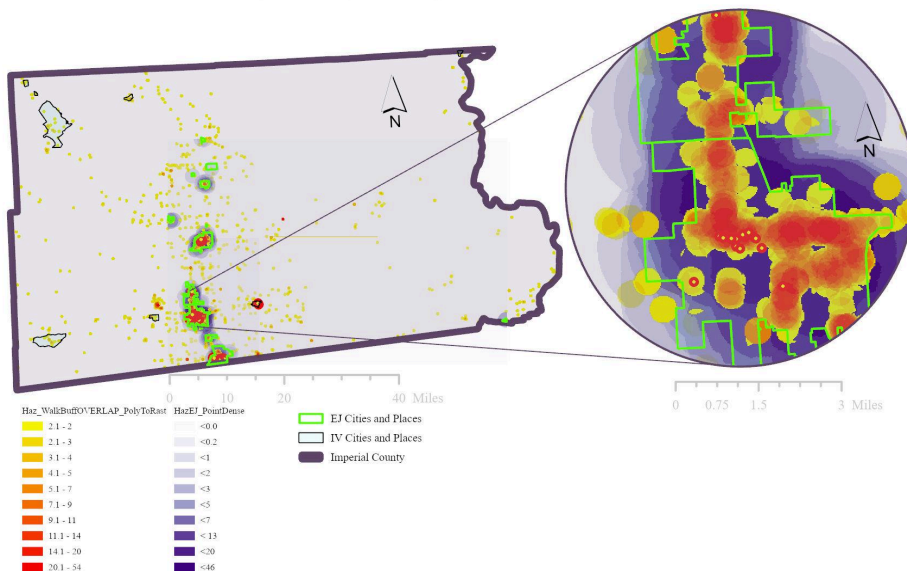
It is important to recall the population is predominantly Hispanic, with over 85% of the population.

These visuals show the percentage of race for the total population of each census tract. The White population is only around 9% of the total population and required a different scale to show any range of data by census tract. This also lets us clearly see that the greatest population of White residents are outside of our EJ community boundaries. Black residents are only 3% of the population.

Figure 18 shows the results of my analysis of the hazardous and toxic site data before I reclassified them and used the raster

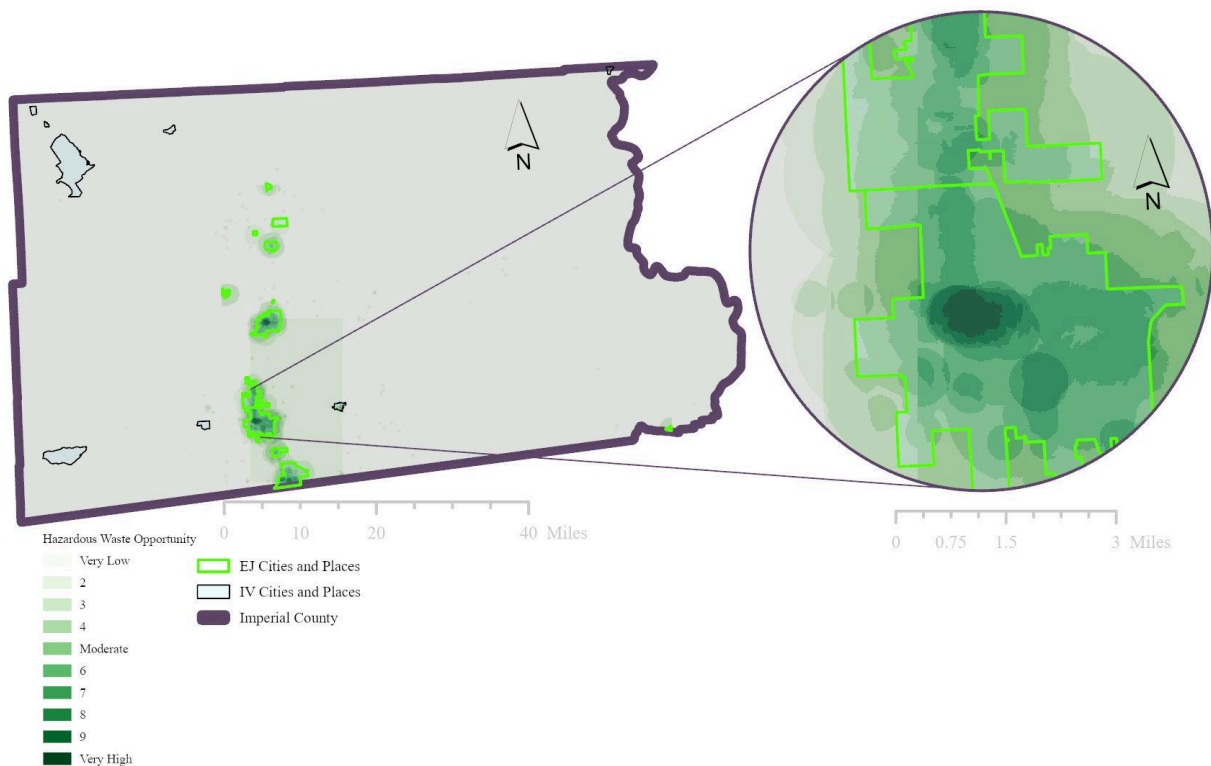
Figure 18: Map of toxic exposure variables before reclassification

calculator. Details of this analysis are in the Methods section under [Spatial Data Analysis](#) for Hazardous Waste.



This final map shows the results of reclassifying each layer and adding them together with the associated weights. I zoomed in towards El Centro and Imperial to start exploring how we can use this tool to identify the specific communities that suffer the greatest impact from their proximity to hazardous and toxic sites. The recommendations in Part 4 will explore all the variables, including policy, planning, and organizing techniques that can decrease exposure, risk, or awareness around this issue.

Figure 19: Final map of toxic exposure (after reclassification)



Access and Circulation

Figure 20 shows existing bus routes and stops; this can be very misleading given the inconsistent and unreliable public transit system. However, it can still be helpful to determine whether more investments, or changes in the existing stops and routes could meet the community's true needs for mobility and accessibility. It may look as if much of the area is not connected, but when we look back at the land use of this area, much of the connected land is either agriculture, sandy areas, mountain ranges, or private farms and homes of land owners. When we zoom in, it does become more evident that people in large neighborhoods and more developed communities do not have public transit connectivity to local grocery stores or childcare.

Figure 20: Map of public transit in with food and childcare locations



This map shows reasonable access, if it was reliable and frequent. Hopefully this encourages municipalities to further invest in their existing infrastructure rather than overtaking a large project that may take longer to implement. Given what we know about the existing transportation infrastructure, the rest of the mobility analysis will consider service areas using vehicles and walking as the primary modes of transportation.

The service area map using grocery stores can be found in Figure 21. Coverage can be seen in our EJ communities, IF they have access to a car. Over 80% of residents solo-travel an average of 22-minutes to work each day resulting in over 200,000 metric tons of carbon dioxide emissions each year. Not only do we need to invest in our public transportation for equitable access, but also to begin our climate resilience journey as temperatures continue to rise.

Figure 21: Map showing driving service area for grocery stores in the Imperial County

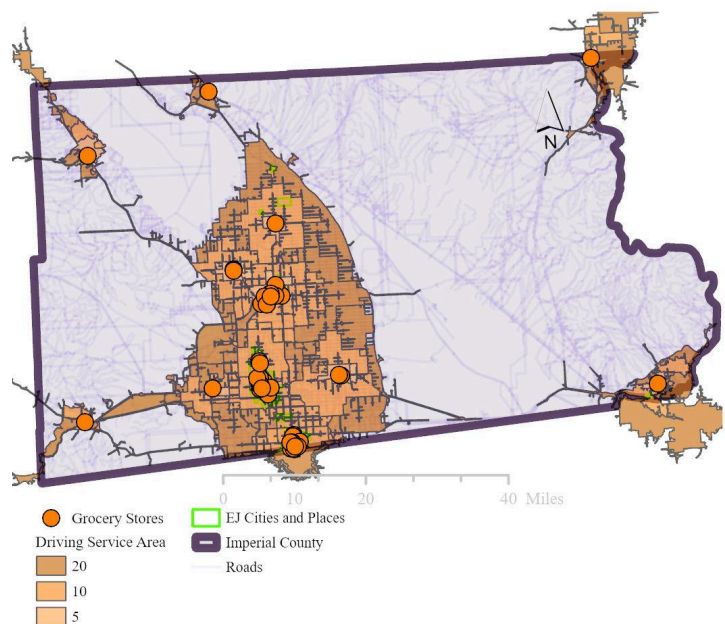
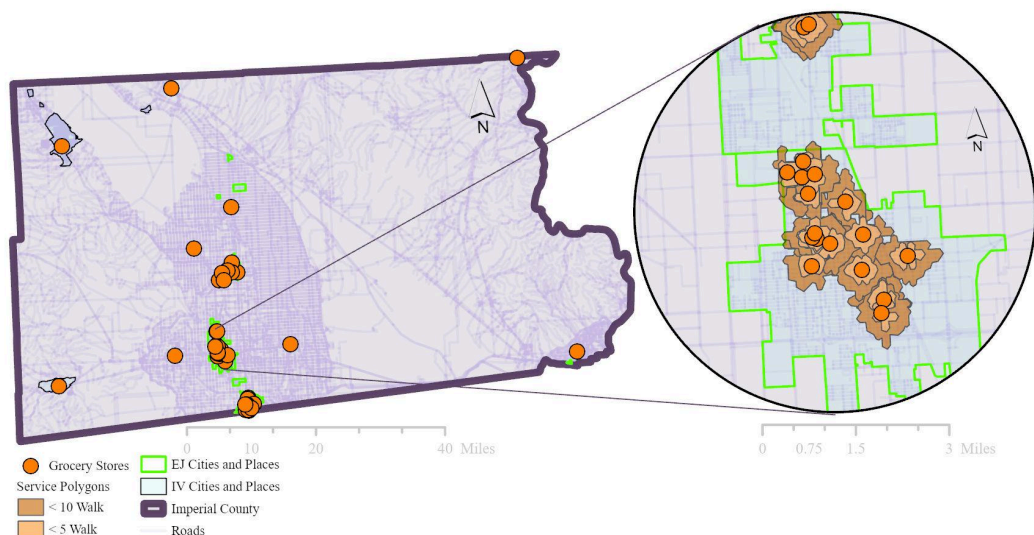


Figure 22 uses the same grocery stores, but changes the mode of transportation to walking distances. There is a clear reduction of service area when we remove access to personal vehicles. Although over 80% of households have access to vehicles, many residents have vehicles over 12-years-old and experience difficulty or break downs each year. Vehicle access can not be included from a justice lens given survey feedback and best practice from previous case studies. This map shows a critical need to improve the public transit system or amend neighborhood zoning to increase opportunity for smaller grocery

Figure 22: Walking distance service area map for grocery stores in the Imperial Valley

stores within existing neighborhoods.



After zooming in and adding schools, I discovered a massive area where communities do not have grocery stores within walking distance in relation to their local public schools and childcare facilities. Existing housing does not provide its residents with even access to education and food, simple basic needs.

