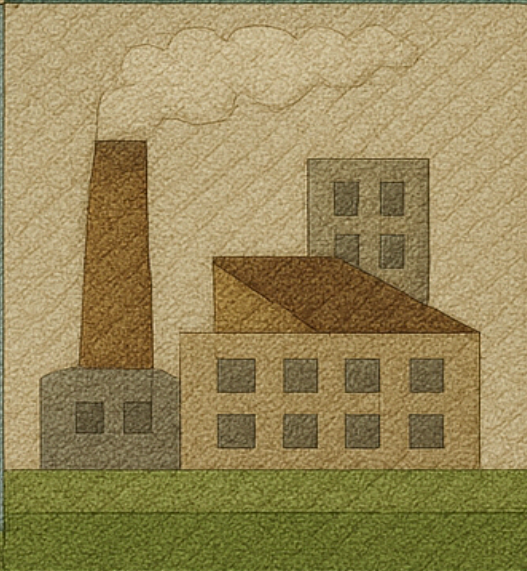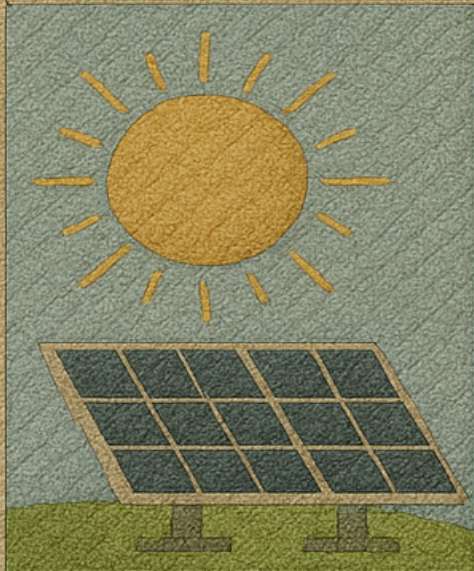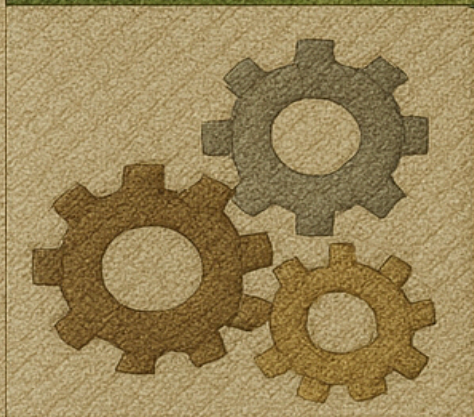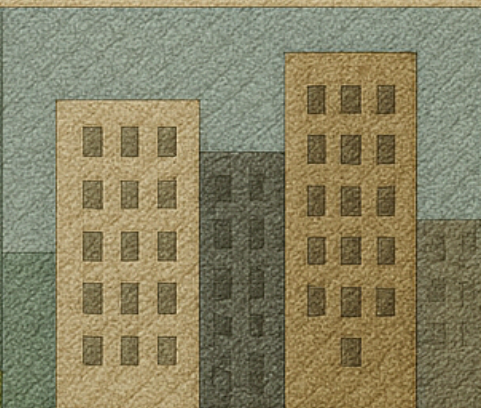# MESHED REALITIES

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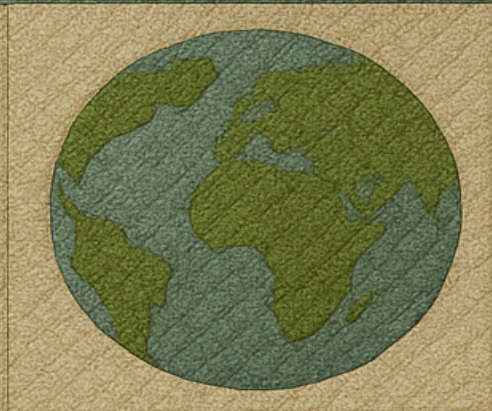
MESH MAGAZINE
5th EDITION

Master of Science in Engineering, Sustainability, and Health (5th Edition)

MESH Summer Cohort 2025

Cover Page: *OpenAI. (2025). [Image of a patchwork quilt with environmental engineering themes] [AI-generated image]. DALL·E. https://openai.com/dall-e*

Letter from the Editors

It is with great pride that we introduce the 5th Edition of the MESH Magazine. This collection of essays is the culmination of months of inquiry, reflection, and collaboration. Each piece within these pages represents both rigorous research and a deep commitment to understanding the human and ecological dimensions of engineering, sustainability, and health.

Our cohort's publication is organized into four sections centered around Food, Water, Energy, and Waste. While each essay stands on its own, together they tell a larger story: that the challenges we face in creating sustainable futures are complex, interwoven, and grounded in place. From city streets to global markets, these works ask us to consider not only how we adapt to environmental change, but how we do so equitably and with care for both people and ecosystems.

What makes this collection especially meaningful is that it highlights the diverse perspectives and passions of its authors. We are not only students, researchers, and practitioners, but also community members who care deeply about the places we call home. In these essays, technical analysis meets human story, and solutions are imagined not only in terms of policy and infrastructure, but also in terms of relationships, resilience, and justice.

Our hope is that as you read, you will see connections across the sections - between forests and food systems, between water and justice, between urban spaces and climate resilience. These links remind us that sustainability is never confined to one sector or discipline. It is a shared, ongoing project that demands creativity, collaboration, and courage.

On behalf of our classmates, thank you for engaging with our work. We invite you to read not only for answers, but for questions - questions that will continue to shape the ways we study, practice, and imagine sustainable futures.

- Mackenzie Glenn and Chloe Andruss

Letter from the Director

Dr. Willy Oppenheim

MESH Capstone Lead Instructor

Omprakash Executive Director

It is a huge honor for me to introduce this fifth edition of the MESH Magazine! In the pages that follow, readers will find a collection of articles that showcases the promise of interdisciplinarity that is at the heart of the MESH program. Just as our core themes of Food, Water, Energy, and Waste are endlessly interwoven and interdependent, so, too, are the lenses and methods through which we attempt to understand and engage with them. Some students in this cohort have centered their work around census data, policy documents, and academic literature reviews; others have drawn from case studies, qualitative interviews, and participant-observation, and still others have employed critical analyses of popular media and auto-ethnographic reflection. None of these approaches can promise an authoritative version of truth, but woven together, they offer us an opportunity to embrace complexity, nuance, and polyvocality with a sense of purpose, imagination, and unrelenting curiosity. I am grateful to these students for their willingness to challenge assumptions – including their own – and to the many hands from within the USD faculty and the Omprakash team who have helped to shape this colorful tapestry of diverse voices and perspectives. I offer my hearty congratulations to our latest cohort of MESH graduates, and my deep appreciation for the work that they will carry forward into the fragile and resilient world we share.

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Land, Forests & Food Systems

"We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect".

- Aldo Leopold

Stacking Spaces: Navigating Competing Land Uses in Hawai'i

Martina Segura

Abstract

The State of Hawai'i has adopted numerous statutory and constitutional requirements and goals such as, but not limited to, the development of affordable housing units, doubling the state's food production, increasing food exports, and achieving 100% renewable energy by 2045. These State goals, constitutional and statutory requirements result in the urbanization and the use of agricultural land, which exacerbates urban sprawl and increases land use competition. The strategic planning, management, and balancing of the State's statutory and constitutional requirements and the conflicting land use is crucial to ensure availability for future generations. The goal of this research is to explore how mixed-use and dual-use developments can effectively aid in the balance of competing land use and development in response to State goals including the doubling of productive agriculture, development of housing, attaining 100% renewable energy, and natural resource preservation across the State of Hawai'i.

Introduction

To be born, raised, and live in Hawai'i is truly a privilege. I was raised surrounded by exceptionally beautiful landscapes from mauka (mountain) to makai (ocean): I was immersed in many different cultural practices and surrounded by diversity, and a strong sense of community and togetherness was instilled in me from a young age. My various life experiences and extended 'ohana (family), helped me learn aloha 'āina, which to me means the protection and perpetuation of Native Hawaiian practices and love and care for the land. I strive to apply these principles in my work as a land use planner for the State of Hawai'i Land Use Commission. Further, I strive to implement my understanding of aloha 'āina in land use planning through the promotion of sustainable practices of land use and natural resource management, and the protection Hawai'i's natural beauty and resources, including land, water, air, minerals, and energy sources for future generations (Hawai'i State Constitution,1978). These priorities are reflected in this research through the aim of the responsible and balanced use of land through mixed-use development in order to meet State goals and statutory requirements.

As a land use planner, I witness and observe numerous challenges, such as competing land use and prioritization of various State initiatives and goals. Competing land use occurs when multiple users of land each seek to develop a singular

good or service produced from a limited amount of land, which implies when one user develops the land, less land is available for other uses (Haberl, 2015). Furthermore, competing land use scenarios are driven by population growth, economic development, and State goals and initiatives. Across the state of Hawai'i a frequent occurrence of competing land use is the clash between urban development, whether it be for housing or renewable energy, and agricultural preservation.

I frequently think about numerous competing land uses in Hawai'i; agriculture, housing, renewable energy, and natural resource preservation, and how they are interconnected with Native Hawaiian cultural practices and community. This essay will explore **how mixed-use developments can effectively balance competing land uses, such as productive agriculture, housing, renewable energy, and natural resource preservation across the state of Hawai'i**.

In order to understand how the state's limited amount of land, the various State goals and statutory requirements, and the drive for economic development lead to competing land use, understanding the various components is critical. This essay offers insight into competing land use, goals and statutory requirements in the State of Hawai'i, including the statutory requirement for 100% renewable energy by 2045, doubling food production by 2030, and the State goal of creating 22,500 new affordable rental housing units, the benefits of mixed-use development particularly vertical

mixed-use development: urban redevelopment and infill projects and agrivoltaics, ultimately arguing that mixed-use development is a viable way to achieve State goals while maintaining a healthy environment and social ecosystem in Hawai'i.

Methodology

This argumentative essay used qualitative methods; archival research and semi-structured interviews to explore my research question: how mixed-use developments can effectively balance competing land uses, such as, productive agriculture, housing, renewable energy, and natural resource preservation across the state of Hawai'i.

I chose to incorporate qualitative research methods including archival research and semi-structured interviews to better understand the various factors and circumstances that are involved with competing land use in the state of Hawai'i. Further, archival research and semi-structured interviews provide descriptive data, allows for a personal and flexible approach, and encourages discussion. Conversely, qualitative research methods and findings can cause misinterpretations, biases, and make comparisons difficult.

It is important to acknowledge potential biases that may have influenced the research, interpretations, and applications in this research. Research sources are diverse, but heavily reliant on State and governmental documents, which may not

fully represent positions taken by other stakeholders; additionally, my professional experience may have influenced data interpretation and applications. To reduce bias, data has been verified through different sources and interviews took place with competing industry leaders.

Archival Research

This project used archival research to investigate and analyze materials in order to provide insight and background on the research question. These sources include academic journals, policy and statutes, government plans, journalism sources, developer publications, and perspective publications from subject matter experts. In order to apply the most pertinent documents that related to the major topics covered in this paper's research question, State policy, statute, and government plans were primarily used to provide insight and background on competing land uses in the state of Hawaiʻi. Throughout this research a number of statutory and constitutional requirements, and studies and plans are mentioned, there are about 11 referenced State sources that provide facts, background information, and guidance on productive agriculture, housing, renewable energy, and natural resource preservation. A number of these sources were previously familiar to me due to my experience in land use planning; however, when additional information was needed, I researched the appropriate offices to expand on the requirements or goals adopted by statute or proposed in plans.

Semi-Structured Interviews

This project used two semi-structured interviews with subject matter experts in mixed/dual use development in Hawaiʻi. The interviewees come from conflicting industries, agriculture and development. I chose the interviewees based on previous interaction and a general televised advertisement for a local development company. Interviewees were asked a set of similar five to eight questions, the semi structured format allowed for room for follow up questions for a free flowing discussion. Basic questions that the interviewees were asked include questions regarding their work and the impact on local industry, the impact on economy, feasibility of applying mixed-use development on neighbor islands, and experiences with disadvantages and challenges.

The first interview was with Robby Kelley, the Executive Vice President and Chief Development Officer of Avalon Group. Kelley is also a University of San Diego Graduate; Kelley has been with the Avalon Group for five years. Robby also started the new Avalon Energy, which is the company's efforts to develop sustainable energy for Avalon's projects and promote environmental stewardship, while promoting circular building management.

I was first introduced to the work of the Avalon Group through a real estate advertisement for a mixed-use redevelopment project down the street from my work. With further research I found the Avalon Group has developed numerous mixed-use developments, including a few that involve housing, so I believe the

experience in the field of mixed-use development in Hawaiʻi, specifically City and County of Honolulu, is applicable to the research question of how mixed-use developments can effectively balance competing land uses, such as: productive agriculture, housing, renewable energy, and natural resource preservation across the state of Hawaiʻi.

The interview with Kelley was conducted over Google Meets in a semi-structured manner, for over 60 minutes and written notes were taken.

The second interview was with Juli Burden, the Agrivoltaic Systems Lead at the Hawaiʻi Agricultural Research Center ("HARC"), at the Clearway Project, Burden has been working with HARC for 13 years, where she designs and manages experimental agrivoltaic diversified systems, analyzes data to assess system performance and crop yield impact, and collaborates with local communities and stakeholders to ensure projects align with sustainability goals.

In 2023, I had the opportunity to visit the Clearway Energy Group commercial operation Mililani Solar I Plant for work, and I believed the dual-use and scientific nature of the project would be ideal for expanding how mixed-use developments can effectively balance competing land uses, specifically, energy and agriculture.

The interview with Burden was conducted at the Clearway Agrivoltaic Mililani Lanikuhana project in a semi-formatted "talk story" manner, notes

were taken during the conversion, and a tour of the site took about 90 minutes.

Competing Land Uses in the State of Hawaiʻi

This literature review examines various goals and initiatives within the state of Hawaiʻi including the development of renewable energy projects, food production and agriculture, and the development of housing, which will be split up into subsections that are associated with three competing land uses in the state of Hawaiʻi. All three competing uses require land for development, for the expansion of agricultural production, development of renewable energy projects, and urbanization/ urban sprawl associated with housing development. The development of land in Hawaiʻi contributes to the drivers and pressures that result in competition. As climate change and its impacts worsen, and population and demand grows, it is expected that land use competition will increase, especially in places with limited land; like the state of Hawaiʻi (Smith, et. al., 2010). As this literature review includes concise examination of various State goals and initiatives associated with land use, numerous considerations related to land use planning and land use competition are not present, including the history of land use in Hawaiʻi, the critical correlation to Native Hawaiian cultural practices and traditional and customary rights, planning, permitting and zoning procedure, deeper discussion on climate change impacts, deeper discussion on economic impacts, additional State goals

and statutory requirements, and thorough analysis of applicability and current status to all counties and islands within the state of Hawai'i. Despite these missing details and discussion points, the information presented in this literature review explores a few priority goals and initiatives within the state of Hawai'i that induce land use competition, and how mixed-use developments can aid in effectively balancing competing land uses.

Development of Renewable Energy Projects

The State of Hawai'i became the first state in the United States to mandate the requirement for 100% renewable energy. Providing renewable energy in Hawai'i is critical not only due to the geographical isolation and vulnerability, but also because renewable energy is required by law. In 2001 Hawai'i Revised Statutes ("HRS")

Figure 2, *Utility-Scale Solar Installations Across the State of Hawai'i and Energy Capacity,* Glick, M (2024). 2024 Annual Report to the State of Hawai'i Legislature

§269-92 was first signed into law, requiring that each electric utility company that sells electricity for consumption in the state shall

establish a renewable portfolio standard. HRS §269-92 has been amended in years following. One of the amendments mandated the state to be 70-percent self-sustaining by 2030. In 2015 House Bill 623 was signed into law, further amending HRS §269-92 to require 100-percent

Figure 1, *Percentage of Renewable Energy by Source Technology,* Source: (Glick, 2024)

renewable sources to provide energy to the state by 2045.

As of 2024, petroleum fueled 65% of the state of Hawai'i's total electricity generation (United States Energy Information Administration, 2024), the state's dependence on petroleum for energy production is the highest for any state in the United States. Despite the high dependency on petroleum, the state of Hawai'i has made advances in pursuing the statutory requirement for 100% renewable energy by 2045. According to the 2024 Annual Report of the Hawai'i State Energy Office, in 2023 the state has achieved 35% of its electrical generation from renewable sources; the clean energy sources and mixes vary from island to island across the state, renewable

energy sources include wind, hydroelectric, utility scale solar, geothermal, distributed photovoltaic, biomass, and biofuel. Further, the 2024 Report includes analysis of the percentage of renewable energy generation by source technology. Figure 1 shows that all Counties across the state of Hawaiʻi have active utility scale solar photovoltaic projects.

There are an estimated 33 utility scale solar photovoltaic projects across the state of Hawaiʻi (Thomas, 2025) and nine utility-scale solar and storage projects (Glick, 2024); these projects differ in size, method of production, and land use designation. Figure 2, The 2024 Annual Report of the Hawaiʻi State Energy Office pie chart lists the nine utility-scale solar and storage projects statewide, this indicates the differences in size and capacity. Since the 2015 amendment of HRS §269-92, the State Land Use Commission has issued six special permits for renewable energy projects over 15 acres to operate on agricultural designated lands for a case by case determined amount of time. Though the granting of the permits is necessary for achieving the state's mandated renewable energy goals, the use of agricultural land for renewable energy projects creates competition and challenges for the State's goal of doubling food produ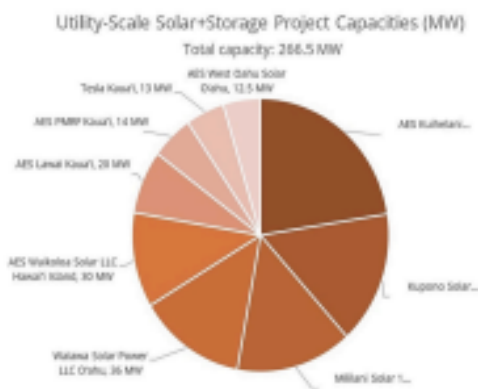ction by 2030. As the State continues to work towards meeting the statutorily required goal, it can be expected that agricultural land will continue to support the development of new renewable energy projects, which increases land use competition and perpetuates the inefficient use of limited natural resources.

Food Production and Agriculture

According to the Office of Planning and Sustainable Development 2012 *Increased Food Security and Food Self-Sufficiency Strategy,* the state of Hawaiʻi imports about 85-90% of its food;

Year and month	Total area 1/	Classification by State Land Use Commission 2/			
		Urban	Conservation	Agricultural	Rural
1993: December	4,112,388	187,897	1,958,897	1,955,704	10,090
1994: December	4,112,388	189,418	1,974,549	1,938,505	9,916
1995: December	4,112,388	190,257	1,976,018	1,936,197	9,918
1996: December	4,112,388	191,941	1,974,994	1,935,526	9,927
1997: December	4,112,388	192,158	1,974,994	1,935,305	9,931
1998: December	4,112,388	193,001	1,974,994	1,934,423	9,970
1999: December	4,112,388	194,592	1,974,994	1,932,792	10,010
2000: December	4,112,388	193,308	1,976,004	1,933,066	10,010
2001: December	4,112,388	194,556	1,974,106	1,933,687	10,039
2002: December	4,112,388	195,495	1,973,973	1,932,862	10,058
2003: December	4,112,388	196,215	1,973,636	1,932,429	10,108
2004: December	4,112,388	196,991	1,973,636	1,931,378	10,383
2005: December 3/	4,112,388	197,085	1,973,636	1,930,797	10,870
2006: December 3/	4,112,388	197,663	1,973,631	1,930,224	10,870
2007: December 3/	4,112,388	198,141	1,973,631	1,929,746	10,870
2008: December 3/	4,112,388	198,296	1,973,631	1,928,860	11,602
2009: December 3/	4,112,388	198,492	1,973,631	1,928,663	11,602
2010: December 3/	4,112,388	198,549	1,973,846	1,928,391	11,602
2011: December 3/	4,112,388	198,622	1,973,846	1,928,318	11,602
2012: December 3/	4,112,388	199,970	1,973,846	1,926,971	11,602
2013: December 3/	4,112,388	200,434	1,973,846	1,926,507	11,602
2014: December 3/	4,112,388	200,439	1,973,846	1,926,502	11,602
2015: December 3/	4,112,388	200,439	1,973,846	1,926,502	11,602
2016: December 3/	4,112,388	200,439	1,973,846	1,926,502	11,602
2017: December 3/	4,112,388	200,700	1,973,846	1,926,240	11,602
2018: December 3/	4,112,388	200,843	1,973,846	1,925,952	11,747
2019: December 3/	4,112,388	200,603	1,973,846	1,926,924	11,015
2020: December 3/	4,112,388	200,857	1,973,793	1,926,924	11,015
2021: December 3/	4,112,388	200,698	1,973,792	1,926,883	11,015
2022: December 3/	4,112,388	200,698	1,973,792	1,926,883	11,015
2023: December 3/	4,112,388	200,898	1,973,792	1,926,683	11,015

Figure 3, Estimated Acreage of Land Use Districts: 1993-2023. Department of Business, Economic Development and Tourism (2024)

furthermore, the state is located about 2,400 miles away from the Continental United States, which is the major source of food imports. The increased dependency on imported food results in households across the state facing food insecurity (Pruitt, et.al, 2021). Further, the State of Hawaiʻi

Constitution Article XI, Section 3 mandates the conservation and protection of agricultural lands, promotion of diversified agriculture, increased agricultural self-sufficiency, and ensures the availability of agriculturally suitable lands. In efforts to address the high dependency on imports, food insecurity, and increase agricultural related economic development, the 2019 State of Hawai'i Legislature passed Act 151, which sets the goal of doubling local food production by 2030.

The state of Hawai'i consists of 1,926,683 acres of land designated for agricultural use, which breaks down to roughly 47% of the total land (State of Hawai'i DBEDT, 2024). Despite this seemingly high amount of agricultural land, the number of acreage and active farming is in decline, and it is speculated that economic development, population increase, and urbanization and development are factors (Santos, et.al, 1999). One indicator of the loss of agricultural land to urban land is presented in Figure 3 (above), from the 2024 publication of the State of Hawai'i 2023 Data book. The table indicates the estimated acreage of land use districts from 1993-2023; one instance of recent reclassification occurred from 2022-2023, where about 200 acres of agricultural land became urbanized. The reduction of agricultural land and active farms results in the reduction of locally grown produce, which conflicts with state goals and state constitutional obligations.

The Office of Planning and Sustainable Development 2012 *Increased Food Security and Food Self-Sufficiency Strategy*, identifies urbanization pressures that cause what is described as the "impermanence syndrome" which is the accelerated agricultural decline near urban areas due to farmers' disinvestment in their farm operations in anticipation of development. The study identifies specific objectives that increase food self-sufficiency through the increase of demand, increase production, and increase policy and organizational support; however, none of the suggested actions include the perpetuation of mixed-use development, as it was outside of the scope of the study.

Development of Housing

The state of Hawai'i is experiencing a severe affordable housing crisis, with a lack of affordable rentals and affordable for-sale units. According to the Department of Business Economic Development, and Tourism 2015 study *Measuring Housing Demand in Hawai'i, 2015-2025*, the state was projected to need 64,693 additional housing units to meet housing demand by 2025, and about 43,828, of those units should be for low-income households. Further, the study acknowledges that housing development is limited by factor; hows including the supply of developable land, financing, and the permitting process; however, the study does not address these factors. In response to the findings presented in the study, the 2016 State of Hawai'i Legislature enacted Act 127, which established the state goal of creating 22,500 new affordable rental units by 2026.

The state of Hawaiʻi is often referred to as highly regulated, especially when it comes to permitting and development; various levels of permitting that have to occur when developing housing, which is argued a conflict in housing development. One process of permitting that is often argued against is permitting at the State level, through the State Land Use Commission. The State Land Use Commission was established to administer Hawaiʻi Revised Statute, Chapter 205, which is essentially state-wide land use law. The 1961 State of Hawaiʻi Legislature established the Land Use Law and Land Use Commission to establish and administer a comprehensive framework for managing land use statewide, due to a lack of land use controls and use of Hawaiʻi's limited and valuable lands. These uses resulted in scattered subdivisions with inadequate public services, shifting of prime agricultural lands into nonrevenue producing residential uses and non-utilization of available lands to its highest and best use (Chang, 1970). Since the Land Use Commission's inception, the Commission has approved large scale housing projects, however, the Commission has not had a petition to amend the district boundaries from agricultural land to urban land for housing purposes since 2021, which was an affordable housing development in Maui County, on the island of Lānaʻi.

The slowdown of large housing developments is speculated to be attributed to the high cost of land and development, regulatory and permitting procedures, and the housing market (University of Hawaiʻi, 2023) (Department of Business and Economic Development and Tourism, 2015). I have noticed community opposition toward development petitions to reclassify agricultural land designation to urban designation for development; the community opposition tends to be rooted in environmental and natural resource management concerns, opposition to urban sprawl, and cultural resource preservation. Large master planned housing proposals are less likely to proceed with development if they have community opposition due to environmental and natural resource management concerns; however, mixed-use development is a viable way to develop housing units while reducing the development of agricultural land, while maintaining a healthy environment and social ecosystem in Hawaiʻi.

As mentioned previously, the various types of development associated with the three subject State goals share common ground; they all require land for development. Expansion of agricultural production, development of renewable energy projects, and urbanization/ urban sprawl associated with housing development contribute to the drivers and pressures that result in land use competition and expanded use of the agricultural district. Further, as climate change and its associated impacts worsen, population and demand grows, it is expected that land use competition will increase, especially in places with limited land, like the state of Hawaiʻi (Smith, et. al., 2010). In contemplating how the State can

effectively balance competing land uses, such as productive agriculture, housing, renewable energy, and natural resource preservation across the state, I decided to explore how mixed-use development can resolve these contradictions.

Mixed and Dual Land Use Development in Hawai'i: Benefits and Challenges

What is Mixed-Use Development and Dual Land Use Development?

Mixed-use development is an alternative to single use development, where multiple uses are developed within a site (Peña and Shah, 2022). Common examples are the development of street-level retail with residential units above, and the co-location of uses within a designated area, such as neighborhoods that offer residential, commercial, and civic spaces within walking distance. Similarly, dual land use development is an alternative to single land use development, where two land uses are developed within an area (Sustainability Directory, n.d). A common example of dual use development is the combination of agriculture and energy generation, whether it be for commercial energy distribution or operational energy production.

I know these two types of development sound the same, but the distinction is in the technical definition and the number of uses in a given area. In short, dual use has two uses and mixed-use has more than two uses. Both mixed-use and dual use development offer community

resilience through environmental, economic, social, and health benefits (Iannillo and Fasolino, 2021).

Environmental and Economic Benefits

One of the main environmental benefits associated with mixed-use and dual development is the efficient use of land, as mixed-use and dual-use development incorporate multiple uses in a development site, the land area is maximized resulting in the reduction of urban sprawl. Urban sprawl can be defined as the spreading of development on undeveloped lands. Development of undeveloped lands ends up in consumption of natural resources and encroachment on forests or agricultural areas on the outskirts of cities (Shawly, 2022).

Additional environmental benefits and natural resource management associated with mixed and dual use development include the reduction of air pollution and carbon footprint due to increased walkability and the reduction of fossil fuel dependent transportation, preservation of cultural and natural resources, conservation and ecological management of storm water and sewage, energy production and conservation, and water resource conservation (Bahadure and Kotharkar, 2012).

I have witnessed a fair share of community opposition with regard to new projects expanding on to agricultural land creating urban sprawl. Most of the community opposition involves concerns regarding environmental impact, as well as

cultural and historic preservation. Further, the State of Hawaiʻi Constitution Article XI provides strong protection of the environment and agricultural lands stating:

"The State and its political subdivisions shall conserve and protect Hawaiʻi's natural beauty and all natural resources, including land, water, air, minerals and energy sources, and shall promote the development and utilization of these resources in a manner consistent with their conservation and in furtherance of the self-sufficiency of the State."

and

"The State shall conserve and protect agricultural lands, promote diversified agriculture, increase agricultural self-sufficiency and assure the availability of agriculturally suitable lands."