Figure 23: Map of grocery store service in El Centro and Calexico

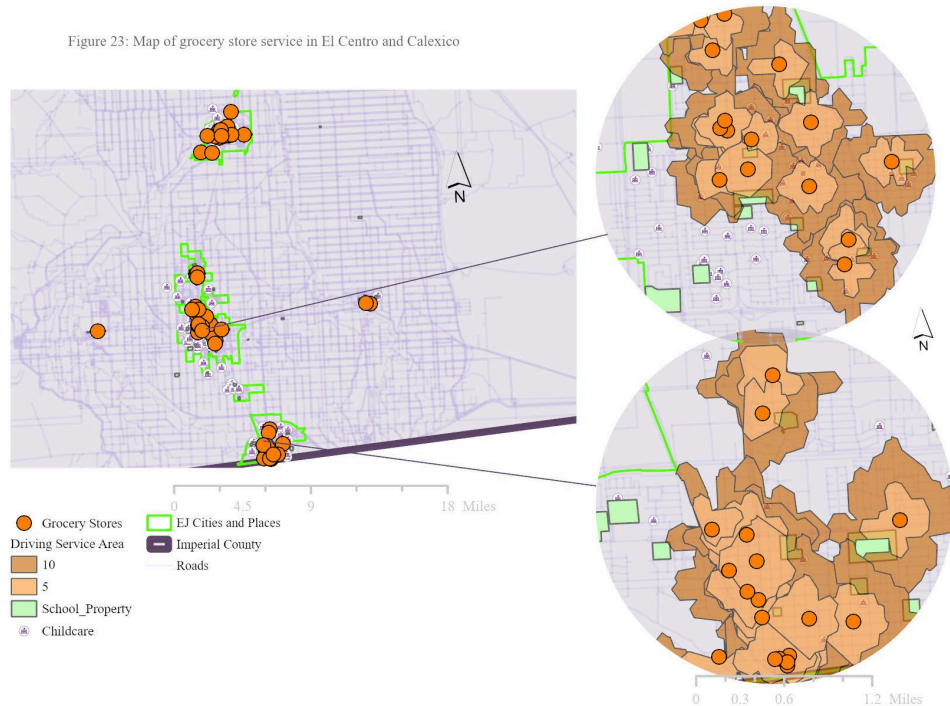
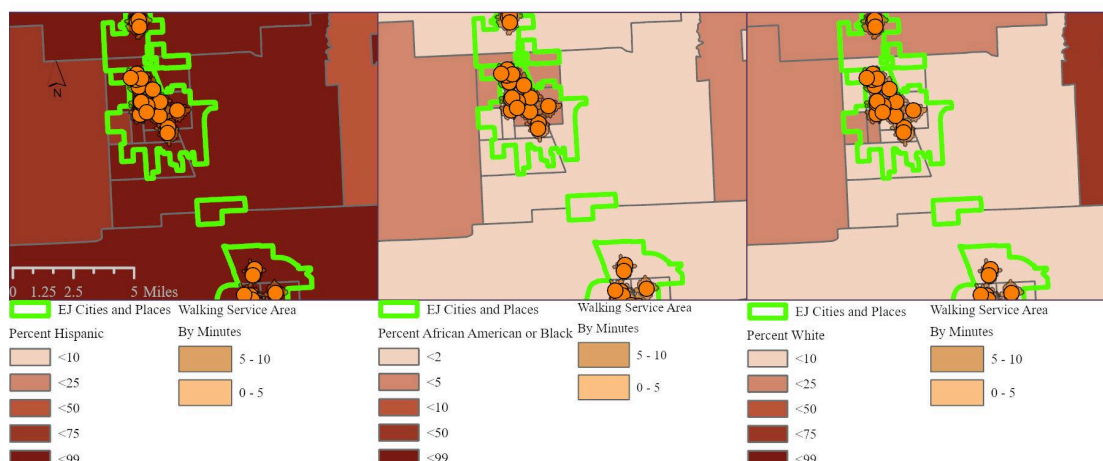


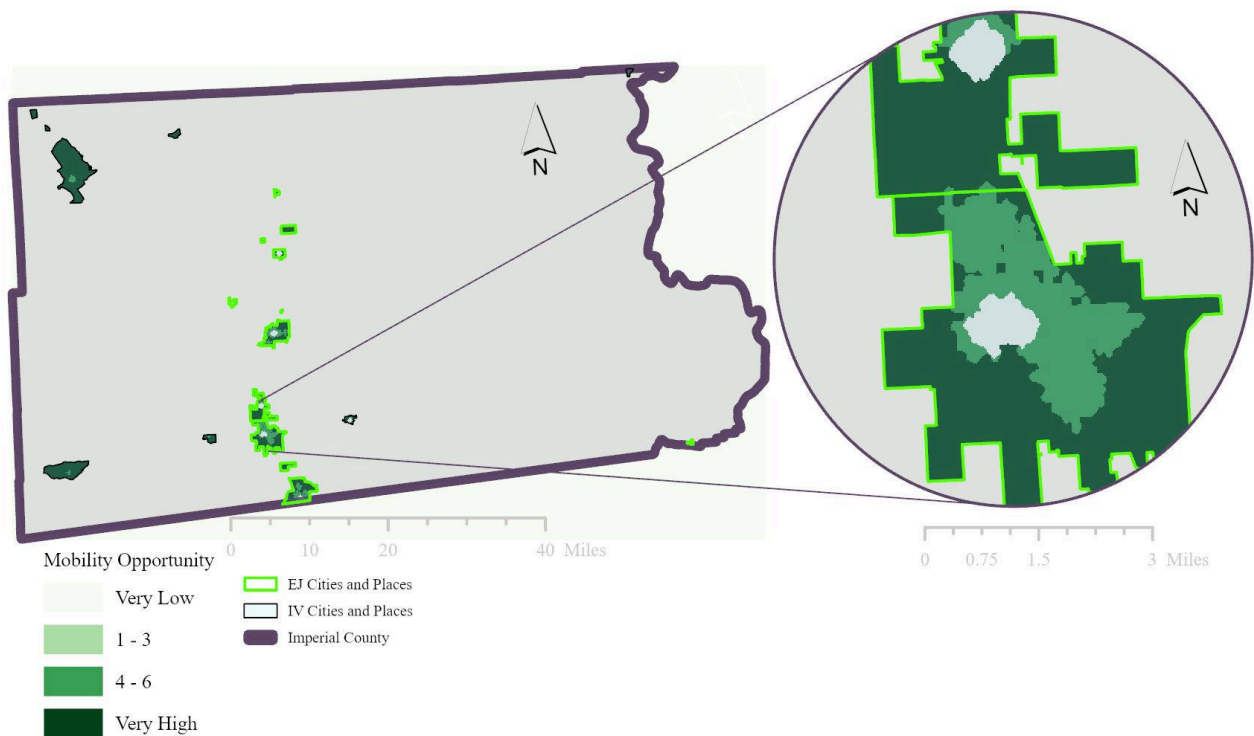
Figure 26 shows the overlay of service area findings with racial data. It's interesting to see some of the Black and White residents have a higher percentage of the census tract population in the walking distance service areas, but the census tract with the largest density of White residents is in a rural community. These areas are disconnected from some of the traditional grocery stores in the cities- but this study does not explore the street vendors or farmers who live off their crops.

Figure 24: Map grocery store service areas and percent of population by race



By repeating the steps described in the Methods section for city halls, I was able to determine the service area for those who have access to a vehicle and walking distance. Results showed even smaller service areas given the fewer locations. The layer created in the city hall analysis was combined with grocery stores to create the final mobility / service area map. The final step for this variable, as described in the Methods section, was to identify areas within a city or place that are not within walking distance of grocery stores or city hall and then reclassify them on the opportunity scale of 1-10. The results are shown in Figure 25 below.

Figure 25: Final map of grocery store and city hall access (combined and reclassified)

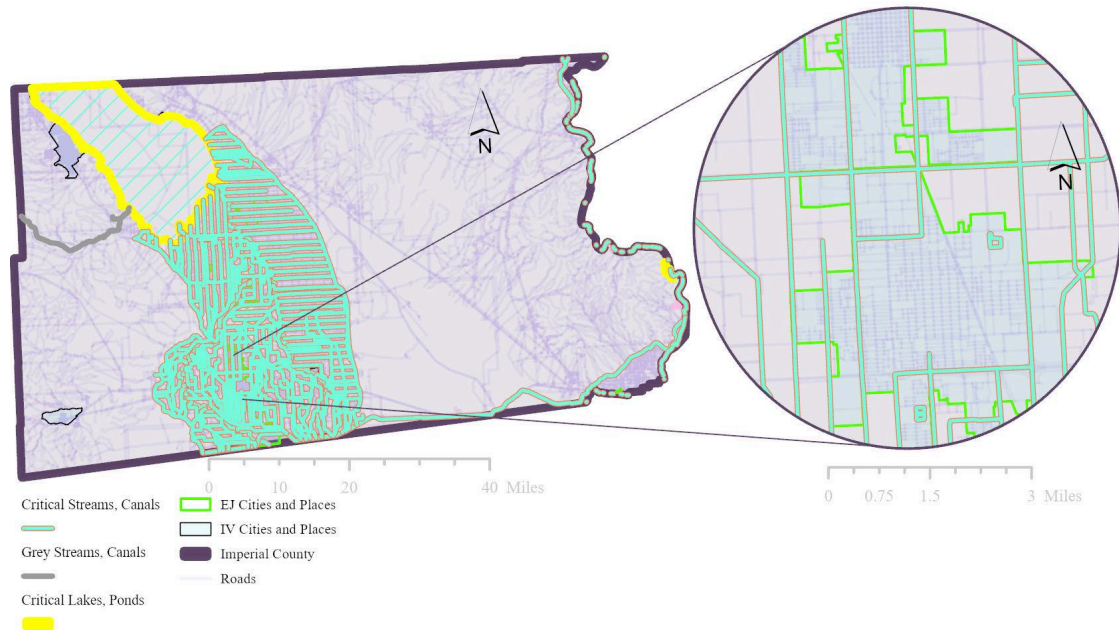


We see large areas of low opportunity at the center of some of these cities and places because those areas are within walking distance to city hall and a grocery store. These maps increase clarity around issues related to sprawl and how we must focus on improving our connectivity through public transportation, but also consider increasing our density and offerings for food and city hall related amenities.

Impaired Waters

The map in Figure 26 visualizes the rivers, streams, lakes, and ponds that do **not** meet water quality standards for nutrient loading from the Environmental Protection Agency. In more technical terms, we have Category 2 and Category 5 water bodies present here: *Grey Water* and *Critical Health Hazards*.

Figure 26: Map showing impaired waters in the Imperial Valley

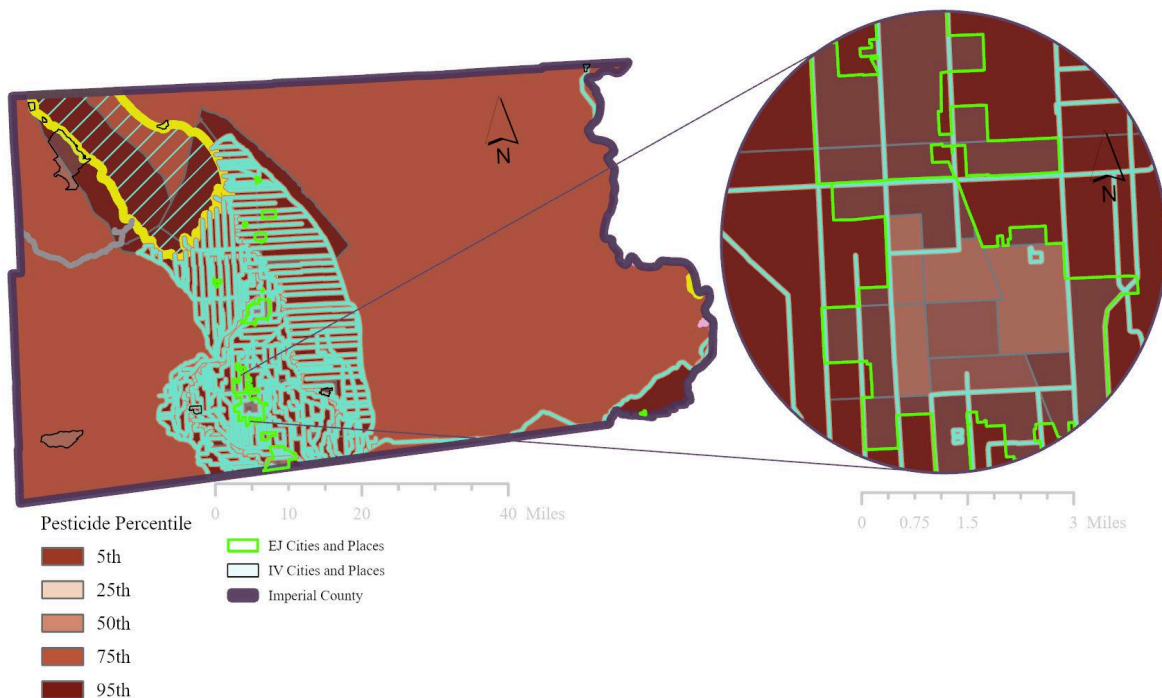


Many of the links within the TMDL report, and in the county materials, were broken and I could find little to no contact information that would let me ask that the correct information be uploaded to county and research websites. Eventually, I decided to approach the TMDL from the Colorado River perspective, given that consistent funding and capacity are available for this water body resource. The State of California Colorado River Basin Regional Water Quality Control Board has a few TMDLs for the Imperial Valley - one specifically for testing pesticides! Thinking about pesticide exposure in these contaminated areas aroused my curiosity, so Figure 30 shows pesticide percentile; this reveals a clear relationship between higher exposure and contaminated waters.