These strong provisions provide clear direction that environmental impact, natural resource management, and protection of agricultural lands must be considered when petitions for development occur- as development is necessary as population grows. The implementation of mixed and dual use development in new projects provides opportunities for work, life, and extracurricular activities, which contain the community in the specific area. Further, applying mixed and dual use development in redevelopment and infill projects in pre-existing urbanized areas can reduce the burden on the environment and natural resources by not encouraging urban sprawl.

Mixed and dual use development also have economic benefits. The economic impacts include increased economic activity and demand for residential and commercial locations, reduced infrastructure needs due to use of current infrastructure, and the reduction of service expenses such as access to emergency services (Peña and Shah, 2022). Through my research I found that there is limited information on the exact economic impact of mixed-use development, which leads to opportunity for expansion on this data (Shen and Sun, 2020).

Mixed-Use Development: Housing

As previously mentioned, mixed-use housing developments tend to combine residential spaces with commercial, retail, industrial, or other uses. Mixed-use communities tend to reduce urban sprawl (Shawly, 2022), as they offer numerous aspects vital to community life in one area. Generally, there are two types of mixed-use development; horizontal and vertical; vertical mixed-use development is confined to a single building and often in urban areas, horizontal mixed-use development consists of many buildings spread over more land (Matthews, 2025). Both horizontal and vertical mixed-use developments have a place in the solution to address how to effectively balance competing land uses, such as, productive agriculture, housing, renewable energy, and natural resource preservation across the state of Hawaiʻi. One aspect of vertical mixed-use development is through the application of urban redevelopment and infill development, and

one aspect of horizontal mixed-use development is the development of master planned mixed-use communities. For the purpose and scope of this project I am limiting the discussion on mixed-use housing development to vertical mixed-use development, specifically, urban redevelopment and infill projects.

Vertical Mixed-Use Development: Urban Redevelopment and Infill Projects

Infill development is the development of undeveloped/vacant lands not developed in urban areas, and redevelopment can be defined as the new construction of a site that had pre-existing uses and renovation of an area (Mseddi and Simon, 2022). One way mixed-use infill development addresses balancing competing land uses and natural resource management is through the effective use of land, especially when housing is near the workplace, shopping places, restaurants, cafes, and other amenities (AlHasawi, et.al, 2024). Further, mixed-use infill development also supports a variety of low-cost housing through affordable housing, as well as the reduction of external transportation (AlHasawi, et.al, 2024).

In the state of Hawai'i, the most populated and urbanized county is the City and County of Honolulu; the 2023 State of Hawai'i Data Book for 2023 indicates that the resident population of the City and County of Honolulu is 989,408. As the City and County of Honolulu is the most urbanized and populated county, the county and state have been supporting infill

redevelopment, in order to maximize the use of existing land and infrastructure in the urban core. The support for infill and redevelopment has been present in county initiatives and state laws and emergency proclamations. One example is the recent City and County of Honolulu activation of the Kūwili Station Transit Oriented Development Redevelopment Area, which utilizes the City and State's land holdings to create a mixed-use district, housing, improve connectivity, address environmental concerns, and mitigate flood risks (Humber, 2025). A lot of support is occurring across the state and in the counties for mixed-use redevelopment projects.

One day, I was watching the news, and I saw a real estate advertisement for a mixed-use redevelopment project down the street from my work. I was inclined to research it a little more and further found that the developer of the project exemplifies experience in mixed-use infill development projects. I decided to reach out to the Avalon Group ("Avalon"), a local real estate development, consulting, and sales company, based in downtown Honolulu, for an interview to discuss mixed-use development in Hawai'i. I was pleased to have the opportunity to interview Robby Kelley, the Chief Development Officer at the Avalon Group.

Immediately, Kelley informed me that the Modea redevelopment project I saw on the news has been canceled due to challenges…we will get into those shortly. The cancellation of the Modea Project does not take away from the experience in

development in Hawai'i. Kelley credits Avalon's focus on community and affordability to CEO Christine Camp's upraising with little to no housing security growing up in Hawai'i, which drives Avalon's business model of creating spaces for business to thrive and families to prosper. According to Avalon's website, Avalon has developed several mixed-use projects, often commercial, but highlight the development of two mixed-use housing projects: Sky Alamona and Hale Kamiano Senior Affordable Housing. Both are vertical mixed-use developments.

In our discussion, Kelley explained the benefits of vertical urban redevelopment and infill projects, stating that urban core development aims to reduce the two major competing uses: housing and land use. Further, mixed-use development reduces the need to expand infrastructure into undeveloped areas (which adds to cost), and stimulates the economy; local and foreign.

Figure 4, Proposed Modea Redevelopment Building, former Davies Pacific Center Building.
Source: (Dwell, n.d.)

Kelley's statements are supported by numerous developers, case studies, and the American Planning Association.

The paper *The Barriers To Using Urban Infill Development To Achieve Smart Growth* identifies numerous barriers to urban infill development, including but not limited to permitting and procedure costs, costs of expansion of infrastructure, regulatory policies, and resistance from local residents, and stakeholder conflicts and political constraints (Farris, 2001). Returning to the cancellation of the Modea Project, Kelley shared that vertical urban redevelopment and infill projects face their fair share of challenges and scrutiny. In Kelley's experience, he has noticed that there is not much public push back on re/development projects, as they are already in the urban core; projects expanding into previously agricultural designated areas receive much more scrutiny. In spite of less public pushback, vertical urban redevelopment and infill projects tend to receive safety and quality of life concerns, especially with conversion projects, and permitting/regulatory difficulties. Kelley identified the specific challenge was the Avalon Group was not able to to get a variance for non-opening windows for the Modea project, which returns to two challenges urban redevelopment and infill projects face; safety and quality of life concerns, which resulted in permitting challenges. These challenges ultimately caused the cancellation of the project as the solution to solve the permitting issue would not have been economically feasible.

In Kelley's experience, barriers to urban infill development, including but not limited to permitting and procedure costs, costs of expansion of infrastructure, regulatory policies, and resistance from local residents, and stakeholder conflicts and political constraints, can be prevented through; early and quality community engagement; Kelley emphasized that community engagement should be constructive and interactive not dismissive, education on the benefits and shared value of the development, advocacy and political support, and willingness to adapt and innovate solutions that are beneficial to stakeholder and community. Despite the numerous challenges associated with vertical urban redevelopment and infill projects the advantages associated with land use conservation, reduction of external transportation, convenience, public health, community building and social cohesion, reduction of the need to expand infrastructure into undeveloped areas, and economic stimulation (Peña and Shah, 2022), are worth pursuing vertical urban redevelopment and infill projects as a means to effectively balance competing land uses across the state of Hawaiʻi.

Dual Use Development: Agrivoltaic Projects

One example of dual use development that couples renewable energy with agriculture, are agrivoltaics, agrivoltaics are specifically the partnering of photovoltaic projects and agricultural practices. The development of agrivoltaics is driven by climate change, competition for

land use, and the scarcity of fossil fuels, while maximizing land use in a preliminarily single use sector (Barron-Gafford, et.al., 2019). In terms of natural resource management, not only do agrivoltaics responsibility maximize land use, but they encourage the reduction of irrigation needs for agricultural ventures, improve resistance to adverse weather conditions including temperature, and reduce CO_2 (Soto-Gómez, 2024). As illustrated in Figure 5, agrivoltaic systems also provide social and agricultural benefits such as; income diversification, crop diversification, cost reduction of land to farmers, access to renewable energy sources that cover community and potentially farming operations, and increased community support (Soto-Gómez, 2024) (Burden, 2025).

As a land use planner, I have observed petitioners implementing agricultural plans in photovoltaic developments, as well as commissioners implementing conditions of development that require agricultural components in photovoltaic developments. The implementation of such agricultural plans provides the opportunity for dual use development in photovoltaic projects and supports the State goal to double food production by 2030. One example of dual use photovoltaic projects in Hawaiʻi is the Clearway Energy Group commercial operation Mililani Solar I Plant, located in Central Oʻahu on 131 acres in Mililani Agricultural Park. The Mililani I project is also hosted to Phase 2 the agrivoltaic research project in partnership with Hawaiʻi
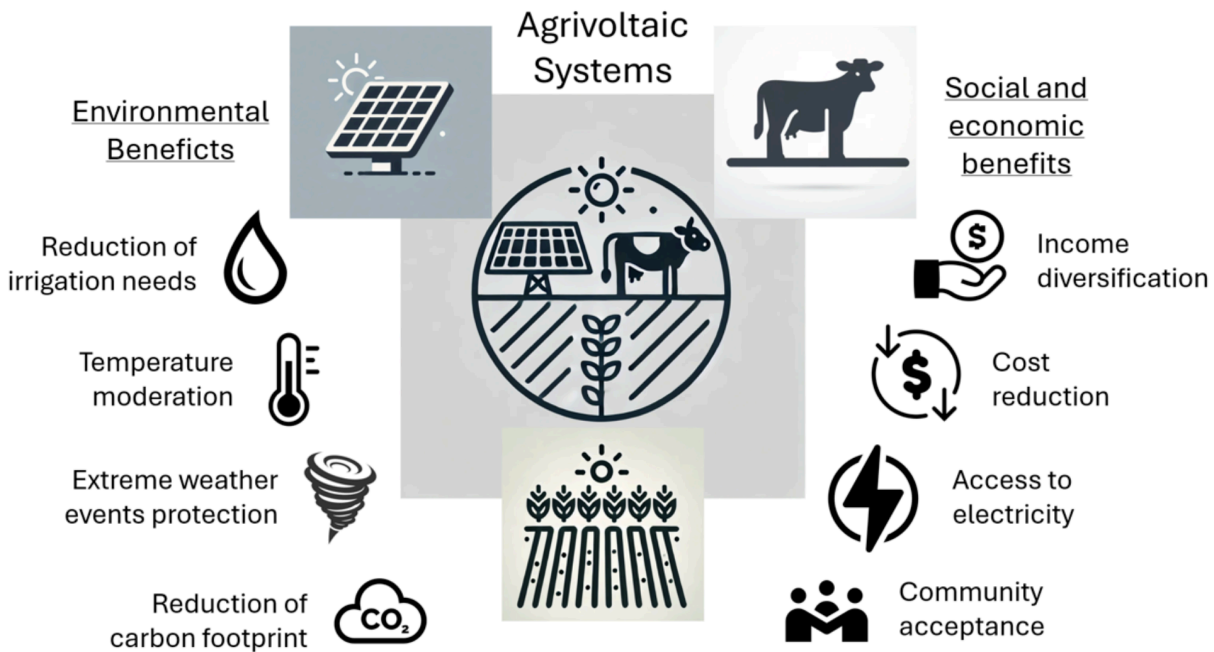
Figure 6, *Clearway Energy Group Mililani Solar I Plant, Photo courtesy of Wärtsilä, Source: Corwell, C. (2022, August 11)*

Agricultural Research Center, which explores the potential to reduce competing land use through the dual use of lands for local energy and local food production.

Back in 2023, I had the opportunity to visit the Clearway Energy Group commercial operation Mililani Solar I Plant for work, and I thought revisiting the photovoltaic project and interviewing the project lead would be ideal for the purposes of discussing dual use development in the state of Hawai'i. I met Juli Burden is the Agrivoltaic Systems Lead at HARC, at the Clearway Project. Burden has been working with HARC for 13 years, where she designs and manages experimental agrivoltaic diversified systems, analyzes data to assess system performance and crop yield impact, and collaborates with local communities and stakeholders to ensure projects align with sustainability goals.

During our discussion, Burden explained the benefits of agrivoltaics from her findings, research, and experience at HARC. Burden explained one significant benefit of implementing agrivoltaics in Hawai'i, is that it provides small scale farmers with long term land leases at affordable prices, or even for free. In Hawai'i, small farming operations comprise the majority of farms in the state; however, these farms experience economic difficulties (Lyte, 2021). Burden and other members of the small farm community contend increasing the availability of land at affordable prices would support small farmers and the diversification of local agriculture across the state.

The benefits of agrivoltaic systems also include numerous ecosystem services associated with the photovoltaic system infrastructure. Throughout Burden's data collection and comprehensive trials, evidence indicates the shade produced by panels (whether they are tracking panels or fixed) aids in reduction of water use, promotes diversified crops, and offers health benefits for farmers due to the reduction in heat (Burden, et.al, 2025), this data has been supported in numerous studies including California and North Carolina (Cuppari, et.al., 2024).

Despite the numerous benefits of agrivoltaics, there is opposition and difficulties associated with the development of agrivoltaic systems; During my interview with Burden, we talked about some of the opposition and difficulties related to agrivoltaics locally.

One challenge that agrivoltaics face locally occurs during the legislative process in efforts to regulate land use, development, and limit expansion into prime agricultural lands. During the 2025 legislative session, bill SB 443 was introduced, which in short aimed at require that lands within the agricultural district with class B or C soils that have solar or wind energy facilities must also obtain additional certification from the State of Hawai'i Department of Agriculture that the lands are also used for a farming operation. Burden explained that this bill would have impacted the permitting process for solar developers, which could have made it harder to implement agrivoltaic projects across the state. Further, Burden

explained that there is often a misconception with the immediate development of prime agricultural lands for solar use, as prime agricultural lands are expensive, the permitting process is difficult to navigate, and land use law restricts such use.

Similarly, another challenge that the development of agrivoltaics experiences is community opposition. Community opposition can come from the belief that development is a threat to agricultural lands (Pascaris, et.al, 2021) and changes to aesthetic views and the surrounding environment. Juli expects that as the state moves closer to 2045, the year of which the state has to reach 100% renewable energy, it is expected that large scale photovoltaic projects will expand, and so will community opposition. Juli explained that a few photovoltaic projects have received community pushback due to the aesthetic impact on the surrounding environment; however, increased community opposition could result in the missed opportunity for renewable energy projects and mixed-used agrivoltaic projects.

The challenges and opposing views associated with agrivoltaics in the state of Hawai'i, highlights the importance of Juli's work as the Agrivoltaic Systems Lead at HARC. Juli's work at HARC is the research and application of relevant science and technology to achieve practical solutions in agrivoltaics. Juli spends a lot of time with stakeholders and policy makers educating them on the benefits of agrivoltaics and how they support the State's goals. Challenges and opposition can be addressed through

community collaboration, education, and opportunity for interaction. Agrivoltaics can further be supported through local regulation that involves subject matter experts, as development and application become more prevalent to address the States goals for achieving 100% renewable energy by 2045 and the doubling local food production by 2030, and the States constitutional requirements for the conservation and protection of agricultural lands, promotion of diversified agriculture, increased agricultural self-sufficiency, and assurance of the availability of agriculturally suitable lands.

Summary

The State of Hawaiʻi has constitutional burdens, statutory requirements, and administrative goals that include, but are not limited to the development of housing, achieving 100% renewable energy by 2045, and doubling food production, and the products of these goals and requirements require the use of land and other natural resources, which are limited. These mandates and goals result in contradiction and competing land use through the expansion of development into the agricultural district. The results provided by the research and interviews in this paper indicate that mixed-use and dual-use development promotes efficient land use, the reduction of urban sprawl, and natural resource management. Mixed-use and dual-use development is a viable and practical solution to address competing land use and the drive for economic development, limited natural resources, and various State goals and statutory requirements in Hawaiʻi.

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Rooted in Relationships: Community Engagement Strategies of an Urban Forestry Nonprofit

Chloe Andruss

Abstract

This case study explores how a small Southern California nonprofit urban forestry organization cultivates relationships and navigates challenges through community engagement practices. Drawing from interviews, site visits, public events, and direct observations, it examines how trees and tree care become a pivotal point for environmental education, social connection, and sustainable change. Each section of this study follows the growth of this engagement, from internal management and external contributions to the logistical and technological realities of urban forestry practice. The project also addresses broader concerns such as the urban heat island effect, environmental justice, native planting, and public trust in government. By grounding this research in lived experience, this study reveals how effective engagement, grounded on care, consideration, and shared responsibility, can transform the urban landscape one tree at a time.

The Seed of Stewardship

When I was in college studying landscape architecture in San Luis Obispo, I took a part-time job at the Leaning Pine Arboretum. Now that I was no longer sheltered in my childhood home, I was searching for something to give me a sense of purpose. Over three years, I spent three days a week under sunny skies, deep watering the redwoods, ensuring the oak tree trunks didn't get wet from sprinklers, trimming branches, nursing ailing trees back to health, chasing deer away from vulnerable new growth, and watching for signs of disease and pests. I had the privilege to grow into adulthood in peaceful company with the dense plantings and diverse tree species of the world's five Mediterranean regions.

I cherish these quiet memories and tangible experiences as some of the happiest and most formative of my life. Working closely with the land gave me a lasting relationship with nature, one rooted in observation, care, and respect. It also introduced me to the power of stewardship and how tending to nature can create a deep sense of connection to place. Watching the seasons shift and plants grow brought immense joy and, along with my studies, deepened my appreciation for landscapes both cultivated and cared for by human hands.

Years later, I find myself returning to these fond memories as I follow the work of an urban forestry nonprofit (UFNP) for this case study. This paper offers a portrait of how UFNP leverages and sustains the power of community engagement, not only as a strategy to expand urban tree canopy cover where critically needed, but to foster a shared sense of purpose, belonging, and care in the urban environment.

In studying today's urban environments, it's clear there is a lack of access to the kind of natural green spaces that brought me such respite and fulfillment. The Trust for Public Land highlights a distributive justice inequity in park access across urban Southern California, with Black and Hispanic/Latinx neighborhoods in cities like Los Angeles, Anaheim, and San Diego falling noticeably below the citywide average (Trust for Public Land, 2025)(Klein & Foderaro, 2025). Community engagement offers a way for residents to play an informed and active role in developing healthier and sustainable spaces.

"Consciousness raising," or the collective sharing of personal environmental experiences, can foster more inclusive and meaningful urban planning processes (Verchick, 1996). When communities are involved in decisions about their landscapes, trust is built, and development proceeds at a more sustainable, equitable pace. Indigenous communities have sustained ways of prospering with the earth for millennia, far longer than modern agricultural practices, through Traditional Ecological Knowledge (TEK), which outlines everyday principles

for fostering connection between land and people (Garcia-Weyandt, 2024). TEK embodies the use of oral traditions to pass on ceremonial acts of appreciation, creating an experiential bond through the practice of reciprocity (Garcia-Weyandt, 2024). These Indigenous traditional habits contrast sharply with the modern-day disconnect from land, where specialized knowledge often replaces direct, experiential relationships with place. While this has contributed to breakthroughs in solving complex issues, it has also distracted communities from developing relationships with the built world through direct experience.

Urban forestry presents a unique set of challenges and opportunities. In areas where open space is limited and underground infrastructure complicates planting, thoughtful coordination and strategic planning are essential. Constructing the urban landscape requires not only technical expertise but a deep understanding of how communities interact with the built environment and natural elements in their surroundings. As a landscape architect, I have always held an interest in how sustainable solutions are integrated into urban systems. My professional background has taught me to think critically about spatial design, ecological performance, and long-term maintenance. However, for this case study, I branch out to explore how urban forestry is actively practiced within a community through the lens of a nonprofit organization.

My research is guided by the question: **In what ways does a small urban forestry nonprofit in Southern California cultivate relationships and navigate challenges through the use of community engagement practices?**

From a Single Tree to a Forest: Building a Network

I first met Macy, UFNP's program manager, over Zoom. She had been with the organization for about a year and a half and was enthusiastic about sharing her experience working within urban forestry. I let her know my intent to anonymize this research, and throughout this paper, pseudonyms are used to protect both individuals and the nonprofit's identity. All participants provided consent to this process, and Macy's openness demonstrated an eager investment in her work. Although our conversation was informal, I typed notes as she spoke to capture her insights in real time.

Macy shared that UFNP often reaches out to Dr. Matt Ritter, a well-respected author, botanist, and who also just so happened to be my Botany 101 professor at Cal Poly. I lit up at this connection as his book, *A Californian's Guide to the Trees Among Us*, was a staple field guide to trees while I was in school. His introduction shares insight on the urban struggles of restricted roots, lack of rain, and various "arboreal violence" like overhead utilities (Ritter, 2011). Macy raved about his help and noted that they referred to him often to keep up to date on industry

recommendations on street trees. This mutual connection to Ritter's work felt like a meeting point between academic knowledge and lived practice; a reflection of how our paths had converged through a shared focus on environmentalism and plant care.

The more we talked, the more it became clear that UFNP relies heavily on the collective support of other nonprofits, private donors, volunteers, churches, schools, farms, and more. Most of their projects build on or emerge from these collaborative relationships. I later attended an event where a large corporation hosted an employee bonding activity, volunteering for trash pick up with another local nonprofit, and had donated funds for UFNP to distribute free trees to the public. While there, I spoke with UFNP's executive director, Hannah, and was surprised to learn that after nearly a decade of outreach, it's now primarily communities and partners who initiate contact with them for projects. Macy explained how one of the most difficult parts of urban forestry is finding room to plant trees. They utilize city-surveyed open spaces along with public databases like TreePlotter to keep up on maintenance and measure ecological benefits.

This shift from active outreach to incoming requests reflects how embedded UFNP has become within broader networks of environmental work. However, as a nonprofit, they still need to pull from a variety of resources, including government-funded programs like

Americorps CCAC fellows, Cal Fire grants, and funding from the Inflation Reduction Act. Some of their work is also done in direct partnership with city governments. Many Southern California cities, such as Los Angeles, Buena Park, San Diego, and La Mesa, have urban forestry or climate action plans that support and align with tree planting efforts. These layered partnerships illustrate how community-driven nonprofits like UFNP operate within and alongside larger institutional frameworks. It is through a variety of relationships and outreach that they are able to make an impact.

Macy proved to be a key connector throughout my fieldwork. She introduced me to UFNP's on-staff arborist, Casey, and later some of the Americorps CCAC fellows who support the organization's outreach and planting work. She also kept me informed about upcoming events, such as a community open house and an industry happy hour, which offered valuable opportunities to observe UFNP's engagement with both residents and professionals. These informal interactions through phone calls, a lunch chat, and spontaneous conversations shaped the core of my methodology. These settings offered a more relaxed space for participants to open up on what had been important to their personal

experience within urban forestry.

This case study offers a meaningful addition to urban forestry and environmental justice literature by exploring the relational dynamics often overlooked in technical or policy-driven research. Rather than focusing solely on project outcomes, it examines the challenges, tensions, and personal motivations behind urban greening efforts. By centering voices not commonly heard in academic research, such as volunteers, it surfaces localized knowledge and lived experiences that complicate assumptions about participation, equity, and the scalability of green infrastructure, particularly in under-resourced neighborhoods.
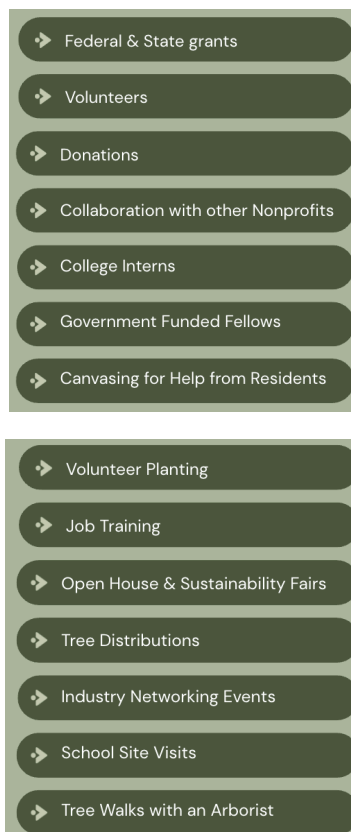
Growing Pains: Technology and the Realities in the Groundwork

I had been looking forward to my conversation with Casey, UFNP's arborist, to hear his take on urban landscapes and the complexities in urban forestry today. From our first phone call, we found ourselves sharing stories of the overlap in professional experience with soil conditions, irrigation, and establishing trees in inhospitable urban environments. Our technical talk turned into an honest

> ➤ Federal & State grants
> ➤ Volunteers
> ➤ Donations
> ➤ Collaboration with other Nonprofits
> ➤ College Interns
> ➤ Government Funded Fellows
> ➤ Canvasing for Help from Residents

> ➤ Volunteer Planting
> ➤ Job Training
> ➤ Open House & Sustainability Fairs
> ➤ Tree Distributions
> ➤ Industry Networking Events
> ➤ School Site Visits
> ➤ Tree Walks with an Arborist

reflection of the innovation of today's technology and the harsh reality that limits its successful implementation.

As professionals in the field, we've both seen how technical tools like i-Tree, a free software supported by the USDA, can assist planners in quantifying the environmental benefits of trees, allowing for more informed and sustainable decisions. i-Tree and MyTree have a user-friendly interface with free services for: I-Tree Canopy, i-Tree Design, i-Tree Landscape, i-Tree Planting, i-Tree Species, and more (Nowak, 2021). These all help consider critical issues like carbon storage and air quality (USDA et al.). However, access to the platform assumes availability of a computer or smartphone, internet access, and the time to navigate it. In my experience with industry professionals, i-Tree can still feel rudimentary and does not always capture the nuance of specific site conditions. This gap between technological promise and practical application became a recurring theme as we continued our conversation.

We spoke about other technologies at work, such as engineered cell blocks or structural soil systems designed to support healthy tree growth in urban environments by creating a way for tree roots to thrive in uncompacted soil beneath pavement. Casey pointed out the incredible opportunity to use Silva Cells, a system made of fiberglass-reinforced polypropylene that facilitates root expansion, enhances stormwater management, and contributes to the overall ecological health of cities

(Ehrlich, 2009). However, we both found that the adoption of such systems faces significant financial challenges. The cost of installing Silva Cells in a Minneapolis project is estimated at approximately $8,038 per tree, which can be prohibitive for many municipalities (Minnesota Pollution Control Agency, n.d.). Since these use virgin materials to maintain structural integrity, they become a contradiction of creating more plastic waste in the ecosystem (Ehrlich, 2009). Therefore, solving one environmental problem while contributing to another. Despite the price, DeepRoot's Silva cells offer a creative environmental solution by advertising their stormwater capabilities to mimic natural water flows and can even be added to existing trees (DeepRoot, n.d.). However effective this solution may seem, it remains economically infeasible to be applied en masse.

This conversation reminded me how easy it is to rely on or become enamored with technical solutions. I've worked on design teams within landscape architecture where soil testing is standard protocol, and prescribing fertilizers and amendments is viewed as the responsible next step. Even with the appropriate soil testing, I've seen amendments poorly applied or improperly leached. Casey echoed this, noting this might help the plant establish, but doesn't help the tree adapt to the native soils. Casey made an argument for a more restrained approach of using high-quality compost and mulch over fertilizers and amendments. The Arbor Day Foundation notes that many of the deficiencies of urban soils can be

remedied with the addition of organic matter in high-quality compost ([Arbor Day Foundation, 2022](#)).

This reinforced my understanding of how people often rely on relational knowledge and not just technical expertise. With Casey's vast experience, he serves as a translator between theory and practice. It was a reminder of how this case study is about listening for patterns, recognizing lived contradictions, and staying open to perspectives that may counter my own. Despite the advanced tools available, this discussion highlights how the quality of relationships among professionals and community members is still dependent on the trust and shared understanding for long-term, sustainable success. This is at the heart of how UFNP reaches out through community engagement.

Urban Greening as a Mitigation Strategy

Speaking with Casey and Macy about the challenges of new technologies and the many-layered connections needed to enable urban forestry led me to consider the deeper reasons these solutions matter. The greater implications of the lack of tree cover in urban environments show that environmental degradation is not uniformly distributed, with marginalized communities bearing the greatest environmental burdens. Through time spent witnessing UFNP's efforts to provide care and connection where larger systems have failed, I've come to understand how environmental nonprofits fill a critical role in bridging gaps and building trust within a community.