When looking at rivers, streams, and canals, we see that all of our communities are greatly exposed to impaired waters. Not only does this reduce biodiversity and healthy levels for aquatic species; it

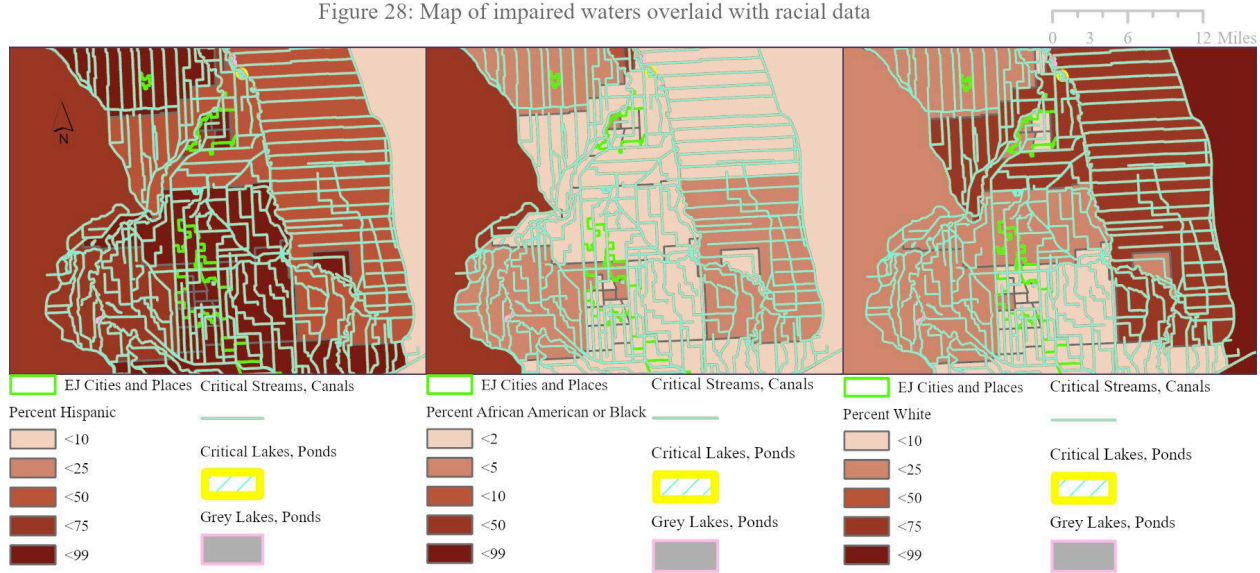
also raises concerns for children and vulnerable populations looking to enjoy these water bodies on hot days—which occur through most of the year in Imperial County. Many youth are exposed to Dippy Duck from an early age; this figure warns them about the dangers of canals, given people’s frequent access to them and the high rates of canal-related injuries and even deaths. Schools invest more money on telling children to stay away from canals than on educating them about the quality levels and usage demands that our communities are imposing on these water systems.

Figure 27: Map of pesticide exposure by percentile at the census tract level in the Imperial Valley



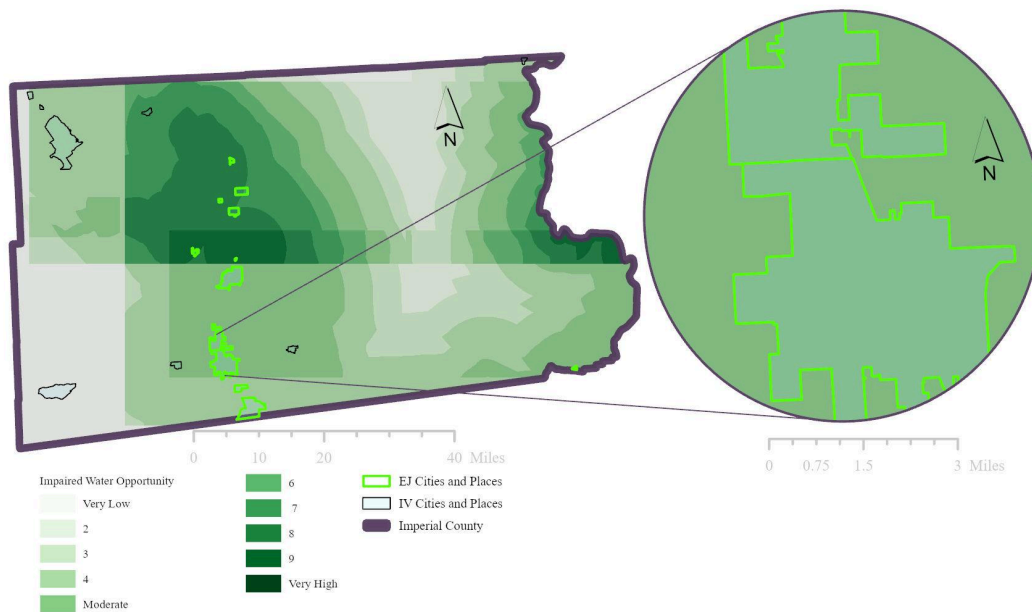
When we explored this data in relation to race, an interesting pattern was found. There are very complex canal and dense canal systems that run through the cities, where a large percentage of the population are Hispanic. When looking at the census tracts where a greater portion of the population is White, we see cleaner systems with straight lines. This could easily be a result of rural land, which has more space for simple systems and runs along existing fields. Or, we might be seeing the results of racial planning and disregard for the Hispanic communities living in the cities. Figure 31 shows the racial demographics around the layers of contaminated rivers, lakes, ponds, and streams.

Figure 28: Map of impaired waters overlaid with racial data



After using the tools described in the methods, I combined all four raster layers to create the final impaired waters index, as shown in Figure 32. Given the critical condition of the Salton Sea, we will see much higher values in that area. Given that some parts of the Valley are barren land or desert areas with little to no water sources, some areas may have a score of one, indicating Very Low opportunity to fix impaired waters there.

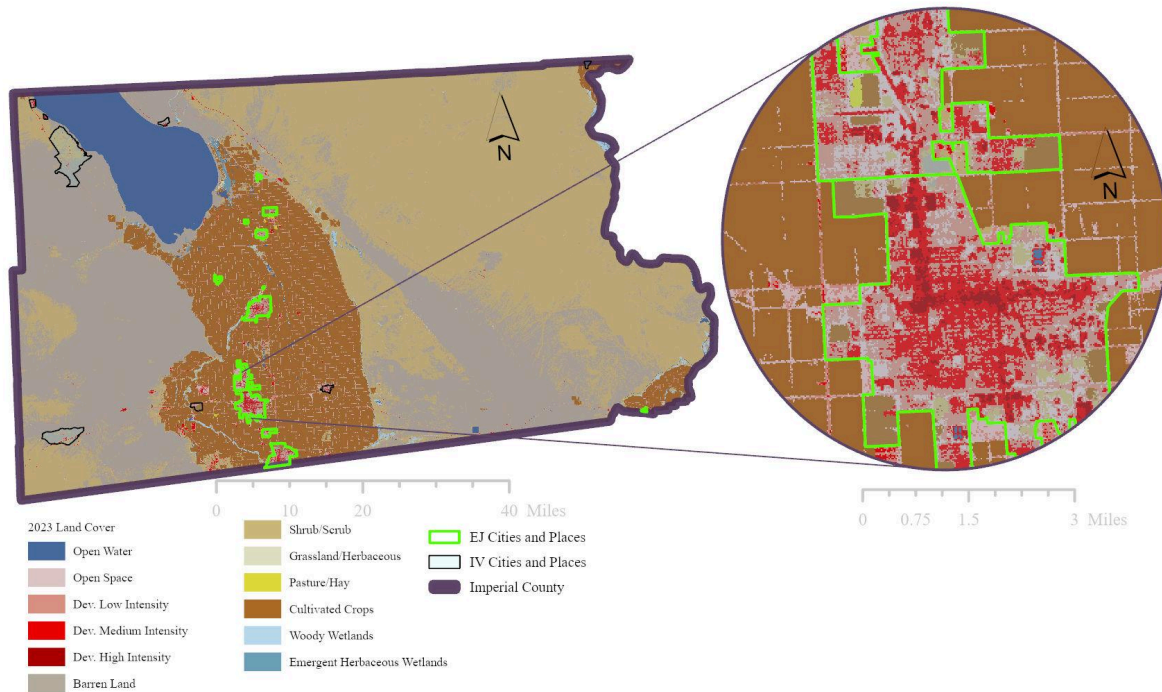
Figure 29: Final map of impaired waters in the Imperial Valley (reclassified)



Access to Green Spaces

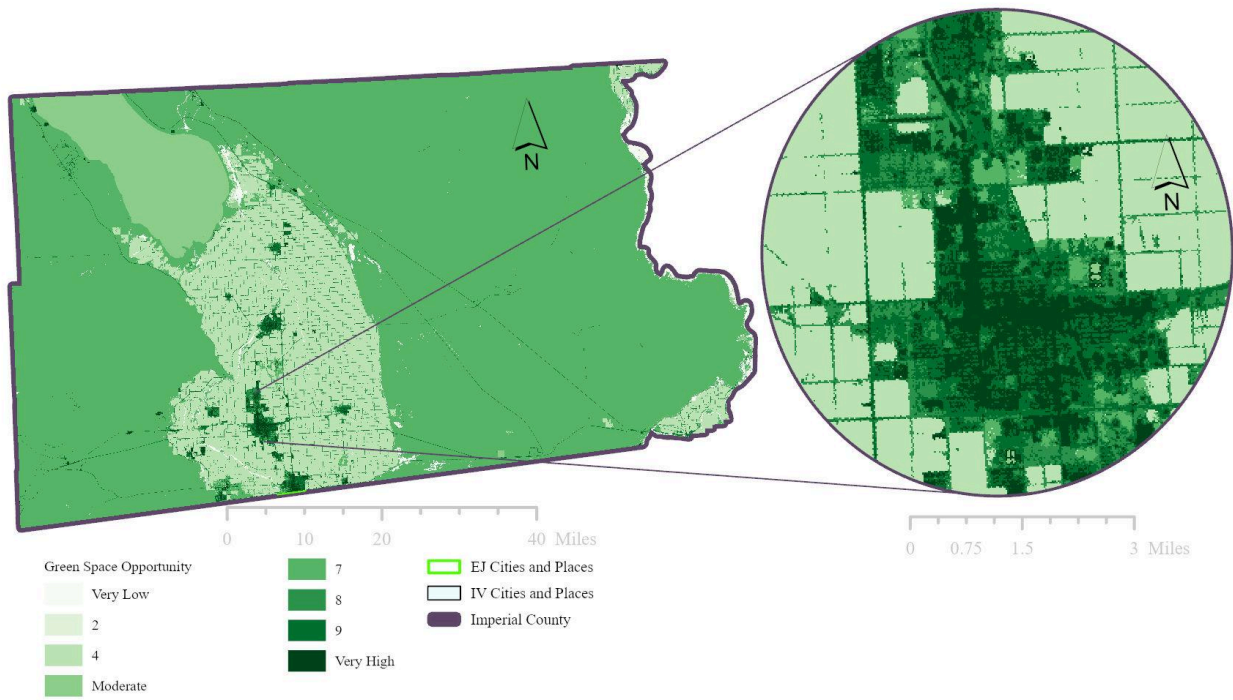
I then reclassified the National Land Cover Data using the tools and intentions described in the Methodology section. Much of what we see is low- or medium-density development surrounded by cultivated crops or agricultural land, with very little access to green or recreational space in the EJ communities.