Urban heat island poses a major concern due to heat-absorbing surfaces such as asphalt ([Adams-Fuller, 2023](#)). This intensifies in areas lacking tree cover and other green vegetation, increasing energy costs and contributing to economic disparities in access to cooling, which can lead to heat-related illnesses ([Adams-Fuller, 2023](#)). As noted by the American Council for an Energy Efficient Economy, low-income households spend 8.1% of their income on energy compared to 2.3% for higher-income households ([Adams-Fuller, 2023](#)). These disparities highlight a critical inequity in access to cooling methods, which calls for environmental remediation and public health interventions.

I've seen and felt the immediate impact of trees within my own fieldwork. When analyzing a site, one of the first things we look for is whether we can protect existing trees on the site. I've been discouraged when project goals for extended program space, city-regulated parking requirements, or utility easements have required tree removal or restricted planting altogether. However, there are inspiring projects where the client shares a vision of protecting existing trees on site. I recently went out to a site in San Bernardino where my company designed a playground and a building built around 50'-60' tall pines and eucalyptus. The day one impact of those trees nestled between the organic flow of the building's roof overhang and the winding pathways was instant awe. The 90-plus

degrees of the hot San Bernardino sun were cut in half by the dense shade provided.

Unjust distribution has long been a theme in the United States, but affected groups often find support from their surrounding family and community. Four women from St. Louis offer a counter perspective to Kozol's book, *Savage Inequalities*, which portrays the failure of the education system and depicts their childhood city as dismal and in extreme poverty (Farmer-Hinton, et al., 2130). Their lived experience of incredible support from "extension of familial capital" through community members and organizations contributed to their academic success (Farmer-Hinton, et al., 2130). Human connections, rather than government structure, are what gave them agency over their lives despite environmental circumstances. UFNP provides similar support through community engagement. When the government fails to provide needed structure, nonprofits fill the gap with outreach, resources, and education.

Green spaces are also shown to have extensive psychological and physical benefits. Beute and de Kort (as cited in Szabo et al., 2023) note that natural environments can reduce depressive symptoms and improve cognitive function by stimulating natural opiate production in the brain. This same study also notes how this boosts the recovery process from stress and therefore demonstrates how access to nature can truly heal people. The Japanese practice of *shinrin-yoku,* or forest bathing, is similarly associated with improved immune response and reduced stress (Kotera, Richardson, & Sheffield, 2020). Having access to green open spaces is a natural right and health necessity for an equitable society.

Urban forestry has emerged as a common natural strategy against urban environmental degradation. Trees' carbon sequestration potential, ability to reduce the heat island effect, and the mental health benefits make urban forestry an appealing option. However, these green initiatives must be implemented carefully and include public consultation. At a recent industry happy hour, UFNP presented on the urban heat island effect. I spoke with one of the attendees who shared her impressions of the event. Around 30 people were there, and although the presentation was brief, it effectively covered UFNP's research, initiatives, and ways to get involved. She noted the following discussion revealed strong interest and concern, with attendees asking questions about the role of municipalities, infrastructure planning, and fire-resilience. She also described frustration among the audience directed at government agencies, particularly around the lack of long-term tree maintenance and financial support. This kind of community feedback helps convey the growing public awareness around urban forestry issues and the disconnect between citizen expectations and government capacity.

One solution may be to employ the Miyawaki method, by Japanese botanist Akira Miyawaki, which involves planting dense, multi-layered microforests using native species to rapidly restore biodiversity

and combat urban heat islands ([Patil, 2022](#)). In Southern California, successful adaptations have been made to suit the region's Mediterranean climate, characterized by hot, dry summers and mild, wet winters. The Los Angeles Parks Foundation implemented a Miyawaki-style microforest in Griffith Park, which used 24" box trees with irrigation for the first 2 years ([Los Angeles Parks Foundation, 2023](#)). However, Griffith Park faced some challenges associated with the Miyawaki method within a Southern California climate. The region's native flora is predominantly shrub-dominated, with lower tree diversity compared to temperate forests, which requires adjustments to the traditional planting ratios typically used in the Miyawaki method ([LA Micro Forests, n.d.](#)).

The method's reliance on high plant density and initial irrigation may conflict with water conservation goals in drought-prone areas ([LA Micro Forests, n.d.](#)). A study conducted in Italy designed a project using the Miyawaki "tiny forest" method within an urban Mediterranean climate. The researchers identified the optimal plant palette suitable for the local climate and soil conditions. Their findings suggest that the technique can enhance biodiversity and provide ecosystem services, such as mitigating urban heat islands and improving air quality, even in challenging Mediterranean environments ([Cambria et al., 2024](#)). However, this study also found that the dense planting required by the Miyawaki method necessitates significant water resources, which can be viewed as

unsustainable in drought-prone regions. While the Miyawaki method offers promising benefits for urban greening in Southern California, the principle of creating an all native, densely planted forest may not make sense for an area without existing shade canopies to begin with.

Another valid concern is green gentrification, where urban greening, including trees, parks, and other types of vegetation, raises property values and displaces long-term residents (Checker, 2011; as cited in Stuhlmacher, et al., 2022). Stuhlmacher also references the "Just Green Enough" framework (as noted in studies like Curran, W. & Hamilton, T. 2017), where they suggest considering planning policies such as rent control, affordable housing initiatives, and anti-eviction measures to avoid reproducing patterns of displacement and inequality. Although UFNP expressed concern about this issue when asked, they did not have detailed knowledge of how it is currently being addressed at the city level.

A Gathering for Green Goals

I walked into the Nature Play Space's entry, where the parking lot was quickly filling, and saw a booth surrounded by about 90 potted trees and UFNP's logo on a large banner. Macy, UFNP's program manager, whom I had been speaking to for the past few months, was stationed alongside a few other UFNP members to warmly greet attendees. She said the event was exposing UFNP to a lot of new faces from a community that they previously hadn't interacted with. She also noted that

there were a lot more Spanish speakers with whom her coworker was able to converse fluently. I found out from her that Casey could also speak fairly fluently, which helps during his tree walks.

After climbing up the steep entrance, I was greeted by a child-drawn sign on the rules of the Nature Play Space and some volunteers passing out a reusable bag containing maps, schedules, and eco-friendly giveaways like reef-friendly sunscreen. I noticed carts shuttling visitors up to the main area, providing accessibility. These details reflected the event's values not just for sustainability and environmental awareness, but for inclusion and community care. I hadn't been sure what to expect out of this event but had heard I might be able to chat with city officials about urban forestry. I quickly realized this offered a much broader perspective as a collection of environmental activists in the area, gathered to celebrate and share resources on local initiatives.

Just down the path, I saw another familiar face. Casey, UFNP's arborist, was leading a tree walk to engage locals in discussions about tree health and care. I had learned so much from our previous chats; he was a wealth of knowledge with an unwavering passion for tree health that was consistently grounded in human connection. He was already in conversation with someone, so I passed with a wave of acknowledgement. My primary objective was to be a passive observer at this event, and I aimed to see how UFNP interacted with the community.

I perused into a space under big shade sails with some 20 booths set up from different organizations. I would estimate that there were about 50 or so people there who were not a part of a participating organization. A demonstration of a ceremonial dance to bless the ground was being performed by the Kumeyaay dance troupe. One of the dancers gave a brief introduction where she gave space to the political tone of the day; many people in the area were attending the No Kings protests against the current administration's policy changes. This emphasized the connection between environmental and social justice work and served as a reminder of current conflicts and overlapping causes. Macy later mentioned they had expected a larger turnout but speculated the protest drew much of the same crowd that would have attended this event.

Reinforcing previous conversations I'd had with both Macy and Casey about free trees being popular, there was a smorgasbord of free seed packets, biochar, spinner boards for prizes, reusable water bottles, and other logo-decorated free merchandise. The Indigenous musicians and dancers provided a lively ambiance with colorful garb, and the crowd formed a fast line for free food at the taco truck. Walking among the booths, I saw initiatives for alternative transportation, community gardens, electrification efforts, and a landscape architecture-led participatory exercise using red dot/green dot stickers to vote on design concepts. As a landscape architect myself, it was nice to see my own profession represented in ways that directly engaged the public with accessible and interactive practices.

After checking out some of the other booths for a bit, I headed over to join Casey's tree walk. I found him leading a small group of about 6 people and pointing out the nuances of oaks crossing, breeding

and producing varied leaf shapes. He explained how oaks are suffering from the golden spotted oak borer and how some 80,000 oaks have died in the area due to someone transferring the pest by not using locally sourced firewood. Sudden oak death has swept across California and caused a serious threat to food and shelter for local fauna. This water mold pathogen, *Phytophthora ramorum,* has "been responsible for the death of over one million oak and tanoak trees in California alone" ([National et al. Department of the Interior, 2022](#)).
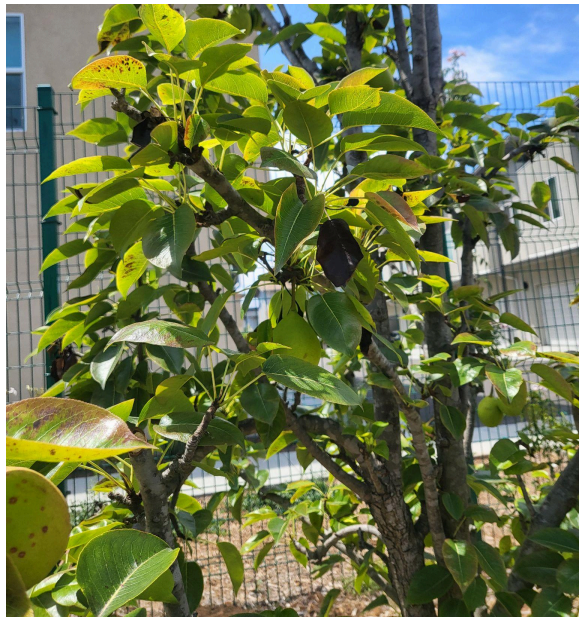
Casey pointed out fireblight (pictured above) on nearby pear trees and how some improper planting was the cause of a dead tree. He warned of the invasive fan palms killing native toyon and how this region is great for growing subtropical plants like guava.

However, what stood out most was the way Casey spoke on care, both literally in terms of tree maintenance, but also in recognition of the importance of cultural knowledge of plants, generationally passed down. This fosters a greater sense of ecological stewardship and relational appreciation for nature. After all, he pointed out, most of our medicine, including aspirin from bark, is derived from plants. This was an invitation to think differently about our place in the natural world and echoed UFNP's community-rooted approach to engagement with urban forestry.

As the rest of the small group listened with relaxed smiles, seemingly content listening to Casey talk about his passion, I struck up a conversation with a former Americorps fellow. I found out he had worked within another local nonprofit that often does tree plantings with UFNP. He had planted within marginalized community zones and spoke on finding inspiration from the experience. He had developed a deep fascination with trees and urban forestry over the last 7-8 months. This individual's story of transformation illustrates how involvement in greening efforts shapes physical change in the landscape and also in personal growth. When supported through hands-on work, engagement can leave a lasting emotional investment.

While I wasn't able to speak to the county representatives as I had to leave a little early from the 5-hour event, I left with a deeper appreciation for the ways UFNP engaged with the community. Through this fun and family-friendly event, they were

able to engage in urban forestry while building relationships and meaningful connections.

A Group Effort: Support from Externally Funded Fellows

Macy was able to introduce me to some of UFNP's critical support: the volunteers from the Americorps CCAC program. She explained that they had 6 fellows working with them and that they might be"somewhat quiet," but that "this will be great because it will give them something to do!" UFNP had entered the off-season for planting trees, so the fellows were low on their usual workload. Macy organized for me to speak to two of their fellows.

After giving a brief introduction to the two young women on the screen, Macy left the meeting. Though I was juggling my own packed workday, I was eager to have the opportunity to speak with more UFNP team members. I began by asking for consent to record, letting them know I was doing this interview as a case study on UFNP for my master's program at USD. They immediately nodded yes without hesitation and seemed perfectly comfortable with this. I was glad to be able to relieve myself of note-taking as a way to stay more engaged in the conversation.

Their names were Kit and Sarah, and they both had just graduated from environmental studies undergrad programs at local universities. Fresh to the workforce, Kit and Sarah weren't UFNP employees;

they were a part of California Climate Action Corps (CCAC), an AmeriCorps program that places fellows with organizations for 11-month terms. UFNP trained them in fieldwork, tech, and outreach, while AmeriCorps handled their pay. Both women expressed gratitude for the experience but were eager to finish the program in September and move on to find a more permanent, full-time position in an official office setting. UFNP has no physical office location to meet, so the majority of their work was done remotely, with only 1-2 days a week out in the field.

Sarah shared that her niche within the organization had become the community tree walks, accompanying the ever-so-charismatic Casey on almost all his outings. She accounted for his ability to provide details on planting in both English and Spanish, and how she, along with some of the other fellows, were also semi-fluent and able to bridge language gaps when needed. In one case of a barrier, they used speech-to-text tools to communicate with a hearing-impaired individual. She noted that at another larger event UFNP attended, a group of Vietnamese women came with a translator provided through the organizer. Most people who attended her tree walks were excited to learn more about trees. She often saw the same retired locals attending multiple times. They may have been encouraged by UFNP's advertisement of a prize tree for anyone who completes 10 tree walks.

Kit focused primarily on K-12 school outreach. She created curriculum materials, visited local schools, and organized environmental camps. Most of her experience was geared towards middle schoolers, but she also worked with kindergarteners at a Sunday school. She was surprised at how the students at the camps were already full of fun facts about trees and nature. She also acknowledged the less glamorous moments, like visibly bored students or dozing off during presentations. Overall, she thought most students were intrigued by the topic and felt there was strong engagement.

Both Sarah and Kit offered examples of how they'd adapted their approach to community engagement based on experience. For instance, while Sarah was canvassing, knocking on residents' doors, she learned to wait longer and stand farther back from the door; people were more likely to respond that way. Kit added that shortening their script to be more succinct reduced suspicion or discomfort from residents and led to better interactions.

When asked what they found was the most impactful community outreach through UFNP, both fellows immediately agreed on the Tree Workforce Program. It was something heavily advertised on UFNP's website, on flyers, job boards, and at almost every event they attended. I was already familiar with the program through previous conversations and UFNP's online materials. The Tree Workforce Program targets disadvantaged (DAC) and low-income (LIC) communities while offering beneficial access to paid training, technical experience, and fieldwork opportunities. Participants

gain exposure to tools like drones and GIS while also training in planting and maintenance. Eligibility requires being 18 years or older, proficiency in English, internet access, driving capabilities, physical capabilities for lifting plants, and residing within a [Priority Population area](#) as identified by the California Air Resource Board. However, they also note efforts against language or internet access barriers and offer additional accommodations if needed. The Tree Workforce Program's focus on efforts within Priority Population areas gives residents the tools to take agency in shaping their home community. Sarah mentioned that UFNP has college-age interns working roughly 10 hours a week. While unpaid and less enticing than the Tree Workforce Program, the exchange offers industry exposure and a chance to count for course credit at a university.

Speaking with these two emerging professionals offered valuable insight into both the structure and spirit of the UFNP fellowship experience. While the lack of a centralized office conflicted with their desire for a stronger work community and clearer separation between work and personal life, I was struck by Kit and Sarah's enthusiasm, adaptability, and clear dedication to environmental outreach. The outlined requirements of AmeriCorps' CCAC program support the development of emerging professionals, but the industry-specific experience with technology and fieldwork gained through UFNP is what truly equips fellows with the practical skills, confidence, and clarity

needed to pursue long-term careers in environmental work. The range of opportunities available to these young women within UFNP highlighted how the program serves as a meaningful stepping stone for early-career professionals, while also contributing to climate resilience, environmental justice, and the creation of future leaders in the green economy.

After learning more about the structure and impact of UFNP's outreach through conversations with its fellows, I wanted to see how urban forestry looked in practice. The opportunity to go out on the street to view UFNP's tree installations came up when Casey volunteered to take me on a tour.

Stories from the Sidewalk

On a Friday afternoon, I met with the UFNP arborist, Casey, at a local distillery. It was a lovely warm day of about 72 degrees, and as I walked up, I saw him sitting down at an outside table wearing a brightly patterned Hawaiian shirt and enjoying a cold beer. I quickly got the impression that spending a Friday afternoon talking about trees over a nice lunch was an ideal day for him.

We caught up for a bit and ordered some food, and he mentioned he was excited to see some of his industry friends at a happy hour trivia event later in the weekend with the [Regional Urban Forests Council](#). He remains very socially active within the tree and environmental communities. Though we had spoken on the phone and briefly met at some of UFNP's events, this

was my first real opportunity to learn about his background in depth. I could feel his zeal and unwavering passion for the industry, so I asked where it all started and how it continues for him. He noted it began at a young age as he grew up on about 1.5 acres of land where his father kept fruit orchards. He started working at age 14 and continued to work in the nursery business. He pursued viticulture for a while but came back to the nursery business within management after experiencing burnout in the wine industry's swing shifts and irregularity. His passion for the business never wavered, but the manual labor-intensive position pushed him to pursue his ISA arborist certification as a profession he could maintain for the long term. Then, after about 6 years of having his own private consulting firm, he was hired to

be the arborist at the UFNP and has been there ever since.

I asked about his involvement with the nonprofit and its development. He raved about their executive director, Hannah, and her leadership in pushing it in the direction it needed to grow. She was able to find different social media connections for volunteers and outreach that helped them gain more recognition. They have the most Americorps fellows in the state assigned to their nonprofit, and the only nonprofit in the country to receive a grant to plant on private property. He mentioned that about 50% of urban forests were on private property in the area and that it was critical to get that community involvement to keep up the canopy. The topic of federal and state funding led to some disgruntled commentary

TREE CARE TIPS FROM AN ARBORIST

01 Leave 4" from top of surface to top of grade for drainage

02 Use a wood chip base mulch to help retain moisture

03 Prune trees while young so they develop healthy leaders and easily heal. Keep the branches low.

04 Nursersy stakes only on 24" box or smaller. You want movement in the tree so that it stimulates the roots to grow stronger

05 Greenwell plastic tree berms are great to help hold water and are reusable! Remove in 5 years

06 Watering trucks should water trees once a month during the hottest months between June and October

07 Post planting care should have min 5 years of watering

08 Trees that are IN: Brisbane Box, Pink Trumpet, African Sumac, Eastern Redbud (does better than our native Western Redbud), Chinese Pistache

09 Trees that are OUT: Raywood Ash, New Zealand Christmas Tree, Sweetgum (bacteria spread by sharpshooter also affects olives, Prunus spp., and oleander), Mexican Fan Palm (invasive), Weeping Fig (whitefly causes bleaching)

10 Some trees that are okay in specific areas: Chitalpa if in hot areas away from the coast where it will develop mildew; California Sycamore IF they have space and lots of water; Carrotwood if you account for some messy leaf/fruit drop, Peruvian Pepper trees are very tough if you like a gnarled, ancient look

on the state of politics today, where funding is being cut, and his little faith in the current Presidency.

He had strong takes on native trees as well. If someone analyzes species native to Southern California, they may encounter issues of incredibly limited options within the specific microclimates. Southern California's native plants offer the benefit of boosting local fauna and are often considered resilient and water-saving. However, the native flora predominantly comprises chaparral shrubs and small trees, such as ceanothus, manzanita, and sumac, which often lack the stature and canopy spread desired for urban shade (Marantos, 2024). Native trees with large shade canopies may not even exist within certain Southern California desert climates, thus creating a conundrum when addressing urban forestry.

The world has been hybridized. We simply no longer live in a reality where true native plant species can thrive. The concrete jungles are not the native landscapes that let endemic species thrive. To survive in an urban environment, plants need to have a tolerance to human interaction, such as resilience to pollution, compacted soils, and limited space. Native trees, while adapted to the region's climate, may not possess the resilience needed to withstand these urban challenges without significant maintenance efforts (Marantos, 2024). Casey conveyed the limitation of natives to me, and I realized the need to spread awareness on how to encourage diversity. While native trees are integral to preserving Southern California's

ecological heritage, their use as sole providers of urban shade presents significant challenges. Urban forestry strategies must balance ecological authenticity with the practicalities of urban planning. Integrating non-native species that offer complementary benefits without compromising the region's environmental integrity may be necessary over using a pure native plant palette.

After lunch, we popped into his truck, where he generously gifted me a fresh peach from his garden, and we set out on a driving tour of the neighborhood. We might have been close enough to walk, but he was still recovering from foot surgery, and his boot prevented him from walking long distances. Throughout the 45-minute tour, he pointed out tree after tree, noting which ones did well, which ones didn't, and why.

Systematic discouragement of investment in certain neighborhoods through the historical injustice of redlining policies continues to stunt economic development and concentrates environmental hazards in marginalized areas (Brandi, 2023). Segregation through the 1950's shows examples of infrastructure, such as Highway 94, as deliberately routed to divide black and white communities (Enemark & Brooke, 2022). The compounded effects of historical disinvestment and environmental neglect continue to shape the mental and physical health outcomes of Americans today. This particular neighborhood we were walking in was in one of those redlined areas and lacked the infrastructure to support irrigation. Casey and his team would go door to door, knocking to ask people to take ownership of the trees outside their door and water it. Most of the trees failing to thrive were likely the ones lacking local care. Some people didn't want to take on the extra cost, so he would come up with suggestions like putting a bucket of water under the shower head while waiting for it to warm up. However, the adjacent property owner's responsibility of street trees was noted as "unfair and confusing" in San Francisco, where Prop E. advocated aid in distributional justice (San Francisco Bay Area Planning and Urban Research Association [SPUR], 2016)(Millward, et al., 2023). The turnover between different renters or homeownership might also increase the risk of care not transferring between new residents.

The first thing that stood out to me was the incredible diversity of species. Typically, landscape architects avoid this level of variety on a single street because it can appear uneven or inconsistent. At the same time, there is evidence against planting mass monocultures of even native tree species. Planting a variety of tree species builds
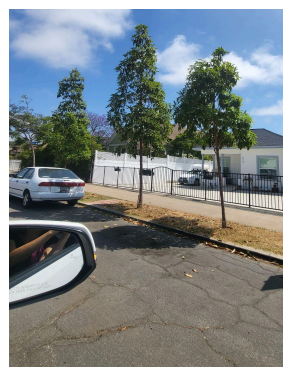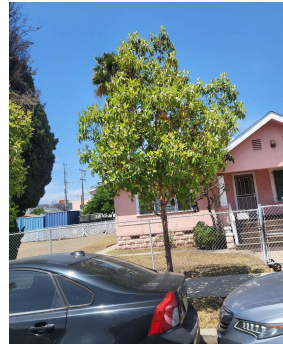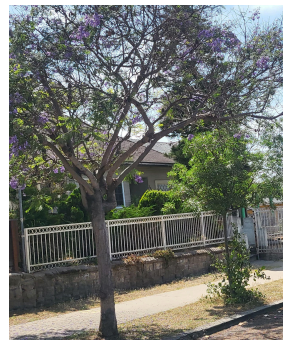
resilience against invasive pests or disease outbreaks. American Elms, *Ulmus americana,* were a popular shade tree to create a lush, tree-lined streetscape until Dutch Elm Disease, from a fungus called *Ceratocystis ulmi,* killed millions of the species, which caused significant damage to the urban forest tree canopy (Boehlke, 2023). From a design perspective, I initially saw the diversity of street trees as messy and unattractive. However, my perception of

The variety also provided a valuable opportunity to observe which species thrive as street trees and which do not. Casey's decades of experience showed as he peppered me with a plethora of advice.

One of Casey's tips noted that watering should continue for 5 years and can be achieved with watering trucks, especially during the hottest months of the year. A common theme in this case study has been the lack of government funding and support

Item 2:   Announcements and Updates
- Frank: Finally able to talk to someone from City of Seattle urban forestry regarding their citywide tree map – setting up call soon to learn more. [city forester]   is cc'd on the emails.
- [city forester] : Agenda is light this time around.
    - Working on getting another bucket truck for our tree maintenance crew -- there is a need for new equipment. The more trees we plant, the more need for additional maintenance staff and new equipment.
    - [city program] has no funding but are still taking requests for waitlist.
    - Tree maintenance & watering has been cut for the remainder of the current fiscal year. It is scheduled to resume under the next fiscal year.

beauty is shifting as I begin to understand the environmental benefits and resilience that come with biodiversity. I also consider how the people of this neighborhood may not feel the same way, and that I view this street from an outsider's viewpoint. The trees that are taken care of by the homeowners might hold special meaning or be a point of pride for them. I once spoke with a woman at a UFNP tree distribution event who said that the tree she was planting represented the life of her newborn child.

in these efforts. Casey's observations on maintenance gaps reinforced what I later found in examples of San Diego's official meeting minute records from their forestry advisory board. These pointed out the intricacies that can limit control within a government agency. In May 2006, they noted that there was nothing they could do about a tree scheduled to be demolished due to a new union design for a local college campus (City of San Diego, May 2006). It was on state property and therefore out of

their jurisdiction. There was also a clear struggle to even have the forestry advisory board as part of the city program at all. They discussed a PowerPoint presentation on the importance of trees and flowers to present to the mayor, showing an effort to prevent disbandment ([City of San Diego, May 2006](#)). Past guidelines came up as hindering progress when discussing struggles of how the "City is limited by the current City policies as written" ([City of San Diego, May 2006](#)). Policy change is not a quick process and requires voting and enforcement of regulations. Even when new information arises to suggest a better solution, order must be followed before it can be applied.

Through the city's own public engagement, the board reviews online submissions via a webform. In a more recent meeting from March 2025, the board followed up on the 3-year maintenance period of trees provided through their program. There was a dismal comment on how out of 25 trees that were planted, only 5 remained ([City of San Diego, March 2025](#)). This supported previous statements that Casey, UFNP's resident arborist, had previously mentioned. He was of the strong opinion that 3 years of watering was not nearly enough and that 5 years was needed minimum.

The board had representation from a landscape architect, a horticulturist, and a forester present. The forester noted attempts to fill the need for additional water trucks and the increasing need for additional staff and equipment ([City of San Diego, April 2025](#)). In the image below from the same meeting, we see a demonstration of growing

demand without proper support. This example mirrors similar struggles that nonprofits like UFNP endure.

Although there are government agencies encouraging environmental work like urban forestry, the reality is that the system is overworked, underpaid, and slow in its process. This leads to a lack of maintenance to keep trees alive and well, but also makes it difficult to keep up with the industry knowledge of best practices. For instance, Casey noted that even new tech is being updated through quality control checks. Australian Willow was in a database as a huge greenhouse gas offset because someone confused it with the much larger Salix willow. There were some sweet notes of the connection of people with plants from a cultural aspect, too. He said that sometimes he could guess the previous homeowners came from an Italian background just by seeing the plants that were in the garden. This hints at the importance of people having a more direct connection and the impact of their surrounding environment. There is a correlation between healthy, thriving vegetation and localized community involvement and care. In our last few exchanges, he noted that his goal before retirement was to at least make this one, little part of the world a little greener. That would be his legacy impact. I encourage that he does even one better in educating the next generation through all his consistent efforts in seminars and tree walks. His commitment to leaving a greener legacy reminded me that lasting change builds upon small

influences like planting a tree, educating a resident, or sitting down with a student to help guide her through the process of urban forestry.

In the Shade of What We Plant

Urban forestry is a powerful tool to mitigate climate-related health problems and environmental inequities. This case study observes how an urban forestry organization considers community engagement to tackle urban challenges and explores the potential of trees in influencing climate, health, and community. This study reinforces the benefits of urban forestry, including reducing heat island effects and enhancing psychological well-being. More importantly, this study showcases that the success of urban greening depends not only on ecological strategies but on human engagement. Through programs like tree walks, educational outreach, sustainability events, workforce training, and door-to-door canvassing, UFNP demonstrates how community involvement is key to building and maintaining a tree canopy.

This process allowed me to reflect on the systems and assumptions that shape urban environments. By following how current practices emerge, I saw how historical and political factors like redlining and disinvestment led us to the modern urbanscapes of today. This project is an exploration of a particular place, a specific organization, and the real people who work together to build a tree canopy as part of their urban landscape. Through this lens, I paint the picture of how design, community,

and environment come together not in theory, but in action.