Figure 30: Imperial Valley map of 2023 National Land Cover Data



Areas that increase quality of life and improve environmental conditions include more access to open water, green spaces, and wetlands; ecological benefits from natural systems include carbon reduction and cleaner air. We see that many of the waters in this area are contaminated and natural systems can only do so much to counteract the anthropogenic influence. The results of this reclassification are shown in Figure 34. Recommendations from the map can be found in [Part 4](#).

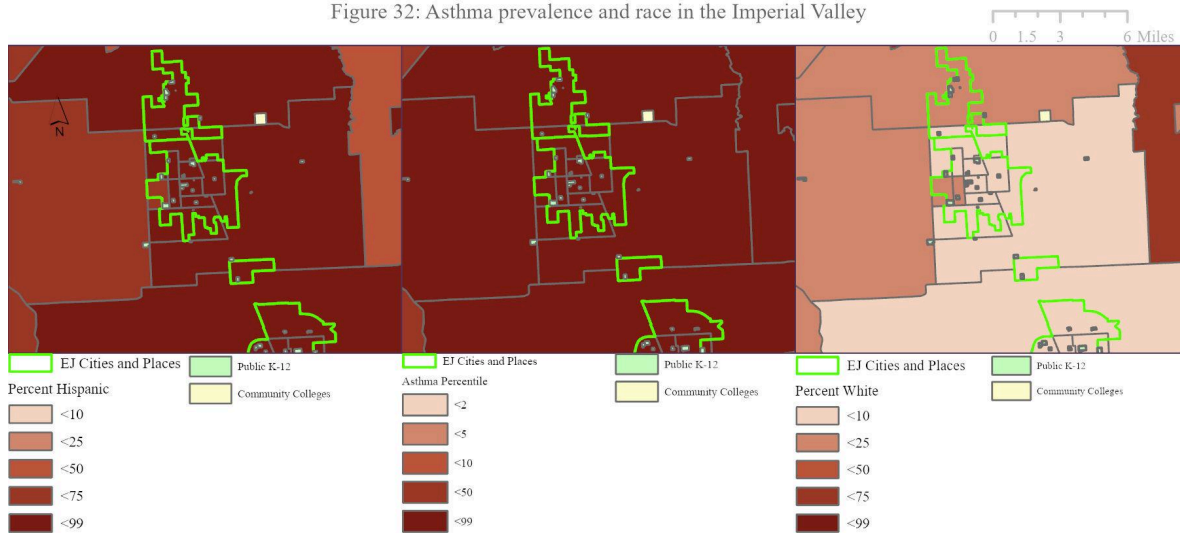
Figure 31: Final map of green space in the Imperial Valley



Air Quality

Studies show an association between asthma rates and air quality and we know the 2025 American Lung Association calculator study gave the Imperial County an “F” for Daily and Annual Ozone Particle Pollution levels.⁴⁶ When thinking about land use, it is important to remember both that density and developed spaces may naturally contribute lower rates of air quality, but also the importance of where populations are living and how their racial demographics may impact their ability to access cleaner areas.

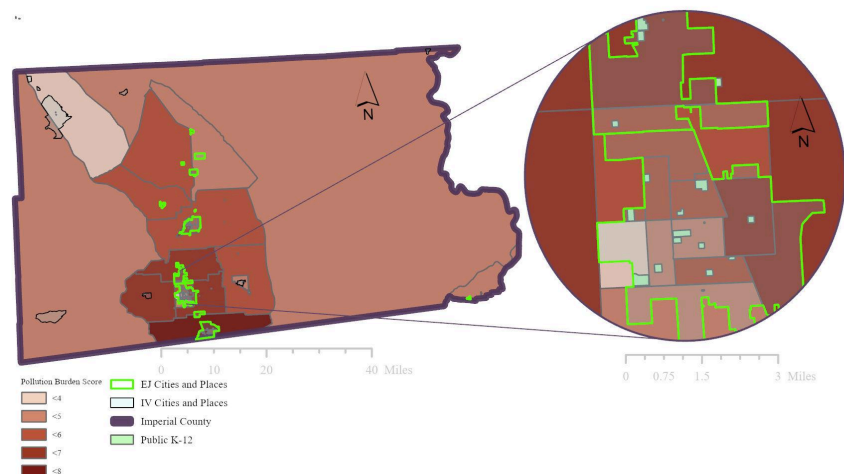
Figure 32: Asthma prevalence and race in the Imperial Valley



For spatial reference, we see the yellow square to the mid upper right area which represents the Imperial Valley Community

College. Interestingly, a large percentage of the schools in El Centro, the middle neon green city, are highlighted. This represents yet another reason to prioritize these areas with vulnerable populations.

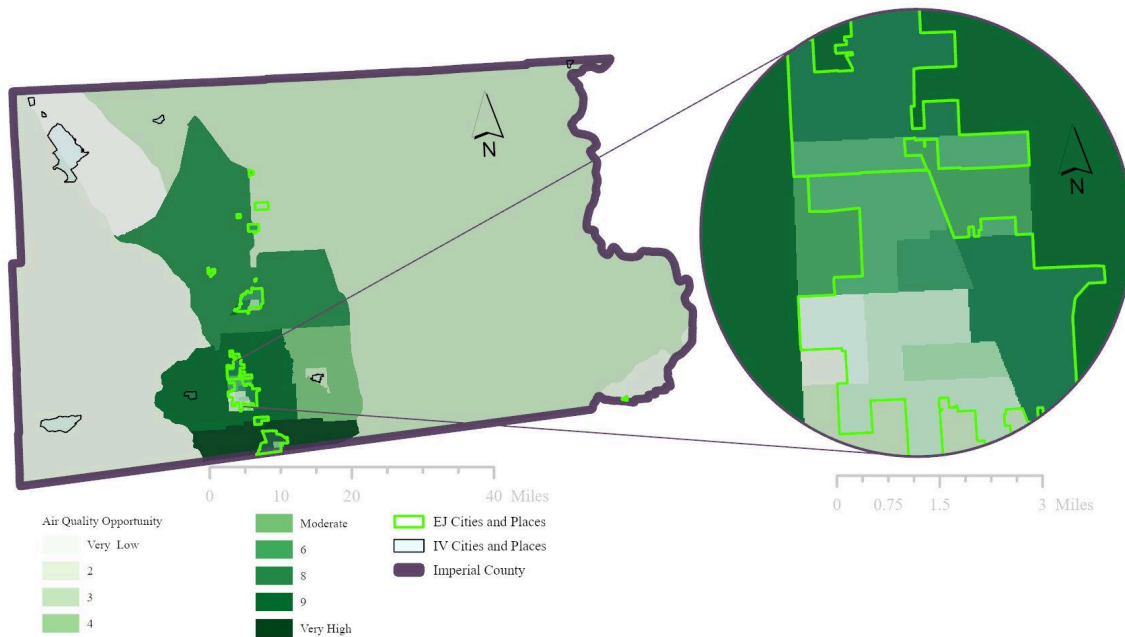
Figure 33: CalEnviroScreen 2019 Pollution Burden Score



⁴⁶American Lung Association, “California: Imperial.”

Following the methods described previously led to the reclassified layer results shown in Figure 37. In both map scopes, we can see the non-EJ communities outlined in black lie primarily in lower burden areas, except for Seeley. Additionally, we see areas of lower burden in the southwestern part of El Centro where newer buildings and open land with higher value are located.

Figure 34: Final map of air quality in the Imperial Valley (reclassified)



Now, having completed this part of the analysis, I report how I combined each layer to consider each variable and see which areas have the greatest opportunity. After I had completed much of my work , I discovered the 2023 Puget Sound Regional Council *Racial Equity Impact Assessment*, which provides accessible methodology for conducting a racial equity impact assessment. This report provides six key steps, with one precondition, as listed below:

Precondition: Early Inclusive Engagement

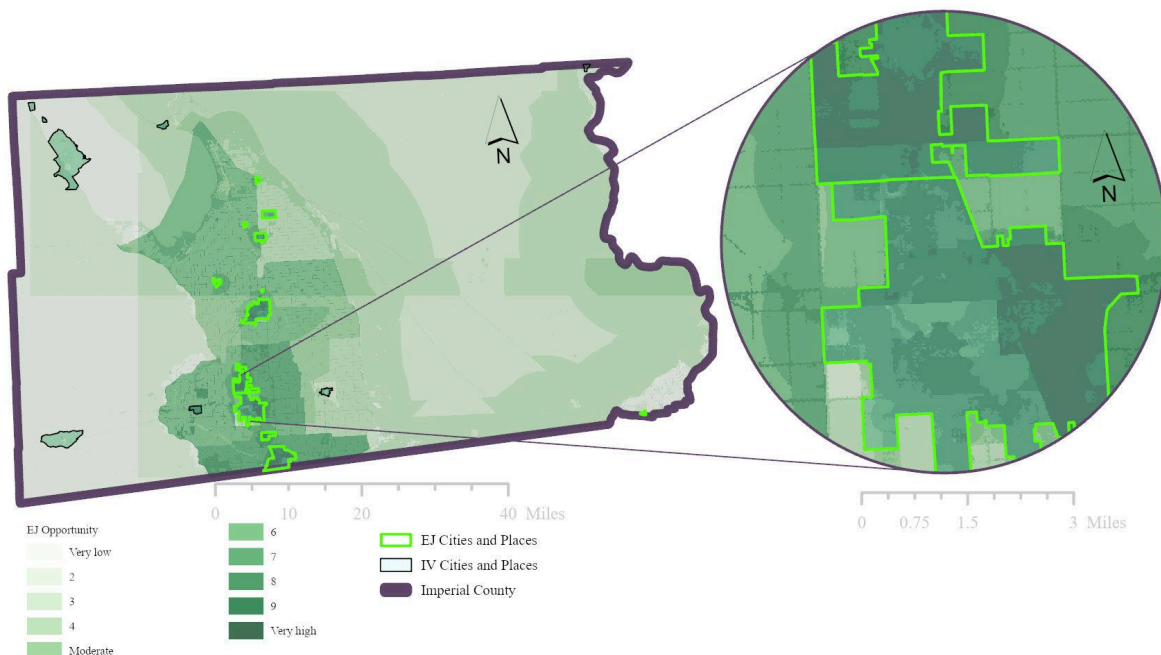
- Step 1: Identify comprehensive plan proposals to assess
- Step 2: Gather and analyze information and data
- Step 3: Engage communities
- Step 4: Identify strategies for advancing racial equity
- Step 5: Ensure accountability and communicate
- Step 6: Evaluate outcomes and next steps

It was nice to see a process similar to mine that compliments these efforts while providing additional guidance. I began my thesis project by consulting with a planner and local organizations before diving into literature and community engagement. In the rest of this paper I will discuss my findings, explore strategies, and identify what comes next.

Part 3: Understanding and Discussing the Tool

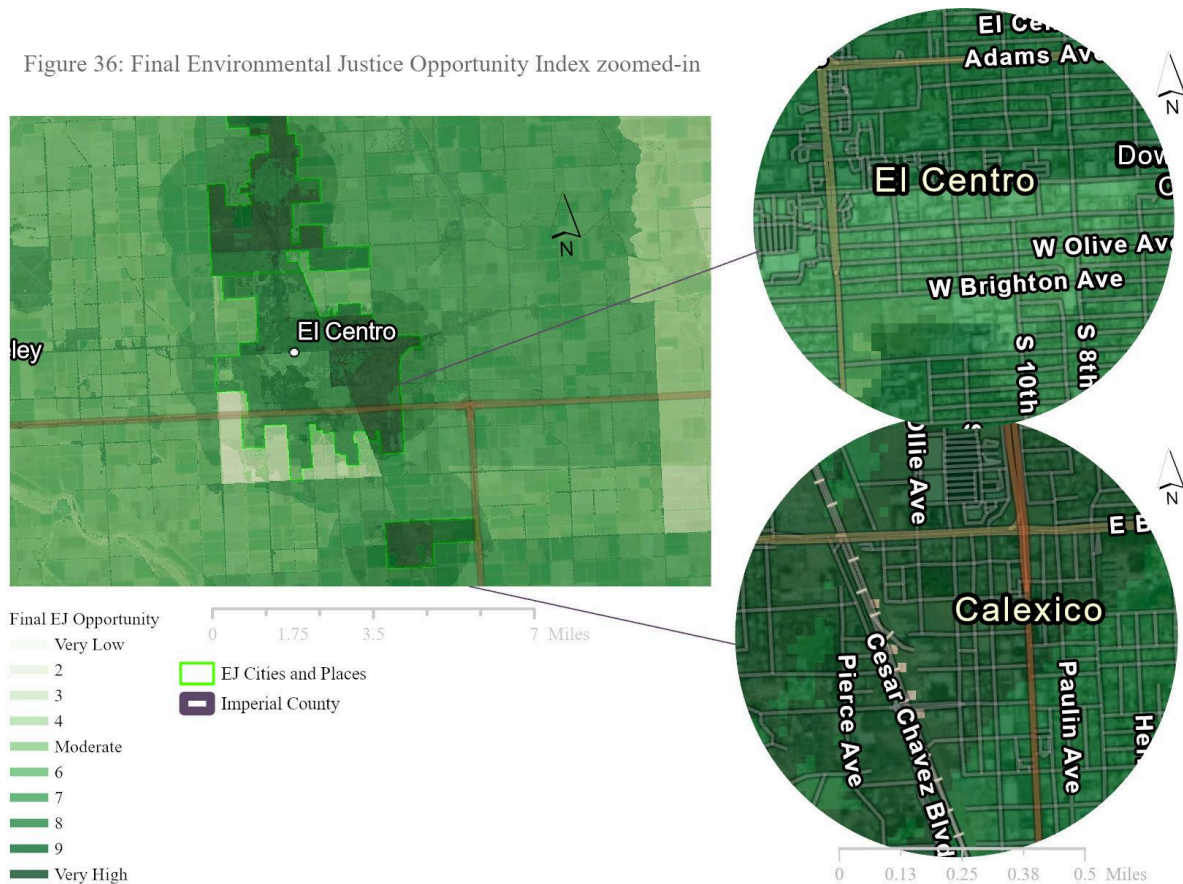
The scale used in this index is inverse to the traditional approach. Here, 1 shows the very low opportunity for increasing environmental justice through an element in a comprehensive plan, and 10 shows a very high opportunity for doing so. This is an inverse from traditional opportunity indices because here I am looking for areas that have a lower standard for quality of life or environmental justice and thus have the highest opportunity—rather than looking for communities that are actively succeeding at implementing environmental justice in their communities. For example, fast and easy access to open spaces and parks will be ranked lower on those lists because they already have a higher quality of access to a variable that is often more difficult to access for black and brown communities. On the other hand, areas that are outside of the “service area” for a grocery store will have a higher score because there is greater opportunity to influence change towards greater environmental justice through an element in the Circulation or Health element of a comprehensive plan. The results of the AHP calculator were seen in Figure 15, where I utilized the survey results to determine the associated weights for the final opportunity index.

Figure 35: Final Environmental Justice Opportunity Index



There is no surprise that high opportunity can be found in the EJ communities, especially since some layers gave higher weight or priority to these areas. In using this tool I was not looking to create new data, but instead to transform existing information using an accessible tool that can point out any need all the way down to the specific neighborhood, street, or parking lot.

Figure 36: Final Environmental Justice Opportunity Index zoomed-in



These maps increased transparency and incorporated a reference layer with street names to show examples of how to identify opportunity at a zoomed-in / neighborhood level. A table of results for each city and town can be found in Appendix 11. This table clearly communicates which communities have highest opportunity scores through different forms: total normalized scores, mean, median, min, and max.

The Power of Space and Organizing

You have to act as if it were possible to radically transform the world. And you have to do it all the time. Angela Davis

The Imperial Valley has two organizations that inspired my work; one is focused on air quality and the other around organizing for equity and justice. Although this study did not quantify how organizing empowers residents to engage in their communities or increase familiarity around topics, the findings on air quality can lead one to believe there is power in community building.

All of the successful environmental justice case studies leveraged the power from community organizing and engagement in the policy process. Although barriers to accessing public decision making spaces still exist, like lack of childcare, transportation, or non-traditional work hours/industries, people have identified the power in gathering. The key is often a shared mission and resources from funders that want to advance those shared values in rights to clean and high quality communities.

Connecting with our neighbors and asking for help are two actions that can profoundly shift how we see our ability to transition from a capitalist society to a gift economy. This need not involve free labor or loss of operational support, but it does mean sharing resources. When we can remember past experience, respect diverse identities, and envision a shared future, we can turn complex challenges into an opportunity to build relationships and celebrate our successes.

One main purpose of the GIS tool created in this project was to remove some of the responsibility for data cleaning and conducting a foundational site analysis from the organizers. Community-based and solutions-focused groups can skip the time needed to gather quantitative data and immediately access, or refer others to, the spatial tool. Organizers can encourage residents to visually understand their relationship to a local concern and can increase their opportunity to uplift change, build trust, and educate their neighbors—which ultimately empowers community engagement in the planning process.

Appendix 11 breaks down Environmental Justice Opportunity Score by community, where we see all nine of the cities or towns with EJ communities have a 7.6 or higher, meaning everyone is above moderate opportunity level. Organizers can leverage this information to increase awareness, engagement, and make real change. A list of recommended resources to start conversation can be found in Appendix 12.

Moving forward, recommendations will be rooted in different methods from this study. The maps, survey statistics, and final environmental justice scores will result in **quantitative** recommendations, or suggestions pulled directly from numerical data. The other recommendations are considered *qualitative* suggestions because they are supported by literature, CA case studies, survey open response, and personal knowledge around current issues and initiatives specific to the Imperial Valley.

Identifying Challenges and Gaps

Leniency in Regulations

Much of the literature, including legal documents from the OPR, includes objectives to identify policies and plans that “address the needs” of impacted communities, but rarely did I see expectations or requirements to clearly identify AND communicate those needs to start. The requirements for compliance when implementing environmental justice in a General Plan are beyond pliable given the need to update two or more elements at once, but the only legal requirement is to update one element ever: the housing element every 4 to 8 years. This stipulation has allowed some jurisdictions in the Imperial Valley to have documents from 1996 directing the planning goals of their city, and still be meeting regulations.

Many efforts that have been proven to support informed planning and the focus on the community are merely recommended by the OPR. For example, specific language around early community engagement is only a recommended way to accurately identify needs. Until there is a way to have full buy-in, capacity, and funding, change may prove to be difficult.

Moreover, the municipalities' planning documents themselves are missing crucial items like clear definitions. Instead we read vague language like "location of disadvantaged communities as well as the nature of their environmental burdens, health risks, and needs". In this study I have aimed to provide this first step of planning to fill the gap for each municipality and reduce the barriers to the next steps of identifying policies and plans to address these needs.

U.S.-Focused Reference Literature

After reading through many legal documents from the State of California, I noticed that many of the examples and literature they referred to did not include efforts or plans in Mexico, or countries with similar racial structures and agricultural industries. Given that the Imperial County borders Mexico, and that many of the residents are immigrants or of Hispanic descent, it feels crucial to acknowledge and explore efforts being made by the Mexican Government and opportunities for collaboration.

Another major concern in the literature is the inability of tribal groups to engage in meaningful decision-making opportunities, which could further align us with the Seventeen Principles of EJ. Although regulatory requirements may differ, this land is still shared and no municipal boundary can prevent air pollution or contaminated water from moving into the next state.

Lack of Monitoring and Evaluating Implementation

According to the California's Governor's Office of Planning and Research, some jurisdictions create a General Plan Element, but do "not numerically track statistics regarding implementation" of the elements. This may well create a major challenge for those trying to evaluate the effectiveness of a policy or plan. Many grants and programs require documentation that shows their funding is going towards tools and plans that will improve a community, but if a given municipality is not held responsible for collecting such data, it may simply become more difficult for the next group that applies for funding to support future efforts.

Emerging ideas support evolution and development but concerns arise when programs lack follow-up or evaluation. For example, little data is available on unhoused populations. The term “homelessness” was introduced in the 1870s, but few have ever planned to support these populations and the widespread failure to include them in household-level data raises concerns about inaccuracy and discrimination. How does the ability to afford a home equate to being valuable enough to be included when the community collects data on needs and existing conditions? If census or community data is collected on a household level, like much of the data used in this project, then analyses based on that data results do not fully represent the community at large, including some of our most vulnerable populations. Similar challenges arise when considering undocumented or non-English speaking populations who are often unaccounted for out of fear, language barriers, or other complex challenges.

Working Remotely

The final, but potentially largest challenge I experienced was physical: being across an entire continent from the population of interest. I measured community engagement and shared my results using methods that could introduce bias and skew my survey results. Additionally, it was very difficult to ensure that hard-to-reach populations were engaged and considered. My inability to connect with local tribal governments also left me disconnected from my deep environmental justice intention of including all peoples and respecting original traditions.

Part 4: Moving Forward

Having explored the background of the community, and explained both environmental justice issues and my methods, I turn to explore how this work can propel other efforts, or at least guide further curiosity and support at individual, organizational, and governing levels.

Limitations and Challenges

A major goal for this thesis was to conduct research and engage remotely in a data-driven planning process . Since the outbreak of COVID-19, many in our world have transitioned into hybrid and remote spaces which have proven to provide a diversity of benefits and challenges. One major challenge is the ability to engage with real people and build trust while working collaboratively towards a shared goal. Many teams and organizations are making great strides in addressing these challenges, but this project taught me the true value of in-person engagement. It proved to be very difficult to match the schedules of a busy graduate student on the East Coast and busy planners and organizers in Southern California . By scheduling far enough in advance, we could find ample times that met both of our needs, but being in different time zones when we met meant we did not always share the same level of alertness.

Being remote made it quite difficult to build trust and communicative relationships with organizers, including Indigenous peoples and owners of agricultural land. These two populations were of unique interest given their position in history and diverse relationships with the land. It is crucial to establish a feeling of belonging and safety about decision-making to develop long-lasting partnerships and collaborative efforts. My survey influenced our interdisciplinary approach to management and priority, but some opinions were not considered in the prioritization.

The need for accessibility remained prominent . City staff have access to the internet, technological devices, and administrative staff to manage conference calls and Zoom meetings. It proved much harder, however, to tap into the “hard-to-reach” populations of immigrants, farmers, and Spanish-speaking organizers.

Data accessibility was a key factor in my ability to determine variables; this biased the map toward monitoring organizations and those with more decision-making power that choose which data can be available for public analysis and what can be suppressed.

Time was a large constraint. I was unable to explore trends in gentrification and the potential displacement that could result from further investment.

Recommendations

Some traditions don't scale sustainably. What worked for a few thousand people on an island doesn't necessarily work for a few hundred thousand.