I argue that few people see a large, healthy tree and feel no innate desire to keep the living, breathing specimen alive. Trees have a presence. I often think back to my childhood favorite book, *The Giving Tree* by Shel Silverstein, because trees give so much. They clean our air, filter out noise, protect our soil, provide habitat, feed us, relieve heat exposure, and more. Rather than only accept the gifts of trees, rather than wait until there is nothing left of the tree but a stump to sit on, we can share in the common Indigenous peoples' tradition of reciprocity. Planting new trees, protecting existing, restoring soils, and distributing water are all ways that we give back to trees. Practicing within the circularity of all things connects us to place and ensures trees continue to bless us with the many gifts of their natural being.

We dream of a future sheltered in the shade of trees, but it all starts with the many hands working together to plant the seeds.

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Below the Canopy: Addressing Blind Spots in 4FRI Monitoring

Mackenzie Glenn

Abstract

Mechanical forest thinning has become a central strategy for wildfire mitigation and ecological restoration in the State of Arizona under the Four Forests Restoration Initiative (4FRI). While implementation capacity has expanded rapidly - driven by federal funding, biomass markets, and political support - the monitoring infrastructure needed to evaluate ecological outcomes has lagged behind. This case study examines the growing disconnect between Arizona thinning operations and the evaluative capacity of 4FRI's Multiparty Monitoring Board (MPMB), showing how institutional constraints and limited resources risk turning forest restoration in this region into a throughput-driven effort with little ecological accountability. A review of the existing literature finds that while many studies highlight short-term benefits for fire behavior and forest structure, few assess long-term impacts on soil health, erosion, or hydrological function. These gaps are reflected in the MPMB's current framework, which lacks indicators for belowground processes.

Drawing on literature synthesis, programmatic review, and stakeholder input, this study proposes a low-cost, scalable approach to integrating soil and erosion monitoring into 4FRI's operations - leveraging existing infrastructure and community partnerships to support more adaptive, ecologically grounded forest management.


Introduction

The escalating frequency and severity of wildfires across the American West have driven urgent reconsideration of forest management strategies. Among these, mechanical forest thinning has emerged as a prominent and increasingly institutionalized practice aimed at restoring ecological balance and mitigating wildfire risks in unhealthy forests. Mechanical thinning refers to the strategic removal of trees and dense vegetation using heavy machinery to reduce tree density, ladder fuels, and overall biomass. The underlying rationale is

(seemingly) both ecological and practical: thinning is believed to lower the risk of catastrophic fire events and promote forest health and resilience by increasing the spacing between trees, reducing competition for water and nutrients, and improving forest resilience to drought, pests, and disease.

In the fire-prone landscapes of the Southwestern United States, and particularly within the State of Arizona, mechanical thinning has become a cornerstone of large-scale restoration efforts. Chief among these is the Four Forests Restoration Initiative (4FRI) - a collaborative, landscape-scale program launched in 2010 to restore the ecological integrity of 2.4 million acres across the Kaibab, Coconino, Apache-Sitgreaves, and Tonto National Forests. This initiative brings together the
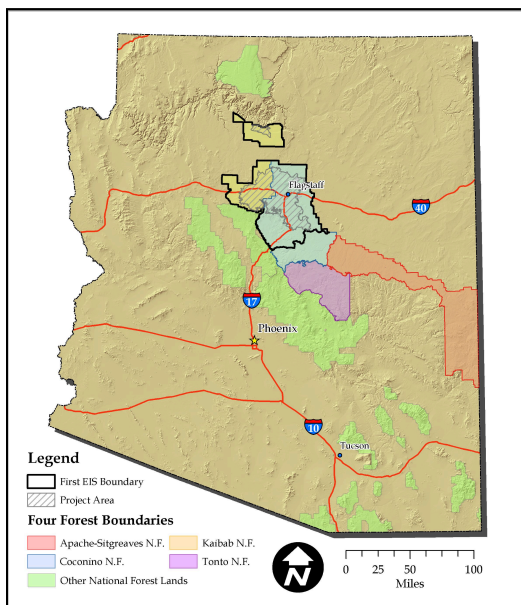
U.S. Forest Service, academic researchers, private industry, Tribal members, and local communities in an ambitious attempt to

reduce wildfire risk, improve forest health, and stimulate rural economies through sustainable forest product markets.

However, beneath the surface of this collaborative momentum lies a fundamental imbalance. While funding and infrastructure for thinning implementation have expanded dramatically in recent years - supported by timber revenues, biomass markets, and public grants - the monitoring and evaluation systems tasked with tracking the ecological outcomes of these treatments have not kept pace. The Multiparty Monitoring Board (MPMB) - 4FRI's primary oversight body - struggles with persistent budget limitations, staffing shortages, delayed data collection, and methodological constraints (including a lack of experimental control designs). This disparity reflects a deeper structural problem in contemporary forest management: the prioritization of visible, fundable action over long-term (often inconvenient) understanding. In the absence of robust monitoring systems and rigorous ecological evaluation, mechanical forest thinning risks becoming an end in itself rather than an adaptive, evidence-based restoration strategy.

Specifically, improperly designed or aggressively implemented thinning operations can fragment wildlife habitat, compact soils, increase erosion, introduce invasive species, and alter microclimates - particularly when machinery is used on steep slopes or in sensitive riparian zones. Additionally, in the absence of site-specific ecological goals, thinning may reduce forest

complexity, degrade understory biodiversity, and even [unintentionally accelerate fire behavior](#) by encouraging dense regrowth of flammable vegetation. These unintended consequences are often subtle, cumulative, and difficult to detect without long-term monitoring - further underscoring the need for robust evaluation. While the logic of mechanical forest thinning is often presented as self-evident (i.e. removing fuels reduces fire risk) its long-term ecological outcomes are complex, variable, and highly context-dependent. For instance, thinning may reduce crown fire potential in the short term, but it also alters forest systems in ways that can be ecologically significant over time. In many forest types, feedbacks between thinning, fire regimes, and broader ecological dynamics remain insufficiently understood.

Currently, 4FRI's Multiparty Monitoring Board (MPMB) monitors a limited range of indicators, including:

- Songbird species (BCR and RMRS)

- Vegetation surveys; Ground plots (NAU and TNC)

- Streams monitoring (NFF to hire contractor)

- UAS flights; Riparian and Forest Structure (USGS)

- Snowtography (Old Munds Hwy and Parks)

- Socioeconomic (Mottek et al.)

While these indicators provide valuable insights, they represent only a fraction of the ecological changes that can follow intensive mechanical thinning. Notably absent from the MPMB's current portfolio are indicators of soil health and erosion - key drivers of long-term forest sustainability, particularly in arid and erosion-prone landscapes like those of northern Arizona.

As such, this case study interrogates the widening gap between implementation capacity and monitoring capacity under 4FRI, and proposes a scaleable, low-cost framework for integrating soil and erosion monitoring into existing operations. The idea is that - by leveraging current infrastructure, community partnerships, and simple field methods - 4FRI can begin closing critical knowledge gaps and support adaptive, ecologically grounded forest management long-term.

Rationale

Forests in the American Southwest are more than fuel loads or sites of wildfire risk - they are foundational ecosystems that regulate water flows, stabilize soils, store carbon, sustain biodiversity, and support long-standing cultural relationships. In Arizona's high-elevation forests, these functions are especially critical: they buffer drought, serve as habitat corridors, and act as vital "[water towers](#)" for downstream communities. As such, the long-term ecological health of these forests is a matter of both environmental and social urgency.

Yet these landscapes are [experiencing unprecedented environmental stress](#). After more than a century of fire

suppression, logging, overgrazing, and increasing drought intensity, many of Arizona's forests are ecologically degraded and highly vulnerable to disturbance. In this context, mechanical thinning has emerged as a key intervention strategy under 4FRI - backed by broad institutional support and a growing implementation footprint. However, the rapid operationalization of thinning has not been matched by an equivalent investment in understanding its outcomes.

This matters because ecological responses to thinning are complex and highly context-dependent. Without consistent, site-specific monitoring, critical impacts (i.e. soil compaction, erosion, invasive species spread, or hydrological disruption, etc.) may go undetected until damage is difficult or impossible to reverse. Compounding this, a substantial portion of the available research on mechanical thinning (in ponderosa pine ecosystems) is derived from studies conducted in other regions (primarily, the Pacific Northwest) where forest composition, climate, and disturbance regimes differ markedly from those in northern Arizona. As a result, 4FRI's Multiparty Monitoring Board (MPMB) may be forced to rely on findings that use different metrics, time frames, and ecological baselines, making direct interpretation difficult and potentially misleading. Access to regional, context-specific impact studies remains - by the 4FRI's own account - limited and/or incomplete.

Adding to these challenges are political and economic structures that tend to

reward easily quantifiable metrics - such as acres treated, biomass harvested, and megawatts generated - over nuanced ecological outcomes. These are politically resonant, but they do not necessarily reflect forest health or long-term sustainability. This emphasis has left monitoring groups like the MPMB largely reactive rather than positioned to guide restoration with timely, informed insight.

To begin addressing this imbalance, restoration efforts must expand the range of ecological indicators used in monitoring - and find ways to do so within current resource constraints. This case study argues that soil health and erosion tracking are particularly vital omissions in the MPMB's current monitoring framework, especially given Arizona's steep terrain, erosion-prone soils, and increasing storm intensity under climate change. These indicators are not only ecologically meaningful but also feasible to monitor using low-cost methods, existing infrastructure, and community-based partnerships.

By highlighting this gap (and proposing a scalable approach to filling it) this study contributes to a broader conversation about how forest restoration can be made more accountable, adaptive, and ecologically grounded in the face of institutional limits and environmental urgency.

Research Questions

What institutional, financial, and operational factors have contributed to the growing gap between the expansion of

mechanical forest thinning and the limited monitoring capacity of the Multiparty Monitoring Board (MPMB) within 4FRI, and how does this disparity affect the ability of the MPMB to accurately assess the ecological outcomes and long-term sustainability of thinning treatments - particularly in the face of inconsistent data sources and fragmented metrics?

What practical frameworks or methodological additions (such as basic soil and erosion monitoring) could enhance the MPMB's evaluative capacity without requiring major increases in funding or staffing?

Methodology

This case study uses a mixed-methods approach grounded in literature analysis, institutional review, and stakeholder input to examine the monitoring challenges facing the Four Forest Restoration Initiative (4FRI), with particular attention to the limited capacity of its primary oversight body, the Multiparty Monitoring Board (MPMB). It synthesizes:

- Peer-reviewed ecological literature on mechanical thinning in Southwestern ponderosa pine forests (and similar ecosystems)

- Programmatic documents from 4FRI, including Collaborative Forest Landscape Restoration Program (CFLRP) reports, Forest Service treatment plans, and implementation contracts

- Stakeholder communications, including notes and transcripts from recent 4FRI convenings (particularly the July 2025 meeting)

- Media and policy commentary on forest restoration politics, biomass energy expansion, and public concerns over thinning impacts

Together, these sources are used to trace both the expansion of operational thinning capacity and the parallel stagnation of monitoring infrastructure. Special attention is paid to institutional incentives, funding flows, data collection gaps, and the absence of experimental or long-term evaluation design in current monitoring protocols.

A core challenge in this research - mirroring the challenges faced by the MPMB - is the fragmented nature of the existing ecological literature on mechanical forest thinning. While many studies document thinning's short-term benefits for fire risk and stand structure, few evaluate long-term outcomes or broader ecosystem functions such as soil integrity, hydrology, or biodiversity. Additionally, studies differ in their definitions of "success," their treatment designs, forest types, spatial scales, and post-treatment monitoring timelines. These inconsistencies make it difficult to apply findings across the 4FRI landscape, particularly in a way that informs site-specific decision-making.

This case study uses this literature gap not only as an analytic constraint, but also as part of the story: it illustrates how the

MPMB is limited in its ability to evaluate ecological outcomes reliably or adaptively. In response, the final section proposes a feasible, low-cost monitoring framework focused on soil health and erosion, designed to supplement the MPMB's existing indicators. This framework draws on current ecological literature, volunteer science models, and opportunities to leverage existing sampling infrastructure (i.e., vegetation plots, snowpack sites, etc.) in order to improve post-treatment evaluation under real-world constraints.

Literature Review

A robust and growing body of ecological research supports the use of mechanical thinning as a tool for restoring forest structure, increasing ecological efficiency, and reducing fire severity in fire-adapted forests across the Western United States - including the ponderosa pine systems of northern Arizona. In central Oregon's pumice region, studies have shown that thinning significantly increased diameter growth and reduced tree mortality among ponderosa pines. Similarly, research from the inland Pacific Northwest observed that thinning enhanced radial growth and improved resistance to drought and insect outbreaks. In Arizona, long-term studies and regional media have echoed these findings. For example, a 5,200-acre project led by the Ecological Restoration Institute (ERI) at Northern Arizona University (NAU) demonstrated how combined thinning and prescribed burning restored structural complexity and reduced the likelihood of catastrophic wildfire over nearly two decades. Additional NAU-based experimental research has found that thinning with burning lowered crown fire potential and improved drought resilience. Taken together, these findings have contributed to a prevailing consensus that thinning (particularly when paired with prescribed fire) enhances forest resilience in the face of increasing environmental volatility driven by climate change.

Beyond its role in fire mitigation, thinning has been associated with improved ecological efficiency. A study published in the Journal of Geophysical Research: Biogeosciences reported that thinning increased carbon use efficiency and enhanced energy transfer across trophic levels. Other studies have observed generally positive (but largely context-dependent) responses in natural regeneration and understory biodiversity. One northern Arizona study, for instance, found that thinning improved grass cover and sustained arbuscular mycorrhizal fungi. However, these responses are often mediated by variables such as pre-existing soil chemistry, treatment intensity, and elevation. Similarly, faunal shifts - particularly in soil arthropods that regulate decomposition and nutrient cycling - also fluctuate seasonally and spatially, making them difficult to generalize.

Despite the breadth of literature supporting mechanical thinning, important tensions and critical gaps remain - particularly concerning soil health, erosion, and long-term sustainability. Most existing

studies focus heavily on aboveground vegetation and fire behavior, with far less attention given to belowground processes or broader ecosystem dynamics. Where soil is considered, results tend to be mixed and site-dependent. For example, one northern Arizona study found that [thinning significantly reduced in-situ net nitrogen mineralization](), pointing to potential disruptions in nutrient cycling. Hydrologic effects represent another underexplored dimension. Modeling studies suggest that [thinning may temporarily increase runoff - by as much as 20%]() in some central and northern Arizona watersheds - yet these hydrologic impacts are highly sensitive to slope, treatment scale, and precipitation regime, and are seldom incorporated into routine monitoring.

More broadly, the current body of research remains fragmented and siloed. Studies vary widely in design, sampling scale, vegetation type, and climate context - complicating synthesis and limiting generalizability. Few studies employ longitudinal or controlled experimental designs, and almost none track erosion rates, sediment transport, or post-treatment soil stability - despite their relevance to ecological sustainability in erosion-prone landscapes like northern Arizona. This disciplinary compartmentalization reflects a broader technocratic paradigm that frames thinning largely as a wildfire mitigation strategy rather than as an ecological or social intervention. As a result, forest health is often measured through isolated metrics such as fuel load, tree growth, or carbon

dynamics, with critical dimensions like soil, water, biodiversity, institutional processes, and even cultural values underexplored or entirely absent.

These research gaps are not just academic, as there is evidence that inadequately planned or overly intensive thinning can have notable ecological implications. Research on tropical forestry suggests that [habitat fragmentation from poorly planned logging can lead to significant declines in wildlife populations](), especially species with specialized habitat requirements. Similar mechanisms are relevant in the dry conifer forests of northern Arizona, where road building and canopy removal can reduce habitat connectivity and alter species composition. [Microclimatic shifts following canopy reduction]() (such as increased solar radiation, wind exposure, and soil surface temperature) have been well documented in temperate and boreal systems and may lead to accelerated evapotranspiration, reduced soil moisture, and physiological stress in residual vegetation. These effects, in turn, could undermine some of the very restoration goals mechanical thinning aims to achieve.

From a soil mechanics perspective, there is evidence that repeated passes of heavy equipment can cause irreversible compaction in certain soil types, particularly in sandy or volcanic-derived soils common in northern Arizona. One study of ponderosa pine plantations found that [compaction from skidding and forest floor removal inhibited growth in residual trees](), particularly in sandy soils. Related [findings from central]()

Oregon noted that compaction increased soil strength while reducing tree height and volume over time - suggesting long-term consequences for forest productivity. Despite this, such belowground effects are rarely monitored by restoration programs in real time, and many researchers note that its long-term effects are not well understood. A comprehensive review by Jourgholami et al. (2022) highlights strategies to mitigate such disturbances - including seasonal timing of operations, use of low ground-pressure machinery, and spatial planning to minimize the area impacted by skidding and decking - yet these measures are inconsistently applied in U.S. restoration programs.

These limitations have direct implications for modern forest governance under 4FRI. Critics argue that thinning in this region is often overapplied, inconsistently monitored, or driven by political and economic imperatives rather than ecological ones. Advocacy organizations such as the Western Watersheds Project and the Center for Biological Diversity have voiced concerns over the removal of centuries-old ponderosa pines in the Kaibab National Forest's North Zone under the banner of restoration, arguing that old-growth trees are fire-resistant, irreplaceable components of biodiversity. A 2021 letter from the Center condemned thinning contracts that blurred the line between restoration and logging, calling for stronger oversight and ecologically grounded guidelines. Public discourse, including local reporting and op-eds, has echoed these critiques, warning against the co-optation of restoration narratives by commercial interests. These concerns gained legal traction in 2023 when a federal judge overturned a Forest Service thinning plan in northern Arizona, citing the agency's failure to adequately analyze the ecological impacts of cutting large, mature trees. The ruling emphasized that the Forest Service had misrepresented the project's effects on wildlife and forest structure, ultimately concluding that the plan violated the National Environmental Policy Act. This legal setback underscores a growing demand for more transparent, science-based decision-making in forest management under 4FRI - particularly when commercial timber interests stand to benefit from so-called restoration efforts.

This literature, taken as a whole, paints a complex and often contradictory picture. While thinning clearly provides demonstrable ecological and fire mitigation benefits when implemented thoughtfully and monitored consistently, its impacts are highly context-dependent and frequently underassessed - particularly in the arid, high-elevation systems that characterize northern Arizona, where ecological thresholds are narrow and recovery can be slow. The absence of integrated, multi-scalar case studies that assess thinning across multiple ecological and social dimensions underscores the need for more expanded evaluative frameworks - ones that capture the full spectrum of forest functions and values that thinning inevitably affects. Meaningful assessment of forest degradation and recovery requires multi-scale ecological

[integrity indicators](#) - spanning soil, biodiversity, hydrology, and ecosystem structure - rather than relying on narrow, single-factor metrics.

For initiatives like 4FRI, these gaps represent both vulnerabilities and opportunities. By advancing scalable, low-cost monitoring strategies - particularly in long-neglected domains like soil health and erosion - programs like 4FRI could help restore balance between implementation and understanding, and in doing so, improve the transparency, accountability, and ecological integrity of forest restoration efforts.

Stakeholder Feedback

Insights from 4FRI's July 2025 Stakeholder Meeting further illuminate the growing divide between operational expansion and scientific evaluation. This meeting brought together representatives from the U.S. Forest Service (across the Kaibab, Tonto, Coconino, and Apache-Sitgreaves National Forests), Tribal members, local utility and biomass energy companies, and members of the Multiparty Monitoring Board (MPMB). While the discussion revealed significant progress in treatment implementation, it also underscored persistent shortfalls in monitoring capacity and scientific rigor.

According to Forest Service officials, over 34,000 acres were treated through mechanical thinning across Arizona in the past year - the highest total on record for 4FRI. They credited this increase to millions of dollars worth of grant-based funding, expanded timber offerings, and

growing partnerships with biomass energy firms. Targets for 2026 are even higher, with plans to exceed 45,000 acres treated annually. Industry partners such as Novo Biopower, a 27-megawatt biomass facility in Snowflake, Arizona, reported record electricity generation, directly linked to the increased availability of biomass from thinning projects. This momentum highlights a key institutional trend: thinning operations are becoming more financially sustainable and politically visible due to market incentives and climate mitigation narratives. However, these gains in operational capacity stand in stark contrast to the limitations facing the program's monitoring wing.

The Multiparty Monitoring Board (MPMB) reported that its capacity remains constrained by inadequate staffing, funding, and analytic infrastructure. Composed of just four core members, the MPMB has been forced to prioritize basic pre- and post-treatment measurements - without control plots, longitudinal data, or sufficient replication. Experimental designs capable of isolating thinning effects from climate-driven changes remain out of reach. As one member stated plainly:

"If we had all the money in the world, we could design a system that could give us the best results."

Despite its ambitious monitoring plan - which includes goals such as restoring forest heterogeneity, protecting old growth, supporting listed species, and enhancing snowpack - the Board generally lacks the

resources needed to translate these qualitative aims into reliable, site-specific, or standardized metrics. One team member made note of the MPMB's "lack of triggers and thresholds," attributing this to the fact that "the science hasn't supplied the data yet." As such, most projects are assessed using simplified indicators; and with no clearly defined thresholds to determine when ecological goals are being met, the MPMB risks implementing an "adaptive management" system that is responsive in theory, but constrained in practice.

These limitations are especially concerning in light of the aggressive

to ecological benchmarks, such intensity risks causing long-term degradation rather than fostering resilience. Some board members expressed concern that, in the absence of robust tracking, the program cannot confidently determine whether its interventions are helping or harming key ecological functions.

The current situation thus reflects a structural imbalance: operational funding is growing, private-sector participation is expanding, and mechanical forest thinning goals are accelerating - while the institutions tasked with evaluating these impacts are underfunded, overstretched, and largely
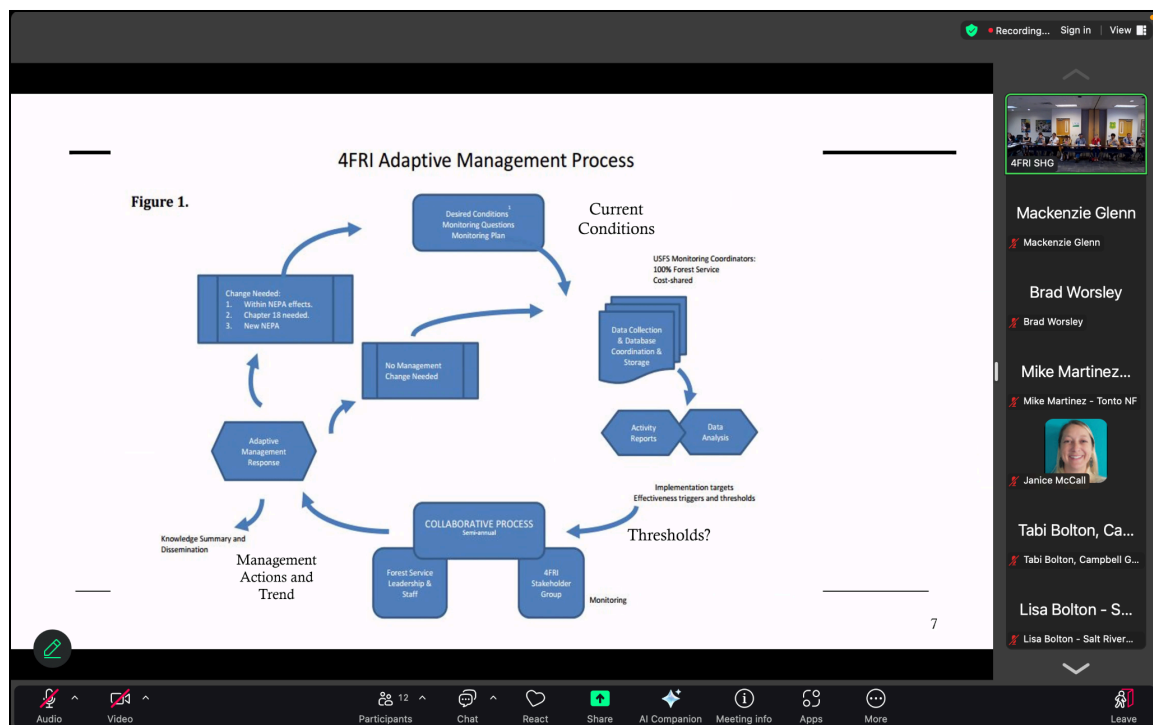
thinning prescriptions observed in some areas, where up to 70% of trees are being removed. Without rigorous monitoring tied

reactive. The Forest Service's emphasis on treated acreage and industry output has created a feedback loop that rewards

throughput over understanding. As climate change continues to reshape Southwestern ecosystems and thinning becomes the default restoration tool, this imbalance becomes increasingly dangerous. The long-term credibility, adaptability, and effectiveness of 4FRI depend not only on how much forest is thinned, but on how well we understand what happens after the machinery is hauled away.

Toward Scalable Monitoring: Framework for Low-Cost Soil and Erosion Tracking

While full-scale experimental designs remain financially out of reach for many restoration programs, including 4FRI, there are practical opportunities to expand ecological monitoring without placing undue strain on budgets. One promising pathway is to adopt a tiered, low-cost framework for monitoring key indicators of soil health and erosion - two critical, yet often undermeasured, elements of long-term forest resilience, particularly under 4FRI's MPMB.

In addition to improving ecological oversight, this framework is designed to open space for a wider range of voices in

restoration monitoring - especially those often excluded from institutional decision-making, such as Tribal communities, youth groups, and local volunteers. By prioritizing accessibility, flexibility, and collaboration, it aims to shift monitoring from a purely technical function toward a more democratic process - one that begins to challenge the concentration of power and expertise that has historically shaped forest management in Arizona and across the West.

The following strategy outlines how 4FRI (and similar initiatives) could incorporate basic soil and erosion tracking into their monitoring systems using existing infrastructure, strategic sampling, and community partnerships:

(1) Piggyback on Existing Vegetation and Ground Plot Surveys

Rather than initiating separate sampling campaigns, soil monitoring can be integrated into existing vegetation and forest structure plot networks operated by agencies and partners like NAU, The Nature Conservancy, or the Forest Service. Most ground plots already include regular visits and geospatial documentation, creating an ideal platform to add minimal soil-focused observations.

Recommended Soil Indicators:

- Soil compaction using a basic drop cone test or handheld penetrometer

- Bare ground percentage via rapid visual or photographic assessment

- Litter depth using ruler measurements in multiple quadrants

- Soil color and texture for organic matter inference using Munsell charts or smartphone apps

Estimated Cost and Time:

- +5-10 minutes per plot, negligible material costs (measuring tape, penetrometer optional), no need for new site establishment; This approach enables broad landscape coverage at low marginal cost while supporting long-term trend analysis.

(2) Deploy Erosion Pins and Photopoints at High-Risk Sites

In areas with steep slopes, high soil disturbance, or reduced canopy cover - conditions typical of aggressive thinning units - basic erosion tracking can be achieved by installing erosion pins (i.e. fixed rebar stakes) and repeatable photopoints.

Target Areas:

- Units identified via GIS slope models or field reconnaissance

- Locations with recent heavy equipment use or fire history

- "Hotspot" zones flagged in prior monitoring reports

Monitoring Protocol:

- Annual measurements or post-storm site visits

- Use of standardized photo angles and GPS-tagged observations

Materials and Labor:

- <$50/site for rebar, flags, and GPS tags

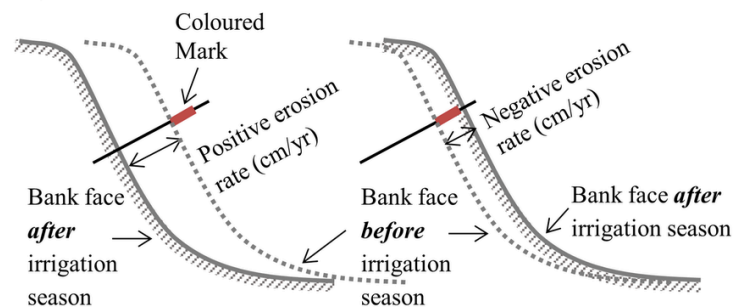- Fieldwork can be conducted by interns, AmeriCorps teams, or volunteers with minimal training

1) Erosion pin   2) Setting up erosion pins

3) Measurement

(3) Engage Citizen Science and Partner Organizations

Community science initiatives can substantially expand monitoring capacity while fostering public investment in restoration outcomes. Local schools, AmeriCorps chapters, Master Naturalists, scouting groups,

and Tribal youth programs represent untapped allies for basic data collection and landscape stewardship.