Ayana Elizabeth Johnson, What if We Get it Right? Prelude

Although it is important to reflect on traditional practices, we must acknowledge the power of technological advancements, the imbalance with ecological reciprocity, and the impacts of anthropogenic climate change. However, what we can take from these learnings is the importance of thinking regionally, but also at neighborhood and individual levels. The Imperial Valley is in a perfect position, given its center suburbs surrounded by rural communities; there is room to grow in a sustainable and innovative way. Rather than trying to implement ideas that the state recommends, I suggest we think about our small communities as offering unique opportunities for sustainable traditions that work with our size and resources. To make change, one must identify the underlying problem, and as we have seen throughout this thesis, many existing policies are not setting cities and towns up for success nor are they holding them accountable for failing to contribute to community-led change. The maps resulted in quantitative recommendations while the literature led to qualitative suggestions. For example, the map identifies hazardous waste sites but the survey explored community interest for engaging in the planning process where over 60% of people who are currently not engaged would like to be. I have **quantitative** recommendations that come directly from the statistics and spatial analysis while the *qualitative* recommendations are derived from literature, survey feedback, and the environmental justice principles.

County Level

Arguably the most impactful efforts, albeit slow and steady, are our county policies and planning documents. After they craft policies with a solid framework, guidance, metrics, and evaluation

guidelines, cities and towns can begin designing equitable plans that address real community concerns.

Redevelop parking lots in Brawley, Calexico, Calipatria, El Centro, Heber, Imperial, Niland, and Westmorland given the high opportunity scores in this area. Prioritize communities with the highest score first.

Create a more accessible and reliable public transit system by first prioritizing routes that increase access to public amenities, green spaces, libraries, and grocery stores. Continuous community engagement will allow city leaders and planners to create optimal routes once they identify which resources are underutilized or inaccessible .

Create policies that limit hazardous waste siting and its proximity to high opportunity neighborhoods. The map created in this thesis can identify specific areas that are greatly impacted by a high density of hazardous waste sites which can be the focus for reduction after a limit has been set.

Require updates of an EJ element or EJ policies/plans embedded into each other element. The final EJ scores and index map can be used to identify the neighborhoods of priority.

Require municipalities to publish “machine readable” plans online to improve comprehension for further research, evaluation, and enforcement of laws. Planners and other city staff can utilize strategies from “Who's really planning for Environmental Justice” to identify which challenges are related to their specific municipality.

Create a centralized database for plans and data to increase accessibility, transparency, and innovative research opportunities.

Increase youth programming to engage the future generation in the planning process and workforce development opportunities.

Identify a strong mission and values statement written in collaboration with municipal governments and county residents.

A Yearly Gala or Conference to Celebrate Accomplishments and Community. An annual gathering can allow residents, planners, organizers, and the public to check on the progress toward environmental justice goals and recognize and celebrate even the small achievements that often go unnoticed. This is a time where everyone can develop their sense of belonging and community.

Ceremony focuses attention so that attention becomes intention. If you stand together and profess a thing before your community, it holds you accountable.

Robin Kimmerer, *Braiding Sweetgrass* p. 249

Municipal Level

Planning has been used as a tool to separate communities and direct impacts towards the most vulnerable or marginalized. Through intentional engagement, data-driven decision making, and community-led investing, the cities and towns can rewrite history and change the fate of its residents.

Focus on air quality conditions in Brawley, Calexico, Calipatria, El Centro, Heber, Imperial, Niland, and Westmorland. Use the EJ scores and final map for prioritizing immediate remediation.

Add shaded cool-down areas near public transit and amenities. Given the heat and low precipitation rates, residents need outdoor places to cool down and rest. Increasing the opportunities to do so near public amenities can increase public use of these resources.

Free transportation to school will increase access to education and create accessible spaces for gathering. The Coachella organizers said that meeting at a school was “the most effective way to engage” students, but unreliable transportation presented challenges. If students and families have

reliable and accessible transportation, they will be more likely to attend both school and community engagement events.

Finish the other GIS indices to create the final Environmental Justice Opportunity Index map. In this thesis I combined priority indices from each indicator to create a soft-launch version of the EJ opportunity index that I originally envisioned. Given the lack of available data, planners and other city staff can start by making a comprehensive list of variables that greatly impact their residents, then create methods to monitor and collect data regularly on these variables. Follow the steps laid out in this project to create comprehensive indices for each identified element, and then combine all of those for the final EJ opportunity index.

Amend zoning to better meet the current needs of the community. Overlay zoning districts are another option to allow for change such as parking minimums and mixed-use districts.

Set internal requirements or goals for community engagement. These include opportunities to evaluate progress after each program or public event.

Conduct strategic planning efforts every 2 years to ensure the mission remains relevant and that everyone in the organization or department is working together to achieve it. One key is identifying internal methods for tracking initiatives and progress. In time, the group can meet quarterly or annually to continue this planning, but first, it must establish intentions and habits that allow it to set achievable goals.

Identify strong mission and value statements crafted by staff centering EJ principles. When an organization or department collaboratively crafts its mission and values, all those involved develop a sense of belonging, along with responsibility and accountability for meeting expectations. Because we can easily forget our goals, a clear statement can guide us through times of stress or uncertainty. I suggest groups **adopt a climate oath**, like the one Ayana Elizabeth Johnson published in her *What If*

We Get It Right: Visions of Climate Futures. Appendix 8 contains excerpts of it. The practices of mindfulness and inclusive action can encourage feelings of belonging and empowerment that support internal relationships and help everyone align towards mutually agreed upon goals.

Organization Level

Engage with residents in Brawley, Calexico, Calipatria, El Centro, Heber, Imperial, Niland, and Westmorland to increase awareness of issues and access to the decision-making resources.

Move to the next set of cities and places based on EJ score.

Request EIRs for developments in high opportunity areas to insure minimal impacts on the local environmental conditions.

Further engage with youth, potentially providing employment and volunteer opportunities.

Identify strong mission and value statements crafted by staff and volunteers and *adopt a climate oath*, such as the Appendix 8 excerpts. Mindfulness and inclusive action can encourage feelings of belonging and empowerment.

Map food pantries and food pick-up areas to immediately increase access to food resources.

Collaborate with other organizations to increase capacity and reach.

Apply for Grants with the California Endowment foundation.

Last, but arguably the critical area of contributions, are:

Individual Level

Identify where you live on the map to begin to understand what factors largely impact the home and community.

Attend public meetings discussing development proposals or other topics that require a decision and result in negative environmental or health impact on the community or home.

Further engage with local organizations to build community and knowledge around existing challenges and opportunities in the community.

Ride a bike during a cool season to show local representatives there is a demand for physical activity and safe bike routes.

Concluding Thoughts and Emerging Ideas

More than forty years ago in the wake of the urban rebellions, Dr. King said that young people “in our dying cities” need direct action projects that transform themselves and their surroundings at the same time

Grace Lee Boggs

I call this section Concluding Thoughts and Emerging Ideas because no real conclusions are possible in this line of work. I am reaching the end of this thesis, but not of my efforts .

I see three major considerations that can influence additional research.

1. How will federal administration decisions impact the funding or credibility of this work?
2. What data is accessible to the public (or has been recently removed)?
3. What capacity do county and city representatives and staff have to implement change, and who is available to prioritize these efforts over other pressing work?

Much of the data and trends shared in this thesis are not new. I have not uncovered a secret life or hidden challenges in decision making. Indeed, many of the authors I have cited are diverse individuals who have collected and or analyzed data related to race and social or climate impacts. It's unfortunate that we must continue to share the same story over and over until the people are heard, but my goal was to create the tools that provide convincing data as people share their stories and experiences. This map will continue to evolve as my partnerships with local organizations, and my trust with current residents, continue to build and develop. Although this began as an intellectual

exercise, hearing from Imperial County residents that they did not know of these impacts, and that they could be directly involved in changing them, motivated me to develop this tool to continue using in the future.

The Appendices include a glossary, additional data, full results, the survey, detailed data sources with methods, and a **list of recommended resources** for learning more, getting support, and getting involved. This is not easy work, but this is real work. Every single person in the Imperial Valley, along with those in other EJ communities, deserves clean air, water, soil, and a happy life with access to the same resources, regardless of their skin color or nationality.

One final note on the data analysis: I remind the reader that many of my final decisions were based on data availability. Transparency and access to data is a crucial barrier that restricts organizers and decision makers with low capacity or funding. One action is within my control: I can take further steps to use this analysis after the thesis deadline. In an upcoming meeting I will share my tool with the local Equity & Justice Coalition, which has been deeply involved supporting community members as they provided comments on the Lithium Valley Specific Plan for Imperial County. These committed municipal structures are supporting community engagement in a crucial decision-making process to address the future of environmental impacts at a time when climate tipping points have been exceeded. After the organizers give me feedback, I will modify the map and share it through a story map that lets people access an interactive version of the maps and index .

The time has come for us to reimagine everything... We have to think not only about change in our institutions, but changes in ourselves... It's up to us to reimagine the alternatives...
Grace Lee Bo

Appendix 1 - Glossary⁴⁷

Word	Definition	Source
Anthropogenic	Relating to or result from the influence of human beings on nature	Merriam-Webster
ArcGIS Pro	A desktop GIS application/ tool where you can explore, visualize, and analyze data; create maps; and share work online	Esri
Case Study	An intensive analysis of an individual unit (such as a person or community) stressing developmental factors in relation to environment	Merriam-Webster
Comprehensive Planning	Sometimes also referred to as a master plan or a general plan, is the foundational document of long-term planning and zoning in the United States.	Planopedia
Fracking	The injection of fluid into shale beds at high pressure in order to free up petroleum resources (such as oil or natural gas)	Merriam-Webster
ModelBuilder	A visual programming language for building geoprocessing workflows	Esri
Organizing	To persuade to associate in an organization, to arrange elements into a whole of interdependent parts, and/or to form an organization	Merriam-Webster

⁴⁷Pulled from Merriam-Webster, Esri, or Planetizen Planopedia in April of 2025

Appendix 2 - Imperial Valley Environmental Justice Community and Element Breakdown

Type	Name	Pop	EJ Residents	Mention EJ	Year	EJ Policy / Program
City	Brawley	26,416	Yes	Yes	2021	Yes
	Calexico	38,633	Yes	Yes	2022	No
	Calipatria	6,515	Yes	No	2013	No
	El Centro	44,322	Yes	Yes	2021	Yes
	Holtville	5,605	No		2017	No
	Imperial	20,263	Yes	Yes	2021	Yes
	Westmorland	2,014	Yes	No	1999	No
CDP: Census Designated Place	Bombay Beach	231	No		*	No
	Heber	6,896	Yes	No	2023	No
	Niland	756	Yes	No	1996	No
	Ocotillo	215	No		1994	No
	Palo Verde	152	No		*	No
	Salton City	5,155	No		2000	No
	Winterhaven	390	Yes	No	1996	No
TOTAL	14	157,563	9	4		3

* No general plan was found for this designated place

Appendix 3 - NVivo Word Frequency for Lit Review

Word Frequency Criteria Run Query Save Criteria...