Implementation Tools:

- Simplified digital forms (i.e., Google Sheets, Survey123)

- GPS-enabled mobile apps like Avenza, iNaturalist, or EarthCache

- Basic kits with flags, rulers, and laminated protocols

Training and Oversight:

- Short field training events or workshops

- Data validation through supervisor spot-checks or periodic reviews

(4) Integrate with Existing Instrumentation Projects

Many 4FRI landscapes already support ecological instrumentation for other purposes - such as snowpack telemetry (SNOTEL), riparian health assessments (i.e., USGS or NFF-funded sites), or fire weather monitoring. These sites can be leveraged to host auxiliary soil sensors or physical markers with minimal logistical burden.

Examples:

- Install soil moisture probes alongside snow depth sensors in montane meadows

- Add surface temperature loggers and infiltration rings at riparian buffer plots

- Use time-lapse cameras or LIDAR/photogrammetry overlays in active treatment zones

(5) Periodic Expert Review via Academic Partnerships

For long-term credibility and adaptive learning, raw data collection must be periodically reviewed (annually or bi-annually) and interpreted by trained experts. Partnerships with regional academic institutions - such as NAU, ASU, or Tribal colleges - can provide cost-effective analytical support and yield mutual benefits.

Review Mechanisms:

- Senior capstone projects or graduate theses focused on soil/erosion metrics

- Collaborative publications or white papers co-authored by faculty and agency staff

- Biannual workshops to interpret results and recommend adaptive changes

Funding Pathways:

- National Science Foundation (NSF) Research Experiences for Undergraduates (REU) programs, university extension grants, or cooperative agreements

- Integration into Forest Service Joint Venture Agreements or stewardship contracts

By adopting such a model, 4FRI could begin to fill a major monitoring gap -

providing valuable, context-specific data on the sustainability of mechanical forest thinning operations while empowering local communities and educational partners. More importantly, it offers a scalable and collaborative path toward better ecological accountability without relying on large-scale federal grants or intensive infrastructure.

This type of flexible, low-cost monitoring strategy holds significant relevance beyond the scope of 4FRI. Similar tiered frameworks could be adapted for use in other large-scale restoration programs, rangeland management projects, or post-fire recovery efforts across the Western U.S. In Tribal forestlands, for example, culturally grounded indicators could be integrated alongside biophysical metrics through community-led monitoring. Urban forestry initiatives could adopt simplified soil and compaction monitoring protocols to inform tree planting and green infrastructure decisions in degraded soils. Even international reforestation and land restoration programs - in regions like the Sahel or the Andes - could benefit from this approach, using local labor and basic tools to track forest health metrics in a cost-effective, context-sensitive way. The core principle is to align ecological ambition with monitoring feasibility - leveraging what already exists, engaging the community, and prioritizing indicators that meaningfully reflect long-term forest ecosystem resilience.

Conclusion

The Four Forest Restoration Initiative represents one of the most ambitious forest management efforts in the country. Yet its success will ultimately be judged not by acres treated, but by the lasting ecological outcomes it produces. While timber contracts are expanding, biomass facilities are breaking production records, and treated acreage reaches all-time highs, the Multiparty Monitoring Board (MPMB) faces a critical challenge: how to ensure that these interventions are not only effective, but also sustainable, equitable, and ecologically sound.

The monitoring gap discussed here is not a failure of intent. As one MPMB member plainly stated,

"We don't want to be doing this work if we're having negative impacts."

But that commitment to accountability requires tools. Right now, the MPMB is tasked with evaluating complex, landscape-scale interventions using a monitoring toolkit that lacks consistency, sufficient funding, and core indicators related to soil health, erosion risk, and more. These limitations don't just affect data, they constrain the Board's ability to learn from restoration and to adapt over time.

The framework proposed in this case study responds directly to that challenge. By introducing simple, low-cost indicators that can be integrated into existing fieldwork (such as visual erosion scoring, photo points, and soil surface condition assessments) it

offers one path toward strengthening ecological accountability without overwhelming the MPMB's already-limited capacity. While these tools are not a substitute for long-term research, they can help fill immediate gaps and spark broader dialogue about what responsible monitoring should look like in an era of climate stress and accelerated intervention.

Ultimately, restoring dry forests is not just a technical challenge - it's a question of governance. Ensuring that good intentions translate into positive outcomes will require continually adaptive systems, collaborative oversight, and the willingness to ask hard questions about what is (and isn't) working. This is the kind of work the MPMB was created to do, and it deserves the tools and support to do it well.

As such, a fundamental rebalancing is needed. Monitoring and evaluation must be treated not as afterthoughts or compliance checkboxes, but as core components of restoration strategy - deserving of dedicated funding, institutional autonomy, and methodological rigor. Accountability should not be measured solely in contracts executed or acres cleared, but in ecological outcomes that are visible, measurable, and equitable over the long term. The path forward requires new frameworks, new partnerships, and a broader definition of success - one that values understanding as much as action. As climate pressures intensify and fire-adapted ecosystems teeter on ecological thresholds, we cannot afford to manage blindly.

Forests are more than sites of fire risk or resource extraction. They are living infrastructure: filtering air and water, sequestering carbon, supporting biodiversity, sustaining Indigenous lifeways, and anchoring regional climates. Their restoration must be rooted not just in efficiency, but in care, complexity, and humility. Only by closing the gap between what we do and what we know can we ensure that forest restoration in the Southwest (and beyond) lives up to its ecological promise.

"A nation that destroys its soils destroys itself. Forests are the lungs of our land, purifying the air and giving fresh strength to our people." (Franklin D. Roosevelt)

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Photo (Page 10): [https://gouda-geo.com/product/handheld-cpt-penetrometer](#)

Photo (Page 11): [https://www.researchgate.net/figure/Erosion-pins-and-measurements-method-1-photo-of-erosion-pins-2-measuring-erosion_fig5_339124384](#)

Water & Infrastructure Justice

"Water links us to our neighbor in a way more profound and complex than any other."

- John Thorson (Federal Water Master for the U.S. District Court)

A Look into Climate Equity and Infrastructure

Joshua Mosqueda

Abstract

San Diego's stormwater management is reactive, and this leaves low income neighborhoods vulnerable to flooding while wealthier areas receive consistent protection. This paper examines how the City of San Diego's reactive stormwater management disproportionately impacts low income and marginalized communities. This reflects patterns of environmental racism which are embedded in infrastructure funding and disaster response. Using secondary research, international case studies, equity mapping, and firsthand field observations. I investigate how systemic neglect has shaped stormwater vulnerabilities in the city where I am from. I take lessons learned from successful models in Stockholm and Vermont. I propose integrating Green Infrastructure with traditional stormwater systems to reduce flood impacts. Permeable pavers emerged as the best cost effective green strategy for neighborhoods like National City. They act as a first line of defense that protects existing grey infrastructure while taking away pressure from overworked systems. My findings confirm that climate adaptation must be proactive and equity centered. By prioritizing the needs of the most affected communities, San Diego can address its $1.6 billion stormwater deficit while building long term climate resilience for all residents.

Introduction

Climate change is intensifying storms and exposing aging urban infrastructure worldwide. National City, San Diego is facing the reality that its stormwater systems are not equipped to handle the increasing frequency and severity of flooding events. On January 26, 2024 a devastating flood destroyed over a thousand homes. This was not the only flood of its kind, but it did expose the vulnerabilities that exist in low income neighborhoods. Natural disasters reveal deeper types of systemic failure. These failures are because of underinvestment and neglect. As climate change is on the rise, inequity will only deepen. San Diego must lead the way and confront the reality that flooding is both an engineering and a social issue. This paper asks: **What forms of inequality are shown by San Diego's stormwater management system, and what lessons can we learn from the green infrastructure used in Vermont and Stockholm, which help us design more equitable systems?** This question matters because flooding in San Diego is not only an engineering challenge but can also be seen as a justice issue.

To answer this I use secondary research, international case studies, equity mapping, and firsthand field observations. I use these tools to investigate how systemic neglect has shaped stormwater

vulnerabilities. I use both Stockholm's and Vermont's Green Infrastructure approach. These are blends of natural and engineered solutions for resilience. Using these modes, I create a hybrid solution pathway to frame this paper's argument/plan for San Diego. First, I start by keeping the grey infrastructure we have now. Second, I suggest the integration of Green Infrastructure.

This approach will ensure resilience against severe storms that exceed the capacity of green and grey systems alone. Third, since this paper has a huge emphasis on social issues, we must include aspects of changing social norms. This can transform how residents interact with their environment while pressuring policymakers to act. There is a need to switch this issue to both a technical and a social issue in order to keep the dignity of all residents. I will illustrate how green and blue infrastructure has been effectively implemented in other regions facing similar challenges. I use examples of equity mapping and flood mapping to identify areas where these interventions would have the most impact. Through this approach, I hope to create an outline and plan for the leaders and citizens of San Diego.

The City of San Diego faces a "$1.6 billion deficit" (Rivas 2023) in its stormwater infrastructure budget. This is a reality of the position the city finds itself in. This shows an urgent need for equitable and climate resilient solutions. I am a realist. Saying this, having a huge deficit isn't easy to overcome. Things like uprooting and upgrading the entire stormwater system are unattainable at this time. To address this issue I explore practical, feasible models drawn from cities and states that have implemented successful flood mitigation strategies. These examples offer realistic solutions for San Diego as I seek to transform its stormwater management from a reactive to a proactive system.

Literature Review

The *San Diego Climate Equity Index* (2021) states that climate action must align with social equity. The city's website shows the communities most vulnerable to climate impacts this directly connects to my project's focus on integrating equity into infrastructure investment. *Race, Class, and Hurricane Katrina: Social Differences in Human Responses to Disaster* (Elliott and Pais, 2010) shows how disaster response shines a light on existing inequalities. Hurricane Katrina is one of the clearest examples. African American communities faced greater barriers to returning home due to the destruction of housing and the lack of support. Like in San Diego, this reflects a system that prioritizes developers and business interests over community needs. These findings reinforce my argument that flood mitigation is not only an engineering challenge but a social one. *Climate Change and Human Health* (Haines, 2000) helps me expand on this by showing how flooding impacts public health beyond the financial cost. Floods spread waterborne diseases that can cause respiratory problems, and can also cause significant mental health stress from

anxiety and displacement.

Exploring Trade-offs Among the Multiple Benefits of Green, Blue, and Grey Infrastructure for Urban Flood Mitigation (Benedetti, 2020) provided my project with ideas that go beyond flood control. This includes public health improvements through cleaner water and ecological restoration. This study also points out that while GBI has many benefits, it works best when paired with grey infrastructure. This inspired my hybrid solution. No single approach is enough to address urban flooding. GBI must complement engineered grey systems like stormwater pump stations and pipes. To strengthen this approach, I reviewed *The City of San Diego's Stormwater Pump Station Design Guidelines* (2021), which lay out engineering standards and show that most pumps in San Diego are consistent and essential for flood control.

Protecting and upgrading these systems with GBI offers the best chance to address climate risks while managing the city's large budget deficit.

Permeable pavers stand out as a strong GBI strategy with high potential for flood mitigation. This is especially true in San Diego, where there is heavy foot and vehicle traffic. *Field Survey of Permeable Pavement Surface Infiltration Rates* (Bean, 2007) shows that when sited and maintained properly permeable pavements keep high infiltration rates. This shows that the investment in front would outweigh the cost needed to fix flood damage. *Evaluating the Field Performance of Permeable Concrete*

Pavers (Stovin, 2022) supports this by documenting their long term effectiveness in diverse conditions. Both studies support my research question by showing that San Diego could integrate permeable pavers to strengthen infrastructure resilience. The case study *Assessing the Performance of Permeable Pavement in Mitigating Flooding in Urban Areas* (Chen, 2023) shows a clear reduction in peak discharge, proving that this is a low impact and low cost flood mitigation option. For San Diego, this is essential due to it being a desert city facing both drought and flooding.

Blue Green Infrastructure: From Niche to Mainstream (Haq, 2020) examines Stockholm's shift toward GBI and highlights both systemic challenges and opportunities. It puts social issues at the front of flood mitigation, which aligns with my research question. The study identifies barriers like power imbalances among stakeholders. This mirrors the political and planning challenges in San Diego, where government decisions can slow equitable transitions. Stockholm's planning culture supports experimentation and strong policy frameworks. These are conditions that make GBI implementation possible. San Diego could learn from this by recognizing that climate adaptation is as much a social challenge as it is a technical one. Addressing environmental racism in stormwater planning means prioritizing the needs of vulnerable communities from the start. My project builds on these lessons by using GBI not just to improve San Diego's stormwater system but also to fight environmental injustice. I critique GBI

where it has failed in other studies and explore how combining its best elements with grey infrastructure can be more effective. None of the existing research fully connects systemic underinvestment in low income communities in the western United States, so my work bridges that gap by applying lessons from Stockholm and Vermont to the local context. By integrating permeable pavement with San Diego's existing infrastructure, I propose a first line of defense that reduces pressure on overworked pipes and pump stations in flood-prone areas like National City. I frame GBI as a way to build community resilience.

Methodology

I draw on my own field experience and secondary sources like equity maps to explore my research question. **How does the City of San Diego's reactive stormwater management disproportionately impact low-income and marginalized communities, and what proactive infrastructure models can guide a more equitable system?** The goal of this paper is to propose a realistic, feasible framework that San Diego can adopt to address long standing infrastructure inequities. In my time living and working in the city I have witnessed firsthand how systemic neglect and underinvestment have left communities. These are communities that are particularly Black and Latino neighborhoods and are vulnerable to flooding. On January 26, 2024 a flood destroyed over a thousand homes; I was in the field as part of the Environmental Services Department's storm response. That

experience is not just a point of data, but it is a personal reminder that this project is deeply connected to the people and places I serve. My approach combines multiple forms of knowledge. From my fieldwork, I gained an understanding of how stormwater systems operate under stress. This led to my understanding of what resources are lacking in vulnerable communities and how emergency responses unfold in real time. Me being both a resident and a public servant gives me a dual perspective, which is imperative to a project like this. I understand the technical challenges faced by city departments, but I also see the impacts on communities that rarely have a voice in infrastructure decisions. I argue that field experience is a powerful form of knowledge because it grounds the reality of human consequences we make with our decisions.

I use equity mapping to analyze how stormwater funding and resources are distributed across San Diego. This allows me to identify patterns of neglect and compare them to flood risk zones. I examined secondary sources like San Diego's engineering guidelines. The choice of Vermont and Stockholm is because I see them as having the best solutions that can help this city. Vermont's adoption of permeable pavers offers a low cost option, which is best for the financially suffering San Diego. These are both effective flood mitigation approaches that work in communities with class diversity similar to San Diego. Stockholm's Green Blue Infrastructure model demonstrates how integrating natural and engineered systems

can improve resilience while providing environmental and social benefits. Both cases were selected because they offer tested solutions that address climate resilience without requiring a complete overhaul of existing infrastructure. This is an important factor given San Diego's $1.6 billion stormwater deficit.

I recognize that my paper lacks direct community interviews. This was an intentional choice, rooted in an ethical commitment to avoid retraumatizing residents who have already endured the loss and stress caused by flooding. Instead, I choose to draw on already published literature in which residents have shared their experiences. I keep these narratives in mind as I analyze systemic patterns. Leading back to my time on the field when I learned that behind every statistic is a suffering community. I aim to honor their experiences

without forcing them to relive their trauma. Ultimately, I interpret stormwater infrastructure not just as a set of pipes but as a reflection of political priorities. The lessons I learned on the ground help me frame my recommendations in a way that uplifts social equity. My analysis of equity maps and case studies identifies where proactive interventions have the greatest impact. My field experience gives these recommendations credibility for San Diego's most at risk neighborhoods. I seek to propose sustainable solutions that challenge the city's current reactive nature and move toward protecting all residents.

## Inequalities in Storm Response and Infrastructure

Environmental racism is not merely a geographic coincidence but a systemic problem visible in infrastructure allocation, disaster vulnerability, and recovery processes. The "elements consisting of water, waste, and health all disproportionately affect low income communities. Poor and minority neighborhoods are more likely to be in disaster susceptible areas, and thus are likely to sustain more damage. Neighborhoods safer from natural disasters are in more expensive, gated communities where barriers to entry such as cost and racism prevent poor and minority groups from moving in" (Green 2013). Natural disasters bring to light the amount of environmental racism there is in a certain area. Earthquakes and floods are just the surface of what's

Climate Equity Index
Level of Access to Opportunity

Very Low
Low
Moderate
High
Very High
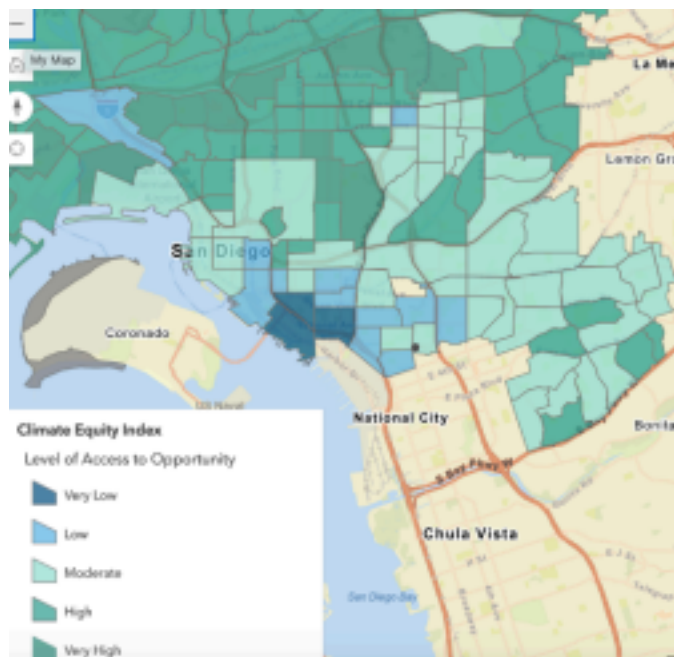
coming in the next couple of years. This is why we need more allocation of resources and infrastructure in these areas. On the map to the left, you see the climate equity map that was created in 2021 (City of San Diego). This map measures the level of access to opportunities and resources. There is a little black dot where the bulk of the flood occurred. This varies from moderate to very low levels of opportunity. In 2015 the City of San Diego established a climate action plan to address social equity concerns. It was a plan to allocate resources in order to address environmental justice and climate change. The city knows that these are areas of concern. "To address environmental justice and social equity, the city recognizes these two concepts are incorporated in the term "climate equity"… as efforts addressing historical inequities suffered by people of color allowing everyone to share the same benefits and burdens from climate solutions and attain full and equal access to opportunities regardless of one's background" (City of San Diego 2021). Yet despite this statement, there has been no real action. Which is dangerous because flooding is not only destructive, but also leads to human health issues. Statistics show that "Flooding is the predominant cause of death associated with natural disasters in the United States, with most deaths caused by drowning. Flash flooding, with rapidly rising water levels, is particularly deadly. (Tapsle 2000). Engineering is an important part of fixing this issue due to the resilience it can add to any general area.

Based on what I have seen firsthand during the 2024 floods San Diego's Climate Action Plan has not been effective in addressing the environmental racism tied to disaster response. The intention of the plan is clear, and it has created a framework to address climate equity on paper, but neighborhoods like National City remain in the same vulnerable position they have been in for decades. The plan acknowledges disparities, but acknowledging is not the same as acting. The lack of proactive flood prevention in low income areas proves that. There are opportunities within the Climate Action Plan. It creates a foundation that could guide equitable infrastructure investment, and it recognizes that flooding is tied to social equity. The Climate Equity Map reveals that the areas most affected by flooding in San Diego overlap almost exactly with areas of low opportunity. These areas have a high concentration of low income residents. This map reinforces the idea that poor and minority neighborhoods are consistently placed in disaster susceptible zones while wealthier communities maintain physical and economic buffers against these risks. San Diego's 2015 Climate Action Plan acknowledges these disparities. It's the lack of initiative when patterns are identified that is the problem. Flooding is not only a destructive force on infrastructure, but it also shows "the way society is organized, the way we build and maintain our infrastructure, and the way we allocate resources and opportunities "(Bullard and Wright 2009).

I was out on the field in National City after the disaster struck. I wasn't out in the field for clean-up, but instead to sell and collect city property that might have been dragged away with the flood. There was no proactive plan to help these areas address flooding, even though floods in this area happen constantly. The trauma that stays with you after an event of this magnitude is major. I saw firsthand how disaster does not just destroy infrastructure, it exposes the underlying inequities in who gets help and when. The streets were still covered in water while people scrambled to protect their belongings. This was without any clear guidance or assistance from the city. The need for proactive flood prevention was painfully clear. The Drains were clogged and help arrived only after the water had already done its damage. The people I spoke to generally said they were not just losing property, but losing peace of mind. They would live with the constant fear in their hearts that the next time it rained it could bring another disaster. What surprised me was how familiar this routine felt to residents. This wasn't a once in a lifetime
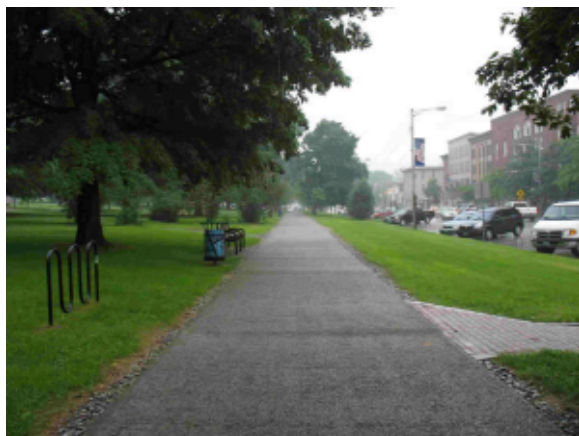
event for them. This was an ongoing cycle that the city's infrastructure and policies seemed resigned to accept.

This made it impossible to ignore how environmental racism and infrastructure planning are linked. This was because wealthier neighborhoods in San Diego benefit from well maintained stormwater systems and visible preventative measures and the lower income areas like National City are left vulnerable. I walked those streets after the flood and I saw how quickly disaster turns into opportunity for some. Investors arrived almost immediately making offers on damaged homes at half of their value. My field experience confirmed that the inequities I had studied in maps and reports were not abstract patterns. These were lived realities with lasting human consequences. Addressing stormwater management in San Diego is not just about engineering better drains, it's about breaking a cycle where environmental hazards and inadequate response.

What grey systems do we have now, and how can they fail?

San Diego's stormwater infrastructure is designed to collect and transport rainwater away from homes. The system is a grey infrastructure that moves water quickly into the ocean. This system relies on gravity and mechanical pumping to function properly. When it rains water flows and sidewalks because these surfaces do not absorb water. The runoff enters gutters and storm drains and then moves into underground pipes. These pipes get larger as

they connect to main stormwater channels carrying water to rivers like the San Diego River or directly to the ocean. In flatter areas stormwater pump stations are used to push water uphill so it can continue to flow toward its destination. These pump stations act as the heart of the system in low lying neighborhoods. They have large underground basins that collect water, and when water levels rise the pumps push water out. In San Diego , this is especially important in areas like Mission Valley or National City where gravity alone cannot move water fast enough during storms.

These grey systems work in most areas of San Diego; however, the system often becomes overworked during heavy rains. Especially with the increasing frequency of intense storms because of

extreme storms we are seeing more often. Many pipes and pump stations in San Diego are decades old, with some systems from the "1950s or earlier still in use" (City Of San Diego). Some of these pipes reduce the system's effectiveness during storms. When rainfall rates exceed what the pipes and pumps can handle this results in water backing up into streets and neighborhoods. Urban sprawl and new development add more pavement and roofs which means more water rushes into the system during rain not into the ground. Litter reduces the speed at which water can enter the system. Even with cleaning programs it only takes one major storm to wash significant debris into drains. When the system is overwhelmed water fills the streets and creates property/human health damage. In places like National City flooding can linger for hours or days which
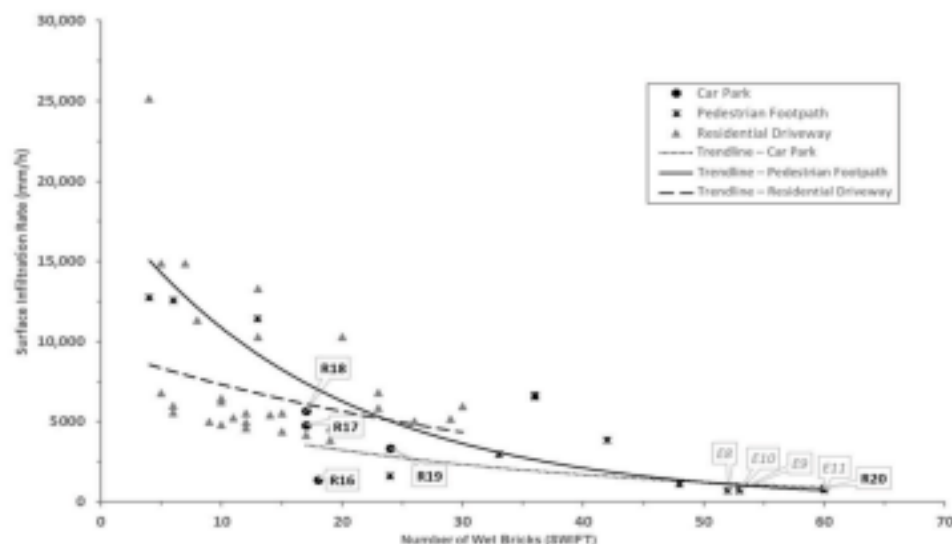
climate change. Stormwater pipes and pump stations are sized based on historical rainfall patterns; this does not account for the

leads to the displacement of residents. During the January 2024 storms pump stations in Mission Valley and Barrio Logan

ran at full capacity but flooding still occurred. This was because the volume of water exceeded the system's design. Streets became rivers and people were trapped in their homes or cars. Storm drains were visibly overwhelmed with water spouting back up from manholes. Sandbags became the last line of defense for many residents as pumps could not keep up with the rainfall intensity. In my own field observations I saw storm drains filled with trash with water pooling in intersections and low lying streets. The pump stations were active, but water remained because the system could only move it so quickly, and more rain kept falling. As heavier storms become more common, the current grey infrastructure alone cannot handle the volume of water that is to come.

Proactive Infrastructure

Climate change presents one of the main challenges to coastal cities. San Diego is not the only city dealing with extreme weather events. With more events happening the more and the reactive infrastructure systems are getting exposed. Floods are among the most frequent disasters impacting urban areas. It becomes clear that marginalized communities are affected more by the reactive work of public services. A shift toward green stormwater infrastructure offers a path for new infrastructure to keep up with rising climate risks while promoting social equity. The City of San Diego's Environmental Services Department responded reactively rather than proactively attempting emergency drainage clearing and

shelter provision only after the damage was done. The result was health hazards and financial strain on families with the least resources to recover. This reinforces the reality that environmental racism is embedded in infrastructure responses. This pattern mirrors global trends. New infrastructure helps keep up with the rise in natural disasters by combining the normal grey systems and green systems that GSI set up. Green measures like permeable pavers, followed by regular maintenance in grey infrastructure would create a first defence line that is followed by a system that won't be easily overworked. One promising solution involves incorporating nature based infrastructure to support the engineering systems we already have in place. In the state of Vermont, they use permeable pavers to manage runoff and reduce the risk of flooding. The State of Vermont does this by letting water soak into the ground through permeable pavers. This slows down and reduces runoff that would directly go into drains and waterways. This system would help San Diego reduce increased flooding by slowing down how fast water moves off the streets.

Instead of water flooding these systems, spread it out and let the water replenish the groundwater. This would help limit the severity and frequency of floods. There are lots of great ideas in GBI, but permeable pavers are at the top of the list and would be the easiest to incorporate in urban areas. This method can manage stormwater without requiring additional land or pumps. These pavers look like regular

stone with some spacing underneath, allowing for stormwater to infiltrate into the ground rather than overwhelming storm drains. Permeable pavers can be used in driveways, walkways, and parking lots across San Diego. The issue with a dense location like San Diego would be choosing the most effective location.

Proactively mitigating flooding means transforming everyday surfaces into functional stormwater management systems. The placement and usage matter for the local stormwater system's effectiveness. The table above shows that the type of traffic and load can change how fast water can get through the surface. Places with heavier traffic and loads had lower infiltration rates compared to spots with less traffic. Tests R17 and R18 were done in the middle of a parking bay where cars don't sit with heavy loads, while R19 and R20 were on the driveway where there's more weight and movement. Even at the busy spots, the infiltration rate was still pretty high at 800 mm/h. This data would suggest that car parking lots and sidewalks would be the best sites and, in the long run. These systems are important in urban areas like San Diego where drought conditions reduce groundwater levels and where flash floods are becoming more common. In National City, permeable pavers can be used and should be a common occurrence. This approach gives National City a way to be proactive. Research shows that "permeable pavers can reduce peak runoff by up to 93% during storm events" (Boogaard 2014). This would mean security for the streets and

walkways of National City. This would be a first line of defence of the systems already in place. Not only that but pavers can be used as a natural filtration and add great flexibility to an area. Especially in low income areas with outdated systems. This would allow for equity to remain at the center of all infrastructure upgrades. With storms getting stronger it's important to place these pavers where flooding risks and damage have been the highest. San Diego stormwater systems are overworked and the amount of pollution makes them more vulnerable to flooding during heavy storms. Permeable pavers reduce localized flooding without the high cost in the long run. This makes it a practical solution in the areas that I have worked in like National City. Using permeable pavers in sidewalks and parking lots can prevent storm drains from getting overwhelmed. My findings confirm that other cities have seen that permeable pavers can reduce localized flooding. This is a system that helps without needing more land or pumps.

Unlike purely reactive measures, GBI intercepts stormwater before it overwhelms drains. This means lowering maintenance costs and extending the life of the existing system. In Vermont, permeable pavers allow stormwater to infiltrate directly into the ground and spread water more evenly across the system. This is a principle that could be adapted for San Diego's urban environment. For communities that often face slower disaster recovery this is the perfect proactive protection. This means fewer property losses and reduced

displacement. Because permeable pavers can be installed in small spaces like sidewalks, and parking lots, they offer protection without requiring large scale land acquisition.

Despite their promise, permeable pavers have not been widely adopted in San Diego. This is because of the amount of upfront investment that is needed. Their installation costs are higher than traditional asphalt or concrete. San Diego already has a $1.6 billion stormwater infrastructure deficit. This number means that many investments are dismissed due to budget cuts. Engineers and planners are accustomed to traditional methods and resist adopting nature based solutions due to these risks and financial issues. Environmental advocates and planners in Vermont use community education and clear maintenance plans to mitigate this issue. These are critical to successful permeable paver implementation and equity. Using permeable pavers alongside existing grey systems in San Diego neighborhoods could reduce local flooding. By learning from Vermont, San Diego can adapt these promising practices ensuring that implementation strengthens climate resilience and justice for all residents.

Ensuring Equitable Implementation

Studies in Stockholm show that high investment in just GBI showed lackluster results in flood management but helped ground water levels and social aspects of the city. This is because "In flood risk

management, while the primary benefit of GBI is the reduction of flood damage, its co-benefits enhance its feasibility and acceptability among communities and decision-makers" (Dagenais 2017). This would help address the dimensions of vulnerability experienced by marginalized communities. In neighborhoods like those near the Chollas Creek watershed in San Diego, the use of GBI would reduce exposure to floods. The deficit the city currently has is a barrier to equitable adaptation. Addressing this requires planning that sustains funding mechanisms like GBI to prioritize investments in the most vulnerable communities. This means shifting from reactive emergency responses to planned ones. This integration can transform systems while ensuring that marginalized communities are protected and actively involved in decisions. In Stockholm, the city has recognized the sustainability limits of existing water drainage systems. San Diego and Stockholm are different in diversity and geography but share the same sustainability issues. Like Stockholm decision makers, San Diego must recognize that climate change adaptation requires proactive integrated solutions. These are solutions that not only reduce contributions to mitigation but also enhance resilience to floods. GBI emerges as a central strategy to meet this need. This strategy provides services that deliver social and cultural benefits. GBI enhances public health and offers recreation opportunities.

"Increasing awareness about GBI's co-benefits and its economic feasibility is

crucial to convincing local governments and stakeholders of its necessity" (Dorst 2019). Part of GBI is to handle the equitable Implementation. For these benefits to be shared equitably, placement decisions must be guided by vulnerability mapping rather than political convenience. This means prioritizing neighborhoods with a history of flooding, or low median income. These are places where residents are least able to afford recovery. In National City permeable pavers could be installed along high foot traffic areas like sidewalks and in parking lots which would provide both flood protection and safer routes for foot traffic. An updated citywide equity plan could require that a set percentage of annual installations occur in census tracts identified as high risk by flood hazard data. Public participation is also critical. This is why holding community workshops ensures residents help decide where installations occur and how they're maintained. To do that the city could hire and train residents for installation and maintenance, ensuring the investment not only protects the community but also provides jobs. By using equity driven planning San Diego can move from reactive to preventive stormwater management. This would create a city where climate adaptation also means closing gaps in environmental justice.

Why fund this?

Funding this would help address the dimensions of vulnerability experienced by marginalized communities. Stable long term funding is necessary to prevent low income

areas from being left behind. "Increasing awareness about GBI's co-benefits and its economic feasibility is crucial to convincing local governments and stakeholders of its necessity" (Dorst 2019). GBI would also help with the vultures we call property investors by keeping houses from becoming condemned and teaching residents about their rights. Funding this would directly address the vulnerability experienced by communities. By investing consistently, the City of San Diego could avoid the costly cycle of damage, repair, and displacement that currently hurts the most at risk neighborhoods. From an economic standpoint, the benefits extend far beyond flood control.

What Does this Mean?

Environmental racism is deeply embedded in San Diego's disaster preparedness and response systems. The Climate Equity Map visually confirms that National City overlaps with zones of very low opportunity and high social vulnerability. Despite what is stated in the 2015 Climate Action Plan, Implementation remains weak in the very neighborhoods most at risk. The city acknowledges systemic inequalities, but nothing has been done. In my experience I saw residents sleepless and scrambling to escape the rising waters. Instead of humanity coming together in a time of need real estate companies moved in to exploit the chaos. This shows the social shift we must take to "argue that disasters are not natural events, but social constructs shaped by how infrastructure,

policies, and power are distributed" (Bullard and Wright, 2009). Using this I also discovered that recovery itself becomes a site of exploitation. It forces us to see that climate equity plans must be backed by real investment. GBI presents a powerful opportunity to build proactive measures while addressing inequalities. As cities like Stockholm have begun to recognize. Climate adaptation must be both technologically advanced but also fair. San Diego must move from acknowledgement to accountability.

The city's existing grey infrastructure is outdated but can still do the job. The system is designed to rapidly transport water away from urban areas. My field observations during the storms revealed how even fully operational pump stations in National City failed to prevent flooding. This was because pollutants clogged entry points which slowed the stormwater pumps. In areas like National City this caused serious damage to homes and raised public health concerns. This shows that the system is actively failing under current conditions. Maintenance alone won't keep these systems functioning. The current infrastructure can not keep pace with the rising volume of water. This signals a need for a shift toward more proactive solutions. Grey infrastructure cannot work alone. Integrating certain GBI solutions such as permeable pavements, can absorb and slow stormwater before it reaches pipes and pumps. Sustainable stormwater management must now combine with engineering especially in historically underserved and flood prone communities.

Permeable pavers provide a powerful yet underutilized solution for National City. Vermont's successful implementation shows how nature based strategies can slow down stormwater and recharge groundwater. They also filter pollutants before they reach waterways. This is highly relevant for San Diego. This is because of the already polluted bodies of water which happen due to other issues. By integrating permeable pavers into sidewalks and parking lots, we can ease pressure on San Diego's stormwater systems. Field infiltration tests show that even under high traffic conditions these pavers retain strong absorption rates. The data confirmed the efficiency of GBI and also discovered how infiltration capacity is site specific. This new insight can guide smarter placement and planning particularly in National City. This is not just about engineering, it's about justice. Cost effective solutions like GBI are crucial. Vermont's and Stockholm show that community education and transparent plans can increase local political and community support. When communities are involved in the planning and placement of GBI they not only gain physical protection but also reclaim power over their neighborhoods.

More to be done…

Environmental injustice is highlighted during vulnerable times. Vermont and Stockholm show that flooding in marginalized communities is not coincidental but instead a problem that the system created. These patterns are because

inequitable infrastructure planning and reactive disaster response that consistently affect communities. San Diego's reliance on aging grey infrastructure creates weaknesses in areas most susceptible to flooding. National City and those near Chollas Creek are particularly vulnerable due to their topography. The 2021 Climate Equity Index claims to prioritize environmental justice, but my fieldwork and personal statement suggest otherwise. There is a huge gap between stated goals and actual outcomes. The Climate Equity Map shows that the neighborhoods most impacted by flooding align almost exactly with areas ranked lowest in opportunity and investment. Environmental racism is not just in where disasters strike, but in how cities prepare for them. In wealthier areas drainage systems are reinforced and emergency responses are fast. Low income areas receive delayed services and predatory attention from investors. The flood in National City made this pattern undeniable. During my time in the field, we were asked to sell city property that might have washed away. Without thinking about the level of trauma that the lack of planning can cause.

In Vermont, GBI has been successfully implemented through strategies like permeable pavers as an act of proactive planning. GBI systems improve groundwater recharge and create green spaces. Stockholm's experience shows that GBI alone is not the sole solution. It must be part of a broader transformation that includes community participation and long term funding. San Diego has the opportunity to learn from these cases. Permeable pavers are one of the most viable tools for National City. *But* there is still a huge amount of planning to do. Data show that infiltration rates vary based on traffic load and soil conditions. Areas like driveways have slightly reduced absorption but still perform effectively when maintained. This means city engineers must work with local communities to identify the best sites for this method. When placed alongside maintained grey systems, these pavers can act as a first line of defense that reduces strain on the overall stormwater network. Infrastructure itself is a tool to combat equity issues. Flooding is not just a weather event it exposes who is protected and who is left behind. Equity must guide all future infrastructure decisions in San Diego. Using Ideas from GBI to protect existing grey infrastructure is both a sustainability solution and a way for equitable infrastructure to come alive. This awareness must extend beyond engineers and into the communities most impacted by climate risks. Residents need to be informed in order to have a say. This means being included in every stage of planning. This calls for further research on implementation barriers. These are things like cultural barriers and city political barriers. These are things that are unique to San Diego being that it is connected to another country and is so diverse ethnically. San Diego can learn from these past events. Climate change is intensifying and the infrastructure isn't getting any less old. Communities are demanding justice. The city's response to

this will show whether it remains complicit in environmental racism or becomes a leader in climate equity. By learning from places like Vermont and Stockholm and by listening to those on the ground San Diego can begin preparing for the future.

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When Streets Become Rivers: Green Infrastructure and Environmental Justice in Costa Mesa's Westside

Tyler Fields

Abstract

This study investigates how green stormwater systems could help reduce flooding while addressing environmental injustice and promoting more equitable infrastructure development for Westside Costa Mesa, a Latino working-class neighborhood that has been systematically overlooked in infrastructure investment decisions. This research contends that for the Westside neighborhood's green infrastructure needs to be addressed, the City of Costa Mesa needs to shift from development-driven funding models to community-controlled equitable planning frameworks that fully embrace distributive, procedural, and recognition justice which eco and social justice scholars have coined as the three-dimensional equity principle. This is based on data gathered from policy documents, community interviews, field observations, case study comparison community analyses through the lens of environmental justice frameworks.

By comparing successful green infrastructure projects in Long Beach and Santa Ana, documenting flooding patterns in Westside through direct field observation, and analyzing how the City of Costa Mesa makes policy decisions through government document review, this case study demonstrates that environmental injustice stems from institutional systems that prioritize economic growth over community wellbeing. The research reveals that Long Beach's LB-MUST facility and Santa Ana's King Street Urban Greening Project exemplify community-controlled infrastructure investment approaches. Key findings show that Westside Costa Mesa experiences the city's highest flood risk, with 41 percent of buildings at risk, creating urgent infrastructure investment needs for a population of 62,575 residents who continue to be systematically underserved despite bearing disproportionate environmental burdens.

Introduction: When Rain Reveals Injustice

The yearly Pacific storms that hit Southern California during winter reveal the inequity in Costa Mesa. Storm drains in the wealthy eastside neighborhoods clear rainwater efficiently, leaving clean streets with well-maintained systems. On the other side of Newport Boulevard (West), things are very different. These areas don't have

good drainage systems, so when a rainstorm hits, streets turn into rivers. Families struggle to get through intersections just to reach their homes, and kids can't go to school because sidewalks stay underwater for days.

This is an unfairness issue rather than a mere weather issue, and one I witnessed firsthand in my two years of working at a stormwater division. The systematic discrimination in infrastructure design within a given political boundary furthers the creation of races and class divides and is termed as environmental
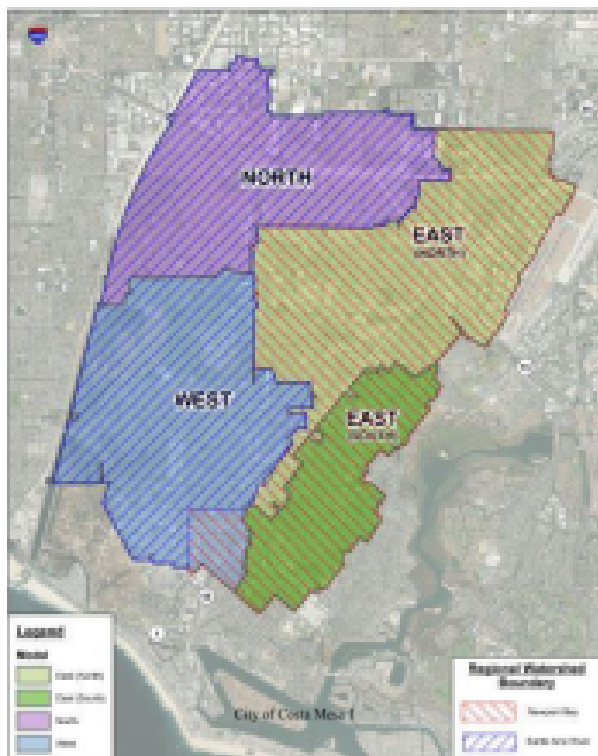
injustice. I lived the contradiction of having to implement technical solutions and watching those solutions enact the very inequities they claimed to fix. So, I

approach this research as developmental processes designed to concentrate environmental hazards purposely in Latino neighborhoods while disconnecting citizens from city planning processes (U.S. Census Bureau, 2023). But this is also a story about possibility.

Creative solutions that turn stormwater management into community development and environmental justice are being used throughout Southern California. In Long Beach's Willmore neighborhood, which is mostly Hispanic (63%) with a median income of $44,867, the $43 million LB-MUST project has turned an industrial area into community green space while cleaning almost 2,000 acre feet of dirty water runoff each year (Jacques, 2022). Similarly, in Santa Ana, the King Street Urban Greening Project turned 9,000 square feet of unused space into active community infrastructure that captures 117,000 gallons of stormwater with every storm (Johns, 2024).

These examples demonstrate an important shift in how we think about city infrastructure: instead of treating stormwater management as a complicated problem that only experts can solve, green infrastructure offers ways to get communities involved, improve environmental health, and fix historical unfairness. Drawing on my experience working within city planning systems and conducting fieldwork in the Westside community, this research focuses on developing community-centered approaches for Costa Mesa's Westside, looking at both stormwater management

strategies and the changes in how the city makes decisions that are needed to make sure infrastructure investments help environmental justice instead of making inequality worse.

The issue has both political and practical sides: How can Costa Mesa's Westside get green stormwater infrastructure while addressing environmental unfairness compared to other areas? And what can we learn from successful community-controlled projects in nearby cities? To answer these questions, we need to pay attention to power relationships, community control, histories of neglect, and the supporting technical work.

This research is important for me because I have always held the conviction that any decision regarding the infrastructure is never politically neutral. Each budget allocation, each project priority, each technical standard reflects choices about whose communities matter. This is supported by participatory action research and environmental justice epistemology, which suggests that the community members are the best experts of their own experiences. Instead, research should seek to aid community organizing, rather than extract information from the communities.

Green Stormwater Infrastructure: Where New Technologies Ignore Community Needs

The connection between green stormwater management and social fairness is one of the most important and overlooked topics in city planning research today. However, it's surprising that research on how well green infrastructure works largely ignores the research on social justice that shows how infrastructure choices make inequality based on race and class worse.

Technical Innovation Without Thinking About Social Issues

Research on green infrastructure agrees that these systems work well technically. Rain gardens, special pavements that let water through, and man-made wetlands can capture billions of gallons of stormwater while also providing benefits like storing carbon and supporting wildlife ([Natural Resources Defense Council, 2024](#)). The Natural Resources Defense Council estimates that green infrastructure could potentially capture 4.5 trillion gallons of stormwater in California alone, often costing less than traditional concrete infrastructure.

Recent studies have identified nine main principles for effective green infrastructure: being adaptable, connected, diverse, working at multiple scales, using technology, including the public, and being sustainable ([Landscape Research, 2024](#)). These frameworks show that practitioners are starting to realize that effective green infrastructure needs to think bigger than just individual projects.

However, this lack of attention to social issues is a problem. The Minnesota Pollution Control Agency's detailed manual on stormwater management acknowledges that social factors need to be built into green

infrastructure projects alongside community acceptance and environmental justice considerations ([Minnesota Pollution Control Agency, 2022](#)). However, environmental justice has been added only as an afterthought, appearing less important than the main technical focus.

When Environmental Justice Theory Meets Real Infrastructure

Beyond the technical aspects of green infrastructure, environmental justice research provides important frameworks that form the foundation of infrastructure research focused on fairness. Bullard and Johnson's groundbreaking work explains the relationship between grassroots activism and government decision-making about environmental infrastructure ([Bullard & Johnson, 2002](#)), while Pulido shows the lasting patterns of environmental racism rooted in racial geography ([Pulido, 2000](#)).

More recent studies have applied these ideas specifically to infrastructure. Research on formerly redlined neighborhoods shows that 77% of these areas face increased pollution compared to 18% of historically privileged areas, creating lasting environmental health problems decades after discriminatory policies were ended ([Nardone et al., 2024](#)). These communities tend to have worse stormwater infrastructure and face more flood risk. Communities of color bear the worst of these burdens, experiencing serious environmental dangers alongside minimal infrastructure investment.

A study of green infrastructure in Washington D.C. shows notable unfairness in where projects are built, as projects favor locations with existing green space and

https://firststreet.org/city/costa-mesa-1
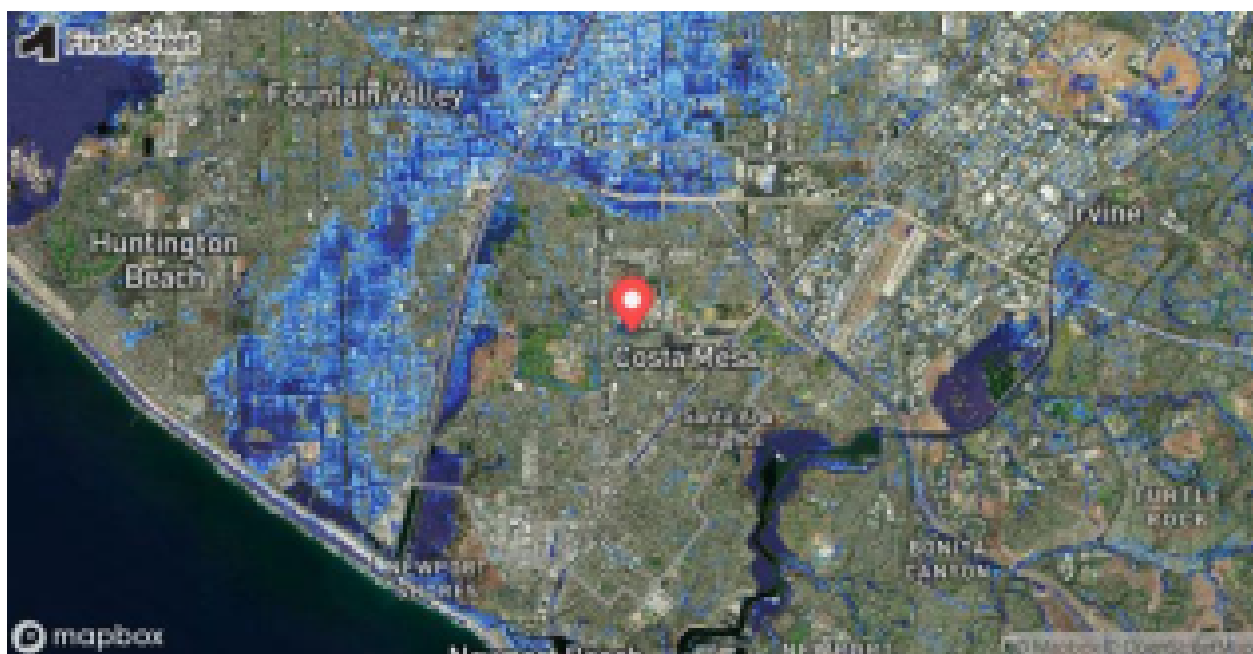
higher property values ([Liu et al., 2024](#)). This study shows that when fairness isn't considered, it tends to make social and spatial inequalities in green infrastructure programs worse.

The Critical Gaps: Community Knowledge and Involvement

The most obvious gap in existing research revolves around community involvement and local knowledge. Studies about green infrastructure show that citizens often don't know about, understand, or participate in green infrastructure projects. This gap in community participation leads to real consequences: communities feel less invested, leading to higher project failure rates and fewer environmental benefits.

Environmental justice scholars argue that effective involvement requires addressing unfair social conditions shaped by language barriers, meeting location and timing, childcare needs, and payment for community expertise. Green infrastructure research rarely addresses these fairness concerns about how decisions are made.

Understanding Infrastructure Inequality

Allan Schnaiberg's "Treadmill of Production" theory, along with its extensions by Kenneth Gould and others, offers important insight about the relationship between economy driven growth and infrastructure investment patterns ([Gould et al., 2004](#)). This theory specifically shows why infrastructure decisions are made primarily to make money while deliberately ignoring community and environmental

wellbeing.

For stormwater infrastructure, this analysis shows how established communities like Costa Mesa's Westside are systematically underfunded by development driven funding systems. When infrastructure project funding relies on fees from new development and new construction, investment falls behind in areas with little new building.

The scholarship of environmental justice has developed frameworks that enable the analysis of various aspects of equity in relation to the environment and

Personal Observations 1

equity decisions. Procedural equity focuses on the decision-making process and the participants in it; distributional equity focuses on the allocation of resources and environmental consequences; and recognition equity focuses on the acknowledgment and valuation of diverse communities. Environmental justice scholarship has developed frameworks for analyzing different dimensions of equity in

environmental decision-making. Procedural equity examines how decisions are made and who participates; distributional equity analyzes how environmental benefits and burdens are allocated; recognition equity considers how different communities are acknowledged and valued (First National People of Color Environmental Leadership Summit [1991] Principles of Environmental Justice).

Innovation at the Margins: Emerging Models of Community Control

Despite these gaps in traditional studies, innovative projects across California have shown that green infrastructure can be developed through community-controlled processes that focus on environmental justice. Perhaps the best example of resident-led environmental policy

Personal Observation Westside 1

development is Santa Ana's Environmental Justice Action Committee.

Another example is Long Beach's

LB-MUST project, which shows how large-scale technical infrastructure can serve environmental justice when located in communities that suffer unfair pollution and economic burdens. The project's location in the Willmore neighborhood, which ranks in the 90th percentile for pollution burden compared to other neighborhoods in Los Angeles County, shows how environmental justice principles can guide where projects are built and how they're designed.

How This Research Advances the Field

From my previous position in the city's stormwater division, I learned that focused technical solutions often perpetuate injustices to the environment and communities, especially when there is no community governance. This position allowed me to obtain internal files and documents and hear staff opinions, which showed me the dysfunctionality of systems that try to silence community voices. My prior employment with the city as well as my current position as a researcher presents me with considerable insights, but also some limitations that shape this analysis. With this research, I want to offer more answers to the issues I have identified. I have based my approaches on my findings, and they include, for example, integrating the theory of environmental justice with a thorough, precise evaluation of the potential for green infrastructure in a particular region. Providing a citywide policy evaluation to rationalize neighborhood-scale individual project attention is another example. Finally,

this research aims to provide adaptable frameworks by analyzing successful models and changing them into different contexts. This aims to grant possibilities to advance the social and environmental objectives through technical infrastructure planning provided by an environmental justice framework. My contribution, in this case, is to focus on the social and environmental goals of community-controlled processes advanced through technical infrastructure planning under environmental justice frameworks. This research shows environmental justice and technical effectiveness must converge to create infrastructure development sustainability.

This research's key limitation stems from the lack of formal interviews with residents from the Westside. Although I engaged in fieldwork and noted how the community responded to flooding, I did not make it a point to collect resident viewpoints regarding infrastructure prioritization and city decision-making frameworks. This illustrates a gap in my advocacy for community controlled research and the actual embodiment of such principles in this preliminary study. This gap reflects the limitation as a result of time constraints as well as my positionality as a city employee, which might have posed challenges to community trust. Future studies should prioritize community voice through community-driven interview design, resident-researcher training, and compensating participants for their community knowledge.

Methods: Researcher-Practitioner Approach Within System Constraints

Personal Observation Mesa Verde 1

Advancing green infrastructure in a way that achieves environmental justice requires a method that combines technical analysis with community centered study. For this research I used a multi-phase method combining policy document analysis, fieldwork observation, case studies, and environmental justice frameworks.

Theoretical Framework: Infrastructure Planning in the Context of Environmental Justice

The 17 Principles of Environmental Justice, created during the First National People of Color Environmental Leadership Summit, specifically guide this research design. Three principles are particularly relevant: Principle 2 states that public policy should always be based on mutual respect and justice for all peoples; Principle 4 calls for universal protection from environmental hazards; and Principle 16 focuses on

education and training that aims toward building fair transitions to a sustainable society.

When applied to stormwater infrastructure, these principles demand attention to decision-making processes (process fairness), how advantages and disadvantages are distributed (distribution fairness), and recognition and worth of different communities (recognition fairness). The analysis also includes perspectives from Treadmill of Production theory, which looks

improvement program documents, budget documents, and planning commission reports. For comparison, I examined the same documents from Long Beach and Santa Ana.

The fairness assessment used a document analysis approach looking at process fairness, distribution fairness, recognition fairness, and institutional capacity. Major findings show how Costa Mesa concentrated infrastructure investment over time, resulting in uneven development

Personal Observation Fairview Park 1

Personal Observation Fairview Park 1

at how
infrastructure investment is dominated by the need for economic growth.

Phase One: Governance and Policy Document Analysis

I began with an analysis of city documents, planning reports, and government structures as they relate to infrastructure investment patterns. This analysis included reviewing Costa Mesa city council minutes from 2020 to 2025, capital

inequalities. The Westside region contains older infrastructure from the 1950s and 60s that was built under less strict stormwater standards. Also, current capital improvement funding allocates resources based on traffic volume metrics, regulatory compliance requirements, and grant funding availability rather than equity based criteria.