Search in: Files and Externals Selected Items Items in Selected Folders

Finding matches: ☐ Exact match only (e.g. "talk")
☒ Include stemmed words (e.g. "talking")

Display words: ☐ All
☒ 50 most frequent

With minimum length:

Word	Length	Count	Weighted Percentage	Similar Words
environmentally	15	435	1.44%	environmental, environmentally
plans	5	291	0.97%	plan, planned, planning, plans
using	5	253	0.84%	use, used, useful, uses, using
policies	8	224	0.74%	policies, policy
racism	6	217	0.72%	racism, racisms
whites'	7	200	0.66%	white, whiteness, whites, whites'
communities	11	197	0.65%	communities, community
industry	8	171	0.57%	industrial, industrialization, industrially, industries, industry
justice	7	157	0.52%	justice
city	4	157	0.52%	cities, city
pollution	9	156	0.52%	pollutant, pollutants, polluted, polluter, polluters, polluting, pollution, pollutions
areas	5	155	0.51%	area, areas
land	4	151	0.50%	land
people	6	139	0.46%	people
siting	6	128	0.42%	site, sited, sites, siting, sitings
states	6	120	0.40%	state, stated, states
populations	11	114	0.38%	populated, population, populations
equity	6	110	0.36%	equity
urban	5	109	0.36%	urban, urbanicity, urbanism, urbanization, urbanized
risks	5	108	0.36%	risk, risks
health	6	108	0.36%	health, healthful
including	9	107	0.35%	include, included, includes, including
publications	12	103	0.34%	public, publications, publics
also	4	97	0.32%	also
spatial	7	97	0.32%	spatial, spatiality, spatially

american	8	96	0.32%	american, americans
may	3	96	0.32%	may
downloaded	10	95	0.32%	downloaded
focus	5	94	0.31%	focus, focused, focuses, focusing
california	10	93	0.31%	california, california's general
los	3	92	0.31%	los
color	5	90	0.30%	color, colored, colors
angeles	7	90	0.30%	angeles
groups	6	87	0.29%	group, grouping, groupings, groups
air	3	86	0.29%	air, aire
variables	9	85	0.28%	variable, variables
income	6	84	0.28%	income, incomes
housing	7	83	0.28%	house, housed, houses, housing
study	5	82	0.27%	studied, studies, study, studying
race	4	82	0.27%	race
racial	6	81	0.27%	racial, racialized, racially
waste	5	80	0.27%	waste, wasteful, wastes
hazards	7	79	0.26%	hazard, hazardous, hazards
terms	5	77	0.26%	term, termed, terms
tracts	6	76	0.25%	tract, tracts
facilities	10	76	0.25%	facilities, facility
analysis	8	76	0.25%	analysis
transportation	14	75	0.25%	transport, transportation
processes	9	75	0.25%	process, processes
content	7	74	0.25%	content, contention, contentment, contents

Variables that could be mapped and addressed through a comprehensive plan

Relevant variables but harder to address through comprehensive plans

Relevant tools or methods

This frequency list was created using the literature review readings.

Appendix 4 - NVivo Word Frequency for Case Studies

Word	Length	Count	Weighted Percentage	Similar Words
health	6	206	2.38%	health
community	9	155	1.79%	communities, communities', community
plans	5	107	1.23%	plan, planned, planning, plans
county	6	94	1.08%	counties, county
development	11	88	1.01%	develop, developed, developers, developing, development
public	6	81	0.93%	public, publication, publications
parks	5	79	0.91%	park, parks
healthy	7	69	0.80%	healthy
city	4	65	0.75%	cities, city
food	4	64	0.74%	food, foods
needs	5	62	0.72%	need, needed, needs
using	5	58	0.67%	use, used, useful, uses, using
project	7	57	0.66%	project, projects
active	6	54	0.62%	active, activities, activity
design	6	54	0.62%	design, designed, designers, designing
including	9	53	0.61%	include, included, includes, including
region	6	51	0.59%	region, regional, regionally, regions
environmental	13	50	0.58%	environmental
working	7	48	0.55%	work, worked, working
arc	3	46	0.53%	arc
local	5	45	0.52%	local, localities, locally
areas	5	43	0.50%	area, areas
policies	8	41	0.47%	policies, policy
institutions	12	40	0.46%	institute, institution, institutional, institutions
process	7	40	0.46%	process, processes, processing
provide	7	40	0.46%	provide, provided, provider, provides, providing
engagement	10	39	0.45%	engage, engaged, engagement, engaging
valley	6	39	0.45%	valley
support	7	38	0.44%	support, supported, supporting, supportive, supports
assessment	10	37	0.43%	assess, assessment
riverside	9	36	0.42%	riverside
opportunities	13	36	0.42%	opportunities, opportunity

collaborative	13	35	0.40%	collaborate, collaborated, collaborating, collaboration, collaborative, collaboratively
additionally	12	35	0.40%	addition, additional, additionally
element	7	34	0.39%	element, elements
land	4	33	0.38%	land
coachella	9	32	0.37%	coachella
sacramento	10	32	0.37%	sacramento
changing	8	32	0.37%	change, changes, changing
meetings	8	31	0.36%	meet, meeting, meetings, meets
angeles	7	31	0.36%	angeles
california	10	31	0.36%	california
climate	7	31	0.36%	climate
funding	7	31	0.36%	funded, funding, funds
los	3	31	0.36%	los
building	8	29	0.33%	build, building
high	4	29	0.33%	high, highly
also	4	28	0.32%	also
anchor	6	28	0.32%	anchor, anchors
d4as	4	28	0.32%	d4as

Variables that could be mapped and addressed through a comprehensive plan

Relevant variables but harder to address through comprehensive plans

Relevant tools or methods

This frequency list was created using the case studies from the California's Office of Planning and Research website.

Appendix 5 - NVivo Word Frequency for OPR General Plan Guiding Documents

Word	Length	Count	Weighted Percentage	Similar Words
policy	6	1417	1.79%	policies, policy
community	9	1278	1.61%	communitie, communities, communities', community
plans	5	1026	1.29%	plan, planned, planning, plans
using	5	973	1.23%	use, used, useful, uses, using
city	4	896	1.13%	cities, city
elements	8	785	0.99%	element, elements
developments	12	694	0.87%	develop, developed, developer, developers, developing, development, developments, develops
health	6	673	0.85%	health, healthful
housing	7	637	0.80%	house, housed, houses, housing
public	6	622	0.78%	public, publication, publications, publicity, publicize, publicizes, publicly
including	9	584	0.74%	include, included, includes, including
local	5	538	0.68%	local, localities, locality, localized, locally
lands	5	532	0.67%	land, lands, lands'
requirements	12	495	0.62%	require, required, requirement, requirements, requires, requiring
general	7	460	0.58%	general, generalized, generally
programs	8	449	0.57%	program, programing, programmed, programming, programs
provide	7	445	0.56%	provide, provided, provider, providers, provides, providing
facilities	10	445	0.56%	facilities, facilities', facility
areas	5	444	0.56%	area, areas
foods	5	358	0.45%	food, foods
county	6	355	0.45%	counties, county
access	6	340	0.43%	access, accessed, accessibility, accessible, accessing
environmental	13	336	0.42%	environmental, environmentally
identify	8	330	0.42%	identified, identifies, identify, identifying
air	3	326	0.41%	air
school	6	324	0.41%	school, schools
improve	7	311	0.39%	improve, improved, improvement, improvements, improves, improving
may	3	308	0.39%	may
services	8	302	0.38%	service, services

quality	7	300	0.38%	qualities, quality
needs	5	299	0.38%	need, needed, needs
activity	8	295	0.37%	activate, activated, active, actively, activities, activity
healthy	7	291	0.37%	healthy
reduce	6	290	0.37%	reduce, reduced, reduces, reducing
code	4	289	0.36%	code, codes, coding
new	3	278	0.35%	new
encourage	9	276	0.35%	encourage, encouraged, encouragement, encourages, encouraging
parks	5	273	0.34%	park, parked, parking, parks
climate	7	266	0.34%	climate, climatic
goal	4	261	0.33%	goal, goals
residents	9	260	0.33%	reside, residence, residences, residency, resident, residents, residents', residing
support	7	258	0.33%	support, supported, supporting, supportive, supports
promote	7	258	0.33%	promote, promoted, promotes, promoting, promotion, promotional
process	7	255	0.32%	process, processed, processes, processing
information	11	254	0.32%	inform, informal, informally, information, informed, informing
transit	7	251	0.32%	transit, transition, transitional, transitioning
design	6	249	0.31%	design, designate, designated, designates, designating, designation, designations, designed, designing, designs
also	4	248	0.31%	also
increase	8	245	0.31%	increase, increased, increases, increasing, increasingly
existing	8	244	0.31%	exist, existed, existing, exists

Variables that could be mapped and addressed through a comprehensive plan
Relevant variables but harder to address through comprehensive plans or map
Relevant tools or methods

This frequency list was created using the planning guide and recommendation documents issued by the California Office of Planning and Research.

Appendix 5 - First AHP Calculator Results

The following were a result of using the AHP Calculator on March 22nd, 2025 for EJ Communities using ranking order to determine priority and addition to determine how much more.

A - wrt AHP priorities - or B?		Equal	How much more?
1	☐ Prox to haz waste ☒ air quality	☐ 1	☐ 2 ☐ 3 ☐ 4 ☒ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
2	☐ Prox to haz waste ☒ accessibility / transportation	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
3	☐ Prox to haz waste ☒ green space	☐ 1	☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
4	☐ Prox to haz waste ☒ impaired waters	☐ 1	☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
5	☒ air quality ☐ accessibility / transportation	☐ 1	☐ 2 ☒ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
6	☒ air quality ☐ green space	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
7	☒ air quality ☐ impaired waters	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
8	☐ accessibility / transportation ☒ green space	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
9	☐ accessibility / transportation ☒ impaired waters	☐ 1	☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9

Resulting Priorities

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons:

Cat		Priority	Rank	(+)	(-)
1	Haz Waste	6.9%	5	0.6%	0.6%
2	Air Quality	38.7%	1	3.6%	3.6%
3	Accessibility / Transportation	11.9%	4	1.4%	1.4%
4	Green Space	21.2%	2	1.6%	1.6%
5	Impaired Waters	21.2%	2	1.6%	1.6%

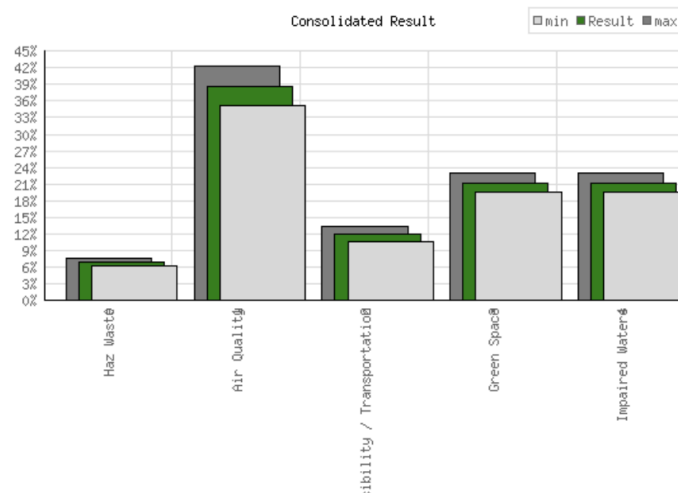
Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix:

	1	2	3	4	5
1	1	0.20	0.50	0.33	0.33
2	5.00	1	3.00	2.00	2.00
3	2.00	0.33	1	0.50	0.50
4	3.00	0.50	2.00	1	1.00
5	3.00	0.50	2.00	1.00	1

Number of comparisons = 10
Consistency Ratio CR = 0.4%

Principal eigen value = 5.017
Eigenvector solution: 3 iterations, delta = 2.5E-8



Appendix 6 - Final AHP Calculator Results

April 8th Results using median using ranking order to determine priority and quotients to determine how much more.