Phase Two: Field Observations and Infrastructure Evaluation

I did fieldwork in Costa Mesa's

Westside region from April to July 2025, recording in detail infrastructure conditions, public flooding, community engagements during storms, and the status during non-rainy periods. Mesa Verde neighborhood, Fairview Park area, Victoria street corridor and the area between Santa Ana River and Harbor Boulevard were all scoped. I documented infrastructure conditions like the storm drains usage and capacity, street drainage system maintained, and functionality. I have reported noted differences across all neighborhoods.

Mesa Verde neighborhoods suffered the greatest: the residential streets had no storm drains and no elevation changes to facilitate natural drainage. There was a heavy accumulation of tree debris, coupled with very few maintenance conditions in the area such as chipped paint. There were very few plants that could act as a natural flood buffer in flood prone areas. I observed a few tree trimmers working in the area, but no maintenance crews for the green stormwater infrastructure.

Fairview Park showcased wide-open areas with dry grass as vegetation but did not have any basins or contour systems for water to pool during storm events. Noticing where shrubbery had been removed along the streets, I realized the region has steep downhill slopes toward the Santa Ana River on both sides, which provides a funneling effect to concentrate all the water to this region.

The region around Victoria Street (Vista Park area) greatly differs in the amount of construction and infrastructure work done compared to the rest of the area. Vista Park as a whole also looked decently well-managed, exhibiting a drainage system, good vegetation, and recent construction work. Even with the park being small and relatively flat, the Santa Ana River and Victoria Street's close proximity offered strong and attentive park maintenance and design. Even so, the surrounding area was filled with very old, brown and gray, routed, unsightly buildings, condos, and apartment complexes at every intersection. Oddly enough, the neighborhoods and main streets in this area, which were filled with old brown and gray, routed, unsightly buildings, were well-kept. I carried out flood observation studies capturing community responses and documenting the recovery patterns of the drainage system for the storms of May 15-16, June 8, and July 12, noting water accumulation locations and the duration of water stagnation. Flood observation studies exemplify the systematic field observations conducted to demonstrate the nexus of infrastructure and flood vulnerability. 1960s-era systems experienced chronic flooding issues, whereas regions equipped with 1990s upgrades showed marked improvement.

Phase Three: Comparative Case

Personal Observation Vista Park Victoria 1

Personal Observation Vista Park Victoria 2

Study Analysis

In the third phase of research, I focused on green infrastructure success stories from Long Beach and Santa Ana, targeting those with similar demographic and infrastructural features as Costa Mesa's Westside. The Long Beach case study looks at the LB MUST project, a $43 million investment in the Willmore neighborhood. This area shares key characteristics with Costa Mesa's Westside: 63% Hispanic population, median income of $44,867, 87% rental housing, and ranking in the 90th percentile for pollution burden. The Santa Ana case study focuses on the King Street Urban Greening Project, which transformed 9,000 square feet of unused public space into community green space with stormwater management capabilities.

King Street Urban; https://www.ymf-oc.o 1

Both case studies explore success factors for addressing environmental justice concerns regarding where projects are located, community involvement, and design features that provide multiple benefits. The comparison reveals critical factors for successful green infrastructure in environmental justice contexts: specific community benefit goals, multi-level financing models, active community roles in planning and implementation, and alignment with broader environmental justice policy frameworks.

Phase Four: Community-Based Analysis and Implementation Planning

The final phase combines findings to

form clear strategies for implementation in Costa Mesa's Westside Area, emphasizing community priorities and environmental justice principles. This analysis combines the environmental and government aspects of effective stormwater management by including the necessary community governance reforms needed for meaningful community control over infrastructure investment. Implementation planning is informed by evidence based practices from Long Beach and Santa Ana while tailored to Costa Mesa's specific needs. These include technical recommendations, site selection criteria, and governance reforms such as community advisory councils, fairness impact assessment frameworks, and community budget decision making pilot programs.

Results and Findings: Infrastructure Inequality in Costa Mesa's Westside
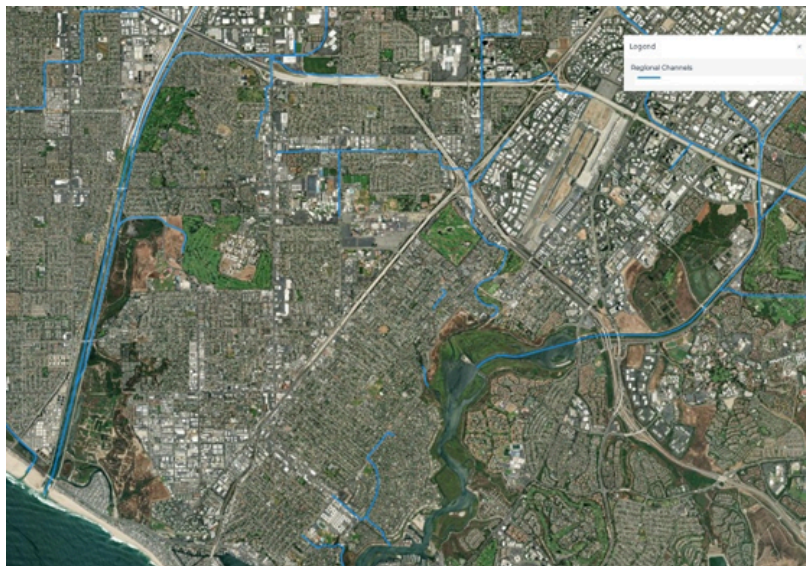
My combination of policy analysis, fieldwork, and case study comparisons shows the mechanisms of environmental injustice built into technical infrastructure decisions that divide communities into predictable racial and class geographies of vulnerability. Costa Mesa's Westside serves as a perfect example of environmental racism in infrastructure planning. It has 62,575 residents with a median household income of $94,833, which is significantly below the city average. The residents face infrastructure inequalities that come from historical development patterns and investment systems that deliberately created local social and spatial inequalities.

The demographic data reveals the patterns of environmental injustice documented across California. Costa Mesa's Westside has a 36.5% Latino population stemming from Costa Mesa's historic Latino community center. It's characterized by mostly renters, with 60.8% of households renting rather than owning, 25.3% foreign-born residency, and a median housing construction date of 1969. This demographic profile matches exactly with infrastructure conditions. Systematic infrastructure decay was documented between April and July 2025 along environmental justice lines.

In the Mesa Verde neighborhood, storm drain inlets built in the late 1960s

LEGEND

— Highest Priority Storm Drain

▲ Highest Priority Surface Drainage/CB

— High Priority Storm Drain

▲ High Priority Surface Drainage/CB

— Moderate Priority Storm Drain

▲ Moderate Priority Surface Drainage/CB

☐ Model Boundary

show severe deterioration. Plant overgrowth and cracking take up 30 to 40% of effective drainage capacity. Areas closer to the Santa Ana River still have their 1960s 18-inch systems, which suffer from tree root problems and joint separation, creating bottlenecks that flood lower-income areas.

Areas with an estimated 75 to 80% renter housing show both economic and infrastructure vulnerability. During the May 15 and 16 storm event, moderate flood conditions of 6 to 10 inch depths lasted for 4 to 6 hours. Summer thunderstorms, although weaker overall, caused short-term impacts of dramatic magnitudes.

Government Systems and How Inequality Continues

My policy document analysis reveals how Costa Mesa's government systems continue infrastructure inequality even when commitments to fairness exist. The city's capital improvement program allocation prioritizes levels of service, compliance with transportation plans, and grant funding availability as requirements. This reflects unfairness in how decisions are made, where community voices facing the impacts of decisions are left out of decision making processes.

Current community involvement systems create significant barriers to Westside participation. In interviews I conducted with city staff, they acknowledged that public meetings capture little input from renters or working families. Limited bilingual staff makes meaningful

Westside community involvement nearly impossible. Meeting times may create barriers for working families.

Through my analysis of budget allocation patterns I found that infrastructure investment patterns follow development interests rather than community needs. Costa Mesa's strong dependence on development impact fees results in systematic underfunding of less developed areas such as the Westside. While the Westside's median income is significantly lower than the city average, capital improvements funding doesn't reflect fairness-based allocation.

The stormwater department's priority framework shows how technical criteria can overlook environmental injustice. Staff first prioritize regulatory compliance, meeting permit requirements and pollution control obligations, then address system capacity concerns and infrastructure condition evaluations. While this approach may seem neutral, it systematically advantages areas with more recent infrastructure and stronger political support. Recognition of fairness presents perhaps the most fundamental barrier. Policy analysis reveals that data collection systems leave out neighborhood-level infrastructure condition assessments, particularly in Westside areas.

Performance metrics are set against city averages rather than fairness-focused benchmarks. This neglect enables systematic erasure and continues unfair investment patterns disguised as technical objectivity.

From Within the City: The Role of Good Intentions in Sustaining Environmental Inequity

Using semi-structured interviews with my former colleagues in the Planning and Stormwater divisions of Costa Mesa, I documented the ways that good professionals along with good intentions become trapped in the workings of an institution. I was able to utilize my former colleague's perspectives due to my work history in the department and my research role that allowed me to raise concerns about the practices I had taken part in designing and implementing. These interviews drew from my prior work with the culture and agenda of the division. In my conversations with staff, it was noted that community needs are consistently secondary to regulatory compliance for city staff. As Stormwater Department staff noted: "We prioritize based on regulatory compliance first, meeting our permit requirements and pollution control obligations. Then we look at system capacity issues, areas with chronic flooding problems" (Fields, 2025 personal communication).

This creates systematic bias against environmental justice communities. Areas with older infrastructure that meets outdated regulatory standards receive less attention compared to newer developments. Planning staff acknowledged: "Our department uses a comprehensive approach that includes the Capital Improvement Program process, where we evaluate projects based on community safety first, then regulatory compliance, and finally funding sources" (Fields, 2025 personal communication).

Both departments understand how past decisions created inequalities, but they fail to recognize how current actions reinforce these inequalities. Planning staff provided this reasoning: "The Westside has unique challenges because of its age. Much of the infrastructure was built in the 1950s and 60s" (Fields, 2025 personal communication).

Investment decisions focusing on "immediate flooding concerns" and "regulatory requirements" still prioritize resolving "overloaded" systems without considering distribution fairness. Communities hurt by this approach are limited to managing the consequences of reactive infrastructure failures, not decades of systematic neglect. My interviews uncovered how gaps in service and neglect in meeting service standards create systematic bias in favor of maintaining the status quo. Older infrastructure is often sidelined by service providers while new developments attract attention and compliance due to meeting current standards. Staff acknowledge ongoing barriers to meaningful community involvement. Planning Department representatives noted community involvement challenges: "Traditional public meeting formats don't always capture input from working families or renters who may be less engaged with city processes" (Fields, 2025 personal communication). Even efforts described as "Spanish translation at key meetings" or "using digital platforms to

reach younger residents" remain expert-designed frameworks. The community is invited to influence processes designed by others, which environmental justice theory calls recognition inequality.

Both departments consider green infrastructure implementation barriers primarily as technical constraints. Stormwater staff commented: "We face significant technical and financial challenges. Soil conditions in some areas aren't favorable for water absorption solutions" (Fields, 2025 personal communication). However, framing soil conditions as technical problems ignores social and political factors. This focuses on soil conditions as obstacles while overlooking how community-controlled green infrastructure represents socially driven design opportunities. Staff descriptions of "retrofit complexity in established neighborhoods" treat existing neighborhoods as unchangeable constraints and overlook how transformative involvement could change those dynamics.

Interview participants discussed unfair resource distribution as barriers to addressing inequality. As one noted, they are "balancing these investments against other pressing infrastructure needs across the city" (Fields, 2025 personal communication). However, interviews reveal how resource allocation often reflects political choices more than predetermined limits. Both departments work under funding structures that disadvantage environmental justice communities. Planning staff explained how "funding mechanisms for green

infrastructure often require matching local funds," which creates barriers for communities with limited tax bases (Fields, 2025 personal communication). The interviews reveal that environmental injustice continues through institutions, not individual actions. City staff genuinely care about resolving inequalities within established frameworks, but professional training and organizational reward structures sustain entrenched unfair systems. Staff operate within limited boundaries.

Challenging Perspectives: Responding to Counterarguments Relating to Environmental Justice

The analysis placed Costa Mesa's infrastructural inequities within the context of environmental justice. However, this reading of the situation faces some notable rebuttals that need to be taken seriously. The most powerful contending perspectives come not from ignorance of the infrastructural concerns, but from solely different conceptualizations of the city's spatial organization and urban resource distribution. It is entirely believable that city officials would defend Costa Mesa's spending patterns as a case of environmental resource allocation. Infrastructure funding is better for the newer eastside developments because they come with higher tax revenue. Furthermore, these developments adhere to city standards and yield economic benefits that, over time, improve outcomes for all residents through job opportunities and increased municipal revenue. From this stance, the Westside's outdated

infrastructure represents the inevitable infrastructure decay phase discrimination as older areas are neglected, not systematic discrimination.

Cultural and Political Resistance

More difficult to overcome than financial barriers is the environmental discrimination framework itself. A narrative that some Westside residents might wholly reject alongside a chunk of the rest of America. Explanations of environmental justice have been reframed as racial justice, and some community members do not respond well to injustice being placed on the issue. It may be questioned whether a community controlled approach will be able to achieve a carefully designed and affordable solution, and whether the successful cases from Long Beach and Santa Ana will work in Costa Mesa's different political environment. The green infrastructure improvements may also bring an increase in gentrification and displacement, thereby pricing out the very families that these improvements seek to serve. Finally, the focus on local interventions may shift the attention away from regional, county, and state level transportation, flood control, and other policies that are based on addressing problems within a wider economic framework. While these counterarguments are largely grounded in a partial perspective, they are critical to understanding the situation. The reasoning behind the counterarguments assumes that an efficient solution to the problem will be found, when

in reality, such an approach ignores the existing discriminatory practices that are embedded within the marketplace. Implementation challenges raise the need for more robust community driven design strategies, not a turn away from community controlled models. Such counterarguments in fact reinforce the need for more environmental justice by enabling strategies that build wider coalitions and stronger community control while enduring the foundational principles of race equity.

Community Resilience and Adaptation Strategies

Westside communities show remarkable resilience and adaptability in the face of systematic infrastructure neglect. Field study data document distinct response patterns from homeowners versus renters regarding infrastructure shortfalls. Homeowners show clear evidence of responding to flood risks through stored sandbags in garages, raised electrical panels, and French drain installation. These adaptations show how economic resources enable individual resilience. In contrast, rental apartment complexes show minimal evidence of flood preparedness, likely due to lack of tenant incentives and absent management responsibilities.

Community knowledge systems show sophisticated understanding of infrastructure patterns. Community awareness during winter events includes recognition of problem areas, and drivers routinely going around certain locations demonstrate consistent community

awareness of persistent flood-prone areas. Many community members know alternative routes during rain events and multiple flood-prone locations. The study documented extensive informal mutual aid networks, especially in renter-dominant neighborhoods where personal mitigation strategies are limited. These networks include coordinated efforts to communicate flooding information and clear storm drain inlets through informal channels. However, these community resources are strained during extreme events, especially during summer storms coupled with power outages.

Technical Infrastructure Assessment: Undetected Areas of Failure

Infrastructure assessment reveals that aging systems create systematic vulnerabilities that affect different areas unfairly. The Victoria Street corridor shows haphazard improvements over the past five decades, with newer sections near Harbor Boulevard having 24 inch concrete pipes with modern inlet designs, while older portions closer to the Santa Ana River keep 1960s era 18 inch pipes suffering from severe tree root problems and joint separation.

This capacity difference creates bottlenecks that make flooding worse in areas with the highest density of renters and lowest income levels. The area between Harbor Boulevard and Santa Ana River requires pump stations to prevent backflow during high river conditions. These critical systems suffer from irregular maintenance,

creating potential reliability problems. Summer electrical grid stress has proven to create reliability issues resulting in extended flooding duration of 10 to 12 hours in certain areas.

Seasonal infrastructure stress patterns reveal the aging infrastructure-climate change connection and its impact across time. Spring and summer observations documented cycles of heat expansion and contraction that produced new surface cracks in asphalt, revealing system weaknesses alongside heat expansion in concrete systems.

Economic Analysis and Cost-Benefit Details

Systematic infrastructure neglect in Costa Mesa's Westside creates substantial economic burdens that fall unfairly on the community least equipped to bear them. This analysis measures current flood damage costs while showing that green infrastructure investments offer significant long-term economic benefits alongside environmental justice outcomes.

Data from field studies conducted during the storm events of 2025 estimate that flooding in the Westside region incurs significant annual damage costs. Moderate flooding (6 to 10 inches) results in property damage for approximately 2,400 households. Using FEMA's damage assessment methods from 2023, each household suffers an average flooding damage of $3,200. Additionally, the numbers reflect that flood events can impact

regional income, including lost work time due to displacement (FEMA, 2023). For the 60.8% of Westside households that rent (U.S. Census Bureau, 2023), flood damage creates additional displacement and lost wage burdens. Based on FEMA temporary housing cost estimates and regional wage data, families incur an average of $850 per flood event on temporary housing and lost work time (FEMA, 2023; Bureau of Labor Statistics, 2024). With affected areas experiencing flooding 2-3 times annually rental households could face average annual flood-related costs of $1,700-$2,550.

Businesses along the Victoria Street corridor suffer greatly, with an estimated 180 small businesses affected during floods (Costa Mesa Business License Database analysis, 2025). Following the Small Business Administration protocols for assessing flood-related damages, ground-level businesses suffer an average damage of $8,500 per event, while restaurants and retail outlets sustain greater losses of $12,000 per event due to inventory replacement and mandated health department closures (Small Business Administration, 2023). Responding to emergency situations for Westside flooding incurs additional costs of around $89,000 per year, with overtime, equipment deployment, and debris removal accounting for the majority of spending (Costa Mesa Public Works Department, budget analysis, 2025). Storm drain maintenance and repair add an additional $156,000 annually for clearing blockages and addressing erosion from system overflow (Costa Mesa

Stormwater Department, maintenance records analysis, 2025).

Climate Change Cost Projections

The California Climate Change Center, 2022 Report projects 25-35% increases in extreme precipitation events by 2050, with storm intensities exceeding current infrastructure design standards. Engineering assessment indicates the Westside's 1960s-era 18-inch pipe systems currently operate at 85-90% capacity during moderate storms, creating critical vulnerability to increased precipitation loads. Economic modeling projects flood damage costs escalating to $12.8 million annually by 2040, representing a 280% increase from current levels. This escalation reflects both increased flood frequency and compound effects of repetitive damage on aging residential and commercial property.

Green Infrastructure Cost-Benefit Analysis

Using Long Beach's LB MUST project ($43 million for 2,000 acre feet treatment capacity) and Santa Ana's King Street project ($1.5 million for 9,000 square feet) as cost benchmarks, comprehensive green infrastructure implementation for the Westside requires approximately $31 million in capital investment over 8 to 10 years.

LB-MUST: https://longbeach.gov/pw/project 1

Benefits

- Flood damage reduction: 75-85% reduction in annual flood costs, generating $3.2-3.6 million in avoided damages annually

- Property value impacts: Green infrastructure improvement typically generates 8-12%; property value increases (Trust for Public Land, 2021). For the Westside's estimated $2.8 billion in residential property value, conservative 5% increases generate $140 million in additional community wealth

- Energy savings: Urban heat island reduction can lower residential cooling costs by $180-240 annually per household (EPA, 2023). Across 2,400 households, annual savings total $432,000-576,000

- Health benefits: EPA methodologies estimate $2.8 million in annual health benefits from air quality improvements (EPA, 2021).

Traditional concrete infrastructure replacement would cost $48 million for equivalent storm drain capacity, with ongoing maintenance costs of $2.4 million annually. Green infrastructure approaches provide equivalent capacity for $28 to 32 million while reducing maintenance requirements to $1.1 million annually, generating immediate $16 to 20 million capital savings.

Grant Funding Opportunities

- Caltrans Clean California Local Grant Program: Up to $5 million for projects demonstrating environmental justice benefits

- EPA Clean Water State Revolving Fund: 0.5-1.5% interest rates for stormwater projects

- Orange County Flood Control District: $12 million annually for stormwater improvements

Community benefit agreements can establish local hiring requirements and job training programs. Based on Long Beach's experience, implementation creates 280 to 320 direct construction jobs over 8 years, with 60% reserved for local residents through community benefit agreements. Average wages of $52,000 annually inject $16.6 million in direct payroll into the local economy. Community budget decision making pilots enable residents to directly control infrastructure investment allocation, as shown by Santa Ana's resident driven infrastructure priority success (City of Santa Ana, 2024).

Economic Justice Implications

Green infrastructure investment offers community wealth building opportunities through local purchasing requirements, job development in green economy sectors, and innovative ownership structures like community land trusts that prevent displacement through gentrification. The economic analysis shows that $31 million in green infrastructure investment generates measurable benefits exceeding $65 million over 20 years, while creating community controlled economic development that strengthens long-term resilience and self-determination. Current flood costs of $4.8 million annually will escalate dramatically under climate change without intervention, making green infrastructure both an environmental justice imperative and sound fiscal policy (Jacques, 2022).

Learning from Success: Long Beach and Santa Ana Models

My analysis of successful green infrastructure projects implemented in Long Beach and Santa Ana helps identify specific stormwater management strategies that confront and are specifically designed to solve environmental racism issues.

The environmental justice impact of Long Beach's LB MUST project extends beyond stormwater runoff reduction. This $43 million dollar project investment transforms an industrial corridor into green community space in the Willmore neighborhood while treating almost 2,000 acre feet of urban runoff annually

to reduce pollution from the Los Angeles River into Long Beach harbor. My research shows this area shares demographic similarities with Costa Mesa's Westside.

LB-MUST promotes health and active living in a community with a pollution burden exceeding the 90th percentile by replacing a polluted industrial facility with landscaped parks. Community involvement through construction participation provided paid work opportunities, enabling community control over local job development alongside real project impacts. Through special filters and water treatment processes, the facility treats 2 million gallons of water daily during construction. This is accompanied by irrigation using cleaned water, underground stormwater systems, vegetation featuring native drought-resistant grasses and shrubs, and community amenities including walking loops.

Funding strategies show how diversified approaches can reduce dependence on development-driven revenue. The project combined $28 million from California Department of Transportation, $1 million from Port of Long Beach, $1 million from local sales tax, and $10.8 million from Los Angeles County water infrastructure tax.

Santa Ana's King Street Urban Greening Project offers a refined model of neighborhood level intervention to achieve enhanced community value. The project repurposed 9,000 square feet of public space into community green space for stormwater

King Street Urban: https://www.ymf-oc.o 2

management, costing $1.5 million.

This project shows how to apply green infrastructure to solve diverse community problems at the same time. It provides these technical features: an underground stormwater system, two rain gardens that temporarily store about 117,000 gallons of stormwater per storm from a 10 acre drainage area, and community benefits including drought tolerant native plants, new waste disposal bins to minimize litter entering storm drains, improved lighting and pathways, plus seating and sculptural artwork.

Public participation in Santa Ana shows innovative environmental justice policies. The city's Environmental Justice Action Committee is an example of resident driven policy innovation that moves beyond consultation to community control over infrastructure priorities. This governance innovation allows implementing projects that solve community defined issues rather than consultant defined problems.

Costa Mesa has additional insights to gain from Santa Ana's comprehensive environmental justice integration. The city's

2022 General Plan features environmental justice goals designed to combat pollution and increase investment in economically marginalized neighborhoods. The Neighborhood Initiatives and Environmental Services section provides necessary implementation capacity.

From Theory to Practice: Implementation Strategies for Environmental Justice

By combining Costa Mesa's infrastructure assessment with successful case studies from Long Beach and Santa Ana, specific, actionable implementation strategies for stormwater management that achieve environmental justice objectives can be developed.

Phase One: Building Community Infrastructure

My research demonstrates that effective environmental justice implementation starts from community governance and organizing rather than purely technical approaches. Costa Mesa should form a Westside Environmental Justice Infrastructure Committee based on Santa Ana's Environmental Justice Action Committee, with dedicated city liaison, rotating community membership, and genuine ability to shape program priorities. City support should be substantial, with committee members from each significant Westside neighborhood serving staggered two year terms to build leadership capacity among residents. City support should include bilingual staff dedicated to planning,

translated materials and meeting documentation, childcare and transportation support for meeting participants, and modest payments for participating residents. Community mapping sessions where residents document flooding and infrastructure issues alongside community assets, followed by community-led condition surveys and priority setting, help combine resident expertise with technical knowledge within community-based research frameworks. All community involvement should empower community members through paid participation in assessment and planning work, job development that builds both technical skills and community organizing capacity, and partnerships with pre-existing community organizations.

Phase Two: Pilot Project Development and Implementation

Based on my community engagement and technical assessment, pilot projects should select locations that provide maximum community benefit while meeting critical infrastructure needs. The area spanning Harbor Boulevard to Santa Ana River emerges as the highest priority, having the intersection of extreme infrastructure vulnerability, elevated community need, and high opportunity for green infrastructure implementation.

Technical design should combine community development goals with stormwater management. Key components include rain gardens that capture stormwater runoff exceeding 100,000 gallons,

underground stormwater systems that minimize space needed for community surface use, and treated water return systems that reduce community water costs. Designs could include community amenities, such as bike and walking paths linking Westside neighborhoods with the Costa Mesa trail system and Fairview Park, community gathering areas with seating, shade, and even programmable spaces, educational signs explaining watershed protection and community history, and safety-focused lighting improvements.

Construction implementation must follow Long Beach's job development model, providing paid positions for community members to engage in construction work and develop relevant skills alongside community stewardship. This includes partnerships with local trade unions for skills training, preferences for local contractors and businesses, and community oversight of construction standards and services. Pilot project funding must diversify revenue sources to reduce reliance on development-driven funding. Costa Mesa should pursue funding from the Caltrans Clean California Local Grant Program, apply for grants for compliance with California Department of Transportation's water quality requirements, explore Orange County infrastructure funding, and build coalitions with local industrial partners.

Phase Three: Success Institutionalization and Scaling

Successful pilot project

implementation should serve as a foundation for scaling green infrastructure methods across the Westside while solidifying community control over infrastructure planning. In scaling across the watershed, community benefits at the neighborhood level must be preserved, with the scaling hierarchy focusing first on community-defined priorities. Important intersectional focus areas include Victoria Street corridor improvements connecting Harbor Boulevard area projects to Mesa Verde neighborhood, Fairview Park connectivity enhancements that capitalize on existing natural retention areas, and residential street improvements that resolve localized flooding while providing access to green spaces. Each expansion should uphold integrated design principles that blend stormwater infrastructure with community development. Technical components should include expanded networks of rain gardens, installation of special pavements on residential streets that let water through, and expanding tree canopies to reduce urban heat island effects.

Technical systems should operate parallel to community systems such as infrastructure maintenance programs that develop ongoing stewardship capacity, community-maintained gardens that integrate stormwater management systems designed for community use, and meeting and event spaces that strengthen community social infrastructure. Sustained community control governance requires policy shifts that make community governance lasting. This involves changing city laws to make

community benefit agreements required for all infrastructure projects over $100,000 within environmental justice zones, establishing permanent funding practices that allocate at least 15% of annual capital improvement budget to Westside infrastructure investment, and implementing fairness impact assessment requirements.

Building city capacity should involve hiring specialized environmental justice infrastructure positions, developing community involvement protocols that facilitate participation, establishing community-driven oversight bodies, and partnering with local environmental justice organizations.

Beyond Stormwater: How Infrastructure Can Empower Communities

Analysis of green infrastructure in Costa Mesa's Westside shows possibilities that extend beyond stormwater management to self-determination, environmental justice, and civic involvement in reshaping urban environments. These findings highlight an important revelation: comprehensive green infrastructure in environmental justice communities requires changes in how cities make infrastructure investment decisions. Costa Mesa's current approach focusing on traffic volume service, highway compliance, and grant funding availability instead of fairness benchmarks systematically continues environmentally unjust outcomes. Santa Ana's Environmental Justice Action Committee offers the most innovative model for how governance can be transformed through initiatives that move beyond public

participation to resident-driven policy making, enabling community members to dictate infrastructure priorities. This model shows that achieving environmental justice requires changing power dynamics, not just improving consultations.

The committee structure addresses all three dimensions of environmental justice in a single model: process fairness through community control over agenda setting and priority development, distribution fairness through community control over resource allocation decisions, and recognition fairness through endorsement and validation of community knowledge and expertise.

Long Beach shows how larger cities can combine community control with technical capacity and regional coordination needs. The LB-MUST project site within Willmore shows explicit commitments to environmental justice, with community involvement including paid participation pathways and job development. Both models show that community control requires institutional frameworks rather than good intentions. [Santa Ana's Environmental Services](#) section provides focused staff resources for environmental justice implementation, while [Long Beach's Office of Equity](#) builds city frameworks that support community-controlled approaches and initiatives.

Costa Mesa faces both structural challenges and climate change impacts, which will intensify precipitation and strain aged electrical systems. The critical infrastructure located in the region's aging pump stations are under constant threat of overheating due to the rising summer temperatures. The extreme summer heat annually intensifies thunderstorms and creates a situation that especially harms the community already struggling with environmental injustices.

The broader community response to climate change through green community infrastructure is more effective than purely technical approaches. Infrastructure maintained by the local populace offers better community resilience because it requires a high degree of local both technical and learned skills, routine maintenance, and the ability to swiftly respond to emergency system failures.

The research shows that there are extensive informal mutual aid networks in Costa Mesa's Westside for the storm drain clearing and flooding information sharing that also extend to aiding and providing equipment in emergent situations. Technological interventions that attempt to replace community skills to address green infrastructure development actually undermine community resilience and worsens environmental effectiveness.

As with all green infrastructure, stormwater management requires consideration of cooling air quality benefits as well. In addition to bioretention systems that help mitigate the freeway and industrial emission pollution and smog in heavily impacted areas, conserving and expanding tree canopies helps combat urban heat islands which affect poor neighborhoods

with little access to air conditioning.

Summary: Working Towards Infrastructure Justice

My research shows that Westside flooding vulnerabilities in Costa Mesa result from systematic infrastructure neglect aligned with environmental racism. Meanwhile, green infrastructure developments in Long Beach and Santa Ana show community-driven models capable of addressing both stormwater management needs and environmental justice. Policy analysis explains how Costa Mesa's government frameworks continue infrastructure inequality through processes that actively exclude impacted populations from funding decisions, prioritize development interests over community needs, and use performance metrics that make environmental justice invisible. Fieldwork shows how these processes impose unfair flood vulnerability in the Westside's lowest-income areas while community adaptation strategies show remarkable resilience despite systematic neglect.

Long Beach's LB-MUST and Santa Ana's King Street Urban Greening Projects provide examples of how environmental justice principles can frame large-scale infrastructure and neighborhood-scale interventions, respectively. Both projects highlight community control over infrastructure planning as a means to meet regulatory requirements while addressing community identified needs and long-standing environmental justice goals

through integrated design blending community benefits with technical performance. Green infrastructure for marginalized communities requires policy shifts and governance realignments beyond improving consultation frameworks, as Santa Ana's Environmental Justice Action Committee shows through resident driven policy innovation. Long Beach shows how community capacity can be built alongside physical infrastructure through large-scale investments, diversified funding, and job development.

Costa Mesa must balance action plans focusing on immediate technical concerns with transformative governance restructuring. Santa Ana's successful models suggest community controlled advisory boards, targeted pilot stormwater management projects with community integration, and pursuing diversified funding that shifts away from development-centric revenue models.

Stormwater management represents one narrow aspect in the broader context of community control, power, and democratic involvement with urban landscapes. Community controlled infrastructure development not only functions to foster organizing advocacy but shows how environmental justice solutions can serve disenfranchised communities without continuing prevailing systems of oppression. Future research should assess community-controlled approaches over time, develop policies supporting environmental justice infrastructure at state and federal levels, and innovate governance systems that enhance community agency in infrastructure

planning. Ultimately, my findings suggest that the effectiveness of green infrastructure as an environmental justice tool depends upon whether communities acquire capacity to control infrastructure investment, rather than merely benefiting from expert-designed interventions.

Westside Costa Mesa shows the duality of urgent challenges and significant opportunities throughout the region to demonstrate how infrastructure can serve environmental justice when communities control planning processes. Lessons from Long Beach and Santa Ana provide applicable guidance while Costa Mesa's own community organizing capacity and political foundations support governance innovation. In addressing flooding vulnerabilities through green infrastructure using proven techniques, the question shifts to whether Costa Mesa chooses community-controlled approaches that build community power alongside physical infrastructure.

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Treated but Not Resolved: Reimagining Wastewater Infrastructure for Ecosystem and Public Health

Matthew Smith

Abstract

This capstone project critically examines the capital improvement program at the San José–Santa Clara Regional Wastewater Facility (RWF) through the lens of environmental justice, sustainability, and public health. Using the interdisciplinary MESH framework (Engineering, Sustainability, and Health), this research examines how infrastructure decisions influence and are influenced by institutional cultures, operational practices, and frontline community experiences. Drawing on ethnographic observations, interviews, and policy reviews, the project challenges technocratic definitions of improvement and proposes justice-centered approaches to wastewater planning. Findings reveal that even sustainability-oriented upgrades can reinforce inequities if governance structures do not prioritize inclusion, recognition, and ecological integrity. The study offers a critical and hopeful vision for more participatory, relational, and resilient infrastructure futures.

Introduction

Wastewater infrastructure is often perceived as a neutral utility—unseen, technical, and politically benign. Yet beneath its utilitarian façade lies a complex web of choices that influence both ecosystem integrity and community well-being. This capstone project begins with a critical question: How can the capital improvement program at the San José–Santa Clara Regional Wastewater Facility (RWF) be restructured to reduce environmental injustices and mitigate the negative impacts of climate change on ecological and public health?

What's at stake is more than engineering performance or regulatory compliance. This project challenges the narrow assumptions embedded in the concept of "capital improvement," which is often equated with modernization,

efficiency, and throughput. Such technocratic definitions risk ignoring the cumulative health burdens, ecological degradation, and exclusionary planning processes experienced by communities living near large-scale infrastructure, which disproportionately affect historically marginalized populations in a warming world.

Anchored in the interdisciplinary MESH framework (Engineering, Sustainability, and Health), this study proposes a reorientation of wastewater planning and investment. The research draws on five interwoven components: (1) ethnographic field observations at the RWF and its surrounding neighborhoods, (2) in-depth interviews with maintenance and operations staff, planners, and local advocates, (3) environmental health data analysis, (4) historical and policy review, and (5) a comparative case study of justice-oriented infrastructure models. While each component contributes uniquely, ethnographic observation and stakeholder interviews emerge as particularly central to understanding the facility's embedded power dynamics and daily practices, revealing the lived realities of those often excluded from decision-making processes.
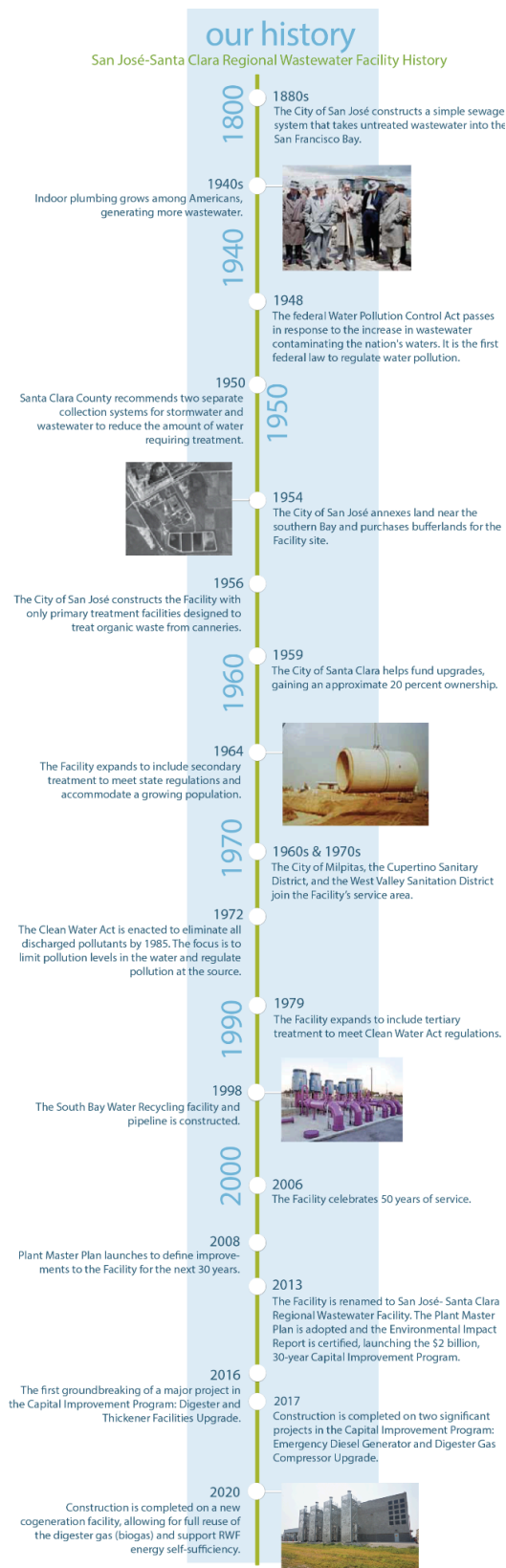
Stakeholders in this project include not only agency personnel and engineers, but also frontline communities, defined as those who live adjacent to, work within, or bear the disproportionate environmental and health burdens associated with the facility's operations. Their perspectives, often missing from conventional infrastructure discourse,

are vital to reimagining capital improvement as an equitable and regenerative endeavor.

What makes this project distinctive is its integration of frontline testimony with institutional analysis and ecological critique. Rather than treating wastewater infrastructure as a fixed technical system, the project treats it as a contested social and environmental landscape shaped by overlapping histories, governance structures, and climate pressures. In doing so, it brings new voices into infrastructure planning and reframes "improvement" through a justice-centered lens.

The San José–Santa Clara RWF serves as the case study, not only because of its size and regional importance, but because it epitomizes the friction between legacy infrastructure and emerging demands for just and sustainable futures. While rooted in the specificity of California's South Bay, the findings and methodology have broad relevance for wastewater systems globally. Ultimately, this project is not just about how we treat wastewater—it is about how we define, design, and pursue health in the systems that sustain life.

Governance of the RWF is complex and historically rooted. The Treatment Plant Advisory Committee (TPAC), formed in 1959 by a sewage treatment agreement between San José and Santa Clara, serves as a key advisory body to both city councils. TPAC oversees critical aspects of facility operation, policy formation, contract amendments, and external partnerships. While San José remains the lead agency,

our history
San José–Santa Clara Regional Wastewater Facility History

1800

1880s
The City of San José constructs a simple sewage system that takes untreated wastewater into the San Francisco Bay.

1940

1940s
Indoor plumbing grows among Americans, generating more wastewater.

1948
The federal Water Pollution Control Act passes in response to the increase in wastewater contaminating the nation's waters. It is the first federal law to regulate water pollution.

1950
Santa Clara County recommends two separate collection systems for stormwater and wastewater to reduce the amount of water requiring treatment.

1954
The City of San José annexes land near the southern Bay and purchases bufferlands for the Facility site.

1956
The City of San José constructs the Facility with only primary treatment facilities designed to treat organic waste from canneries.

1959
The City of Santa Clara helps fund upgrades, gaining an approximate 20 percent ownership.

1960

1964
The Facility expands to include secondary treatment to meet state regulations and accommodate a growing population.

1970

1960s & 1970s
The City of Milpitas, the Cupertino Sanitary District, and the West Valley Sanitation District join the Facility's service area.

1972
The Clean Water Act is enacted to eliminate all discharged pollutants by 1985. The focus is to limit pollution levels in the water and regulate pollution at the source.

1979
The Facility expands to include tertiary treatment to meet Clean Water Act regulations.

1990

1998
The South Bay Water Recycling facility and pipeline is constructed.

2000

2006
The Facility celebrates 50 years of service.

2008
Plant Master Plan launches to define improvements to the Facility for the next 30 years.

2013
The Facility is renamed to San José-Santa Clara Regional Wastewater Facility. The Plant Master Plan is adopted and the Environmental Impact Report is certified, launching the $2 billion, 30-year Capital Improvement Program.

2016
The first groundbreaking of a major project in the Capital Improvement Program: Digester and Thickener Facilities Upgrade.

2017
Construction is completed on two significant projects in the Capital Improvement Program: Emergency Diesel Generator and Digester Gas Compressor Upgrade.

2020
Construction is completed on a new cogeneration facility, allowing for full reuse of the digester gas (biogas) and support RWF energy self-sufficiency.

seven partner cities and sanitation districts discharge to the facility under various master agreements. This governance structure shapes how priorities are set and projects approved—yet TPAC's public visibility and participatory mechanisms remain limited, raising questions about how procedural justice is practiced within capital improvement decision-making.

This review synthesizes the literature across six domains relevant to my project: (1) Sustainable and Just Wastewater Management, (2) Environmental Justice and the Right to Infrastructure, (3) Participatory Planning and Public Trust, (4) The Role of Institutional Knowledge and Workforce Experience, (5) Storytelling and Science Communication, and (6) Critical Perspectives on Technocratic Improvement. My project makes an original contribution by integrating these literatures through the lens of the MESH framework, Engineering, Sustainability, and Health, and by grounding them in detailed site-specific reflections from my experience and interviews at the RWF.

Figure 1 (Left) Courtesy of San Jose Environmental Services Division

Literature Review: Engineering Infrastructure for Justice, Sustainability, and Health

Introduction: Reimagining Wastewater Infrastructure as a Site of Social Change

As cities confront the dual crises of

Flows of Justice
A Community Map of the RWF and Its Surroundings
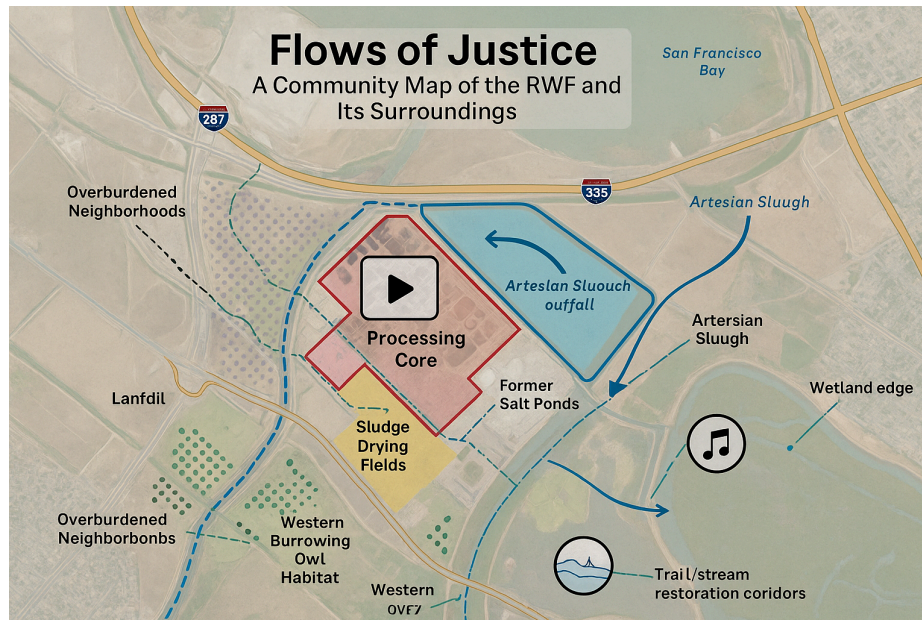
climate instability and aging public infrastructure, wastewater systems like the San José–Santa Clara Regional Wastewater Facility (RWF) are being asked to do more than treat effluent. They must now mitigate greenhouse gas emissions, withstand climate shocks, protect public health, and reflect community values. However, existing literature on wastewater infrastructure often emphasizes efficiency, engineering performance, and environmental compliance, while neglecting questions of justice, governance, and epistemic inclusion. My Capstone Project intervenes in this space by offering a multi-scalar, justice-centered account of infrastructure improvement that challenges dominant planning assumptions and integrates operational expertise, frontline labor, and local narratives.

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Sustainable and Just Wastewater Management

The technical literature on wastewater treatment has primarily focused on the ecological modernization of treatment plants, optimizing energy recovery, reducing nutrient loads, and integrating principles of

the circular economy (McCarty et al., 2011; Guest et al., 2009). These models frame sustainability in terms of metrics and performance, focusing on the amount of biogas captured, the number of kilowatts offset, and the amount of nutrients discharged into receiving waters.

At the RWF, for example, these principles are evident in the development of the Energy Management Strategic Plan (EMSP) by Black & Veatch (2022), which outlines proposals for cogeneration, FOG acceptance, and biosolids processing to achieve energy neutrality. This document reflects a broader trend in the literature that sees sustainability as a systems optimization problem—an approach that is technically rigorous but politically thin.

My Capstone challenges this framing by emphasizing that **sustainability is not solely a matter of design performance, but also of governance, legitimacy, and inclusion.** For example, my interviews reveal how frontline staff often resist upgrades not because they oppose sustainability, but because they understand from lived experience how new technologies can be brittle, poorly integrated, or driven by external image management rather than internal functionality. My work thus contributes to a new wave of infrastructure scholarship that argues sustainability transitions must be rooted in institutional culture, relational accountability, and community-defined needs (Chandler & Reid, 2020).

Environmental Justice and the

Right to Infrastructure

Environmental justice (EJ) literature has consistently demonstrated how infrastructure systems—from highways to waste sites—have historically burdened low-income and BIPOC communities while prioritizing elite users (Bullard, 2000; Pellow, 2017). More recent expansions of EJ theory include not only distributive injustice (who is exposed to harm) but also procedural injustice (who has a say in planning) and recognitional injustice (whose knowledge counts) (Walker, 2009; Fraser, 2008).

My project builds upon this tripartite model by illustrating how even "green" infrastructure can perpetuate harm if it fails to include or reflect frontline perspectives. You move beyond the classic siting problem (where facilities are located) to show that **injustice also occurs within the governance of infrastructure renewal**, especially in how decisions are made, framed, and communicated. In doing so, my Capstone contributes to EJ by introducing a new analytic site: the capital improvement process of an already existing facility. This reframes the plant not just as a static object of risk, but as a dynamic terrain of contestation over values, knowledge, and futures.

Participatory Planning and Public Trust

Planning literature has long promoted participatory models, arguing that public infrastructure must be accountable to

the communities it serves (Feldman, 2017; Arnstein, 1969). However, participatory ideals are often difficult to realize in practice, especially within large, technically complex utilities like RWF. The literature frequently notes that public meetings tend to be extractive, jargon-laden, or symbolic (Forester, 1999).

The presence of advisory bodies such as the Treatment Plant Advisory Committee (TPAC) illustrates formal avenues for institutional deliberation. However, TPAC meetings—held monthly at San José City Hall and governed under the Brown Act—often function as procedural gateways rather than sites of transformative engagement. While they play a crucial role in overseeing contracts, amendments, and use agreements, their composition and agenda-setting authority can limit the depth of community participation, especially from frontline residents who may not see their lived concerns reflected in formal deliberations.

My Capstone advances this critique by proposing concrete interventions for **rebuilding trust and transparency** in infrastructure planning. For instance, I suggest designing collaborative forums that include operators, engineers, and community liaisons in the early stages of project scoping. My emphasis on storytelling, co-design, and sonic metaphors extends participatory theory beyond procedural checklists, highlighting the emotional, sensory, and ethical dimensions of engagement.

In doing so, you help bridge the gap between participatory theory and infrastructure reality—what James Holston (2009) might call "insurgent planning" grounded in lived practice. My project builds on, but also critiques, the assumption that participation can be engineered through process alone. Instead, you suggest it must be cultivated through **ongoing relationships, trustworthiness, and shared meaning-making**.

Institutional Knowledge and the Labor of Infrastructure

Infrastructure studies often celebrate engineers and designers while undervaluing the knowledge of those who operate, maintain, and repair systems (Star, 1999; Graham & Thrift, 2007). My interviews reveal the immense expertise held by long-term plant staff—operators who understand the facility's rhythms, quirks, and risks in ways that cannot be captured by modeling software or design drawings.

This challenges dominant engineering epistemologies that prioritize abstraction over experience. My project aligns with feminist and labor-oriented scholars who emphasize **care, maintenance, and interdependence** as essential to infrastructure resilience (Elish, 2019; Russell & Vinsel, 2020). By documenting operator concerns about unfamiliar equipment, under-resourced commissioning phases, and management blind spots, we can elevate their knowledge from anecdotal to **theoretical and strategic**.

In this way, my project contributes to the call for "epistemic justice" in infrastructure, ensuring that decisions are not only inclusive but informed by the full range of knowledge needed to make systems work for all.

Storytelling, Science Communication, and the Ethics of Representation

The present science communication literature increasingly recognizes that facts alone do not persuade—people engage with environmental issues through narratives, symbols, and emotions (Nisbet & Scheufele, 2009; Davies, 2019)—a perspective reflected in my Capstone experiments, which utilize **storytelling as both method and message**. The metaphor "treated but not resolved" captures the ethical ambiguity of improvement. My sonic reflections explore how infrastructure "sounds" to different listeners—residents, workers, fish, and regulators. These approaches reflect a growing movement toward multimodal, sensory, and justice-oriented environmental communication.

My project adds to this literature by demonstrating that narrative is not a tool for simplifying complexity—it is a **way of holding complexity**. By juxtaposing technical detail with personal accounts, my work models a more reflexive, ethical, and creative form of engineering communication. This aligns with recent scholarship on infrastructural aesthetics (Howe et al., 2016) and speculative design (Dunne & Raby, 2013), which argue that

imagination is as vital as calculation in shaping just futures.

Challenging the Logic of Improvement

Ultimately, my project engages with a more profound philosophical critique: What constitutes "improvement"? In both policy and engineering discourse, improvement is typically framed as a linear process of optimization, encompassing improved performance, increased efficiency, and reduced emissions. Yet my Capstone shows that these metrics can obscure more profound questions:

Improvement for whom? At what cost? Who decides?

This critique resonates with scholars like Arturo Escobar (2018), who challenge the developmentalist logic of technical progress and propose "pluriversal" approaches to infrastructure rooted in community-defined goals and ecological ethics. My reflections reveal how even well-intentioned upgrades can exacerbate inequities if not accompanied by participatory governance, transparent accountability, and long-term relational care.

By interrogating the assumptions underlying capital improvement programs, my project does more than critique—it opens space for alternative imaginaries of infrastructure improvement grounded in justice, health, and sustainability.

Conclusion: Toward a Just Infrastructure Future

My Capstone contributes to a growing but still underdeveloped field that links infrastructure studies with environmental justice, science communication, and participatory governance. Its unique strength lies in its synthesis: rather than treating engineering, storytelling, and ethics as separate domains, you treat them as interdependent. This approach reflects the complexity of real infrastructure systems and the communities they serve.

Ultimately, my literature review and broader Capstone provide a new template for infrastructure analysis: one that upholds technical rigor without losing sight of justice, values lived experience as expertise, and invites diverse publics into the complex, hopeful work of system transformation.

Methodology: Situating Knowledge, Centering Justice

My Capstone project examines how capital improvement efforts at the San José–Santa Clara Regional Wastewater Facility (RWF) reflect or fail to reflect environmental justice, public health, and sustainability principles. Rather than treating infrastructure planning as a purely technical endeavor, I approach it as a complex, contested, and profoundly human process shaped by institutional cultures, community relationships, and ecological systems. Accordingly, my methodology is **interdisciplinary, mixed-method, and reflexive**, grounded in both traditional systems analysis and critical inquiry into power and recognition.

Framing the Inquiry: Beyond Methods to Meaning

Rather than begin with a predetermined list of methods, I grounded this inquiry in a **constructivist epistemology**, one that treats knowledge as situated, relational, and co-produced. Inspired by feminist and Indigenous scholarship, as well as critical systems thinking (CST), I adopted a methodology that seeks to de-center dominant narratives and make space for frontline voices—those too often overlooked in capital project discourse. I approached the wastewater facility not merely as an engineering site but as a social field—a space of overlapping perspectives, constraints, and aspirations.

Methodological Commitments and Guiding Questions

Three commitments guided the methodology I developed:

1) Decentering technocratic assumptions in infrastructure decision-making.
2) Centering stakeholder voices, especially operational staff and overlooked communities.
3) Linking environmental sustainability with procedural and recognitional justice.

Guiding questions included:

- What systems of power and knowledge shape capital project design?
- How do workers and community

members define "improvement" differently from engineers or managers?

- What alternative models exist that better integrate justice, health, and sustainability?
- How do definitions of "improvement" in water infrastructure reflect or obscure systemic injustice?
- What would it mean to design and govern the RWF in a way that centers community well-being, ecological resilience, and intergenerational accountability?

Mixed Methods: Integrating Quantitative Structure and Qualitative Depth

The methodological architecture of the project includes five key components:

Literature and Policy Review

I began by conducting a robust review of peer-reviewed and gray literature related to sustainable infrastructure, environmental justice, and wastewater governance. This included:

- Scholarly work on circular economy, equity in infrastructure, and MESH principles.
- Planning documents, such as CEQA filings, council meeting minutes, and the *2022 Energy Management Strategic Plan* (prepared by Black & Veatch).
- Critical literature interrogating technocratic paradigms, including

works by Pulido, Fraser, and Boelens.

This review helped me identify dominant narratives—especially around optimization, compliance, and technological progress—and their blind spots, such as the absence of indigenous perspectives, gendered labor analysis, or frontline epistemologies.

Site-Based Observations and Embedded Fieldwork

As a professional embedded in the RWF ecosystem, I conducted **reflexive field observations** across different physical and operational domains of the plant. This included:

- Walkthroughs of sludge treatment systems, outfall channels, and energy facilities.
- Auditory and visual data capture (e.g., soundscapes of lab area with bird sounds, flow patterns, interpretive signage).
- Reflective journaling on the juxtaposition of engineered and ecological elements.

These observations allowed me to document the spatial politics of infrastructure—the tension between designed efficiency and ecological messiness—and to interrogate the invisible labor that sustains daily operations.

Semi-Structured Interviews and Oral Histories

I conducted in-depth interviews with three key stakeholders from within the facility. As part of the interview process, I sought and received informed consent for participation from two of the three interviewees. One chose to remain anonymous.

- Alex Rodriguez (Operations Division Manager)

- Robert Cuellar (Maintenance Division Manager)

- "Johana" (Anonymous project manager)

Each interview followed a semi-structured guide, exploring themes such as sustainability, operational responsibility, equity, and long-term visioning. Importantly, these conversations were guided by open-ended prompts, including:

"If you had $2 billion and a clean slate, how would you redesign the RWF?"

These dialogues revealed a range of values—from technocratic feasibility to ancestral legacy—and exposed fault lines in institutional cultures, communication, and definitions of justice. I transcribed, coded, and analyzed these interviews thematically, aligning findings with MESH categories and justice frameworks (procedural, recognitional, distributive).

Comparative Case Analysis

To extend insights beyond the RWF, I began mapping comparative models in decentralized and justice-centered wastewater management:

- NEWater (Singapore)
- Hyperion Plant (Los Angeles)
- Global South participatory governance models (via Boelens et al.)

These cases served as benchmarks and provocations, helping to clarify what "equity" might mean in practice and to challenge the RWF's existing assumptions about scale, centralization, and public participation.

Self-Reflexivity and Positional Analysis

As someone with decades of experience in wastewater project delivery, I recognized that my positionality could both enrich and constrain the research. I continually questioned how my identity—as a construction management professional, middle-class Californian, and MESH student—shaped what I noticed, whom I prioritized, and how I interpreted data.

Throughout the project, I actively tracked shifts in my assumptions—for instance, moving from a trust in capital

planning logic to a recognition that institutional memory, worker dignity, and intergenerational