A - wrt AHP priorities - or B?		Equal	How much more?
1	☐ Haz Waste	☒ Air Quality	☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
2	☐ Haz Waste	☒ Accessibility / Transportation	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
3	☐ Haz Waste	☒ Green Space	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
4	☐ Haz Waste	☒ Impaired Waters	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
5	☒ Air Quality	☐ Accessibility / Transportation	☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
6	☒ Air Quality	☐ Green Space	☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
7	☒ Air Quality	☐ Impaired Waters	☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
8	☐ Accessibility / Transportation	☒ Green Space	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
9	☐ Accessibility / Transportation	☒ Impaired Waters	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
10	☒ Green Space	☐ Impaired Waters	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
CR = 0% OK			

Resulting Priorities

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons:

Cat		Priority	Rank	(+)	(-)
1	Haz Waste	16.7%	2	0.0%	0.0%
2	Air Quality	33.3%	1	0.0%	0.0%
3	Accessibility / Transportation	16.7%	2	0.0%	0.0%
4	Green Space	16.7%	2	0.0%	0.0%
5	Impaired Waters	16.7%	2	0.0%	0.0%

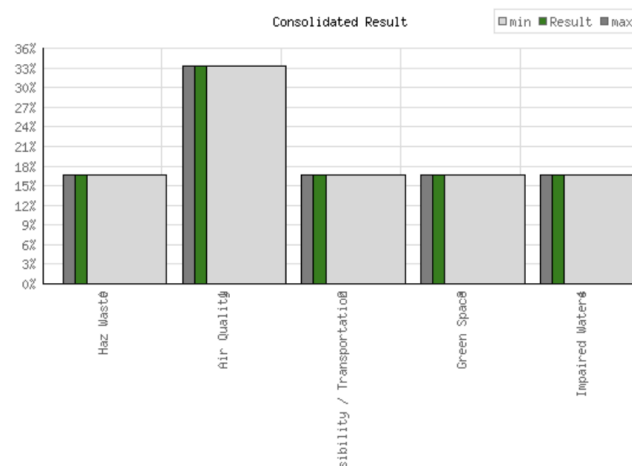
Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix:

	1	2	3	4	5
1	1	0.50	1.00	1.00	1.00
2	2.00	1	2.00	2.00	2.00
3	1.00	0.50	1	1.00	1.00
4	1.00	0.50	1.00	1	1.00
5	1.00	0.50	1.00	1.00	1

Number of comparisons = 10
Consistency Ratio CR = 0.0%

Principal eigen value = 5.000
Eigenvector solution: 1 iterations, delta = 0.0E+0



Appendix 7 - Other AHP Calculator Results

AHP results from April 8th using mean value for EJ communities.

A - wrt AHP priorities - or B?		Equal	How much more?
1	☐ Haz Waste	☒ Air Quality	☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
2	☐ Haz Waste	☒ Accessibility / Transportation	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
3	☐ Haz Waste	☒ Green Space	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
4	☐ Haz Waste	☒ Impaired Waters	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
5	☒ Air Quality	☐ Accessibility / Transportation	☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
6	☒ Air Quality	☐ Green Space	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
7	☒ Air Quality	☐ Impaired Waters	☐ 1 ☒ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
8	☐ Accessibility / Transportation	☒ Green Space	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
9	☐ Accessibility / Transportation	☒ Impaired Waters	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
10	☒ Green Space	☐ Impaired Waters	☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9
CR = 1.3% OK			

Resulting Priorities

Priorities

These are the resulting weights for the criteria based on your pairwise comparisons:

Cat		Priority	Rank	(+)	(-)
1	Haz Waste	16.8%	3	1.7%	1.7%
2	Air Quality	29.7%	1	5.9%	5.9%
3	Accessibility / Transportation	16.8%	3	1.7%	1.7%
4	Green Space	19.8%	2	5.5%	5.5%
5	Impaired Waters	16.8%	3	1.7%	1.7%

Number of comparisons = 10
Consistency Ratio CR = 1.3%

Decision Matrix

The resulting weights are based on the principal eigenvector of the decision matrix:

	1	2	3	4	5
1	1	0.50	1.00	1.00	1.00
2	2.00	1	2.00	1.00	2.00
3	1.00	0.50	1	1.00	1.00
4	1.00	1.00	1.00	1	1.00
5	1.00	0.50	1.00	1.00	1

Principal eigen value = 5.059
Eigenvector solution: 4 iterations, delta = 4.8E-9

Appendix 8 - Ayana Elizabeth Johnson's Climate Oath

Excerpt from "What if We Get it Right?" by Ayana Elizabeth Johnson, pg 421-422:

“‘Do no harm.’ In conversation within this book, the need for a new Hippocratic Oath in the face of the climate crisis was mentioned repeatedly... We offer this model for you to make your own, and pass along:

On the Majesty of turquoise Seas, and fireflies, and aspen trees,
On the honor of our parents, our ancestors, and humans-to-come,
On the wonders of laughter and sunshine,
I make these devotions to climate solutions for my community and for our magnificent planet:

First, move from ‘I’ to ‘we’...

Second, do no harm...

Third, less is more...

Possibility exists.

This is a world of our making.

We can remake it, remix it, restore it, rebalance it.

The path of least resistance is only one of many paths.

I will be part of getting it right.

We will be part of getting it right.

Appendix 9 - The Survey

English

Introduction

Hello and thank you for taking time to complete this survey for my Graduate Thesis. This is completely anonymous, so honest answers are greatly appreciated! At the end of the survey you will find information on how to contact me if there are any questions, concerns, or comments. All the best!

Demographic

Where do you currently live? (Please click the box below to see other options)

- ☐ Under 18
☐ 18 - 24
☐ 25 - 34
☐ 35-64
☐ 65+

Which of the following best represent your race/ethnicity?
Please select all that apply.

- ☐ American Indian or Alaska Native
☐ Asian
☐ Black, African, or African American
☐ Native Hawaiian or Other Pacific Islander
☐ White
☐ Hispanic or Latino
☐ Other (please specify)

Are you currently a high school student?

- ☐ Yes ☐ Unsure/Maybe
☐ No

Have you received a high school diploma or equivalent?

- ☐ Yes
☐ No
☐ Unsure/Maybe

Which of the following reflect your current employment status?
(Select all that apply)

- ☐ Employed (full time, part time, contract, temporary)
☐ Unemployed
☐ Student
☐ Retired, Disabled, or Unable to work

Please select all of the following that best represent your situation during the current academic school year.

- ☐ Full-time student
☐ Part-time student
☐ Full-time employee
☐ Part-time employee
☐ Community college / Associates / Vocational
☐ Undergraduate degree
☐ Graduate degree / Post-doc

What industry best aligns with your work? (Please select all that apply)

- ☐ Agriculture / Natural Resources
☐ Education
☐ Healthcare
☐ Government / Public Service
☐ Environmental or Sustainability
☐ Other (please specify)

Variables

Rank the following in order of importance: What can we address to target environmental and social issues within your community?

Hazardous waste sites

Impaired waters (bad quality, low flow)

Accessibility / Transportation

Green spaces (such as parks)

Air quality

If you had to distribute 100 points, how many points would each of these receive? (Receiving points reflect value and importance)

Hazardous waste sites	0
Impaired waters (bad quality, low flow)	0
Accessibility / Transportation	0
Air quality	0
Total	0

Values

How engaged do you believe you are in the decision making process for your community? Think about public meetings and giving your opinion on development projects or local policies.

	I DO NOT WANT to be very engaged	I WANT to be somewhat engaged	I WANT to be very engaged
I am NOT very engaged	☐	☐	☐
I AM somewhat engaged	☐	☐	☐
I AM very engaged	☐	☐	☐

Imagine your ideal community in the future. What would exist or be different in your perfect world when thinking about environmental and public health?

Appendix 10 - Full Methods Data List

Info	Type	Connection to Method	Source
Brawley Environmental Justice Element	PDF	Admin Docs / Case Study	City of Brawley
CA Schools Points	Shapefile, points	Spatial	GIS Open
CalEnviroScreen Dictionary	PDF	Spatial, Survey	COEHHA
CalEnviroScreen 4.0	shapefile, points & polys	Spatial	COEHHA
CalEPA Hazardous Waste Sites	csv	Spatial, Survey	CalEPA
CalGEM Orphan Well Screening	Shapefile, points	Spatial	ArcGIS
Census All Lines (all types of roads)	Shapefile, line	Spatial	Census - TIGER
Childcare Facilities (PreK, Headstart, Afterschool)	csv	Spatial	Data Axle
City of Calipatria 2025 General Plan	PDF	Admin Docs / Case Study	City of Calipatria
El Centro Environmental Justice Element	PDF	Admin Docs / Case Study	City of El Centro
Food to Share as Healthy Community and Environmental Justice Case Study	PDF	Admin Docs / Case Study, Survey	OPR
Fresno Environmental Justice Chapter	PDF	Admin Docs / Case Study	Fresno COG
Imperial County Environmental Justice Element	Website	Admin Docs / Case Study	ICPDS
Imperial County General Plan		Admin Docs / Case Study	ICPDS
IVAN		Spatial, Survey	County Org
Jurupa Valley - The 2nd California Environmental Justice Element	PDF	Admin Docs / Case Study, Survey	OPR
Land Use Planning Awareness Project	PDF	Admin Docs / Case Study, Survey	OPR
Local roads	Shapefile, line	Spatial	Esri Living Atlas
Los Angeles Countywide Parks Needs Assessment	PDF	Admin Docs / Case Study, Survey	LAC
National City's Health and Environmental Justice Element	PDF	Admin Docs / Case Study, Survey	CEJA
National transit roads		Spatial, Survey	GEOData Gov
NLCD Land use	Tiff, raster	Spatial	MRLC
Oehha	Shapefile, csv	Spatial, Survey	CA Gov
Public Schools in CA - Polygons	Shapefile, polygon	Spatial	CA Org
Roads	Shapefile, line	Spatial	Census - TIGER
San Diego Environmental Justice Element	Website / PDF	Admin Docs / Case Study	SDP
School data by county		Spatial, Survey	Ed Data
Social Explorer - California specific data (population density)	csv	Spatial	ACS 5-year
Social Explorer for state, county, place/remainder, and other counties for reference	csv	Spatial, Survey	ACS 5-year
Unduplicated Pupil Count of Free/Reduced-Price Meals, English Learners & Foster Youth	Vector - with Address	Spatial	CA Gov
Verified Grocery Stores	csv	Spatial	Data Axle

Appendix 11 - Final EJ Index Scores by City or Place

Environmental Justice Opportunity Score					
City or Place	Normalized	MEAN	MEDIAN	MIN	MAX
Bombay Beach	8.1	7.3	7	4	8
Brawley*	10.1	9.1	9	6	10
Calexico*	10.4	9.4	10	6	10
Calipatria*	9.1	8.2	8	5	10
Desert Shores	7	5.4	6	3	6
El Centro*	9.7	8.7	9	5	10
Heber*	10.7	9.6	10	7	10
Holtville	7.3	6.6	7	3	8
Imperial*	10.5	9.5	10	7	10
Niland*	10	9	9	5	10
Ocotillo	5.5	5	5	2	6
Palo Verde	6.1	5.5	6	3	7
Salton City	5.8	5.3	5	2	7
Salton Sea Beach	6.3	5.7	6	2	6
Seeley	10.3	9	9	8	10
Westmorland*	10	9	9	7	10
Winterhaven*	7.6	6.8	6	5	8

*Environmental Justice Communities

Normalized scores took the total sum and divided it by the land area (then multiplied by 10 for readability) to account for differences in size amongst the communities.

Appendix 12 - Recommended Resource List

Organizations to get involved with or learn more from

- ☐ Imperial Valley Equity & Justice
 - ☐ Comite Civico Del Valle, Inc
-

Publicly Available

Behind a Paywall

Readings Available at a Public Library, Book Store, or Online*

- ☐ **Doughnut Economics by Kate Raworth**
- ☐ **Braiding Sweetgrass by Robin Kimmerer**
- ☐ **What If We Get It Right? by Ayana Elizabeth Johnson**
- ☐ **All We Can Save by Ayana Elizabeth Johnson and Katherine Wilkinson**
- ☐ **Dumping in Dixie by Robert D. Bullard**
- ☐ *State of Resistance by Manuel Pastor*
- ☐ *The Earth the City and the Hidden Narrative of Race by Carl Anthony*
- ☐ *Environmentalism and Economic Justice Laura Pulido*
- ☐ *The Intersectional Environmentalist by Leah Thomas*
- ☐ *The Wrong Complexion for Protection by Robert D. Bullard and Beverly Wright*

Video and Documentary

- ☐ [Why This Town Is Dying From Cancer](#)
- ☐ *Our Planet*

* Consider asking your public library to order a copy of try shopping second hand like a thrift store, ThriftBooks, or other sustainable options.

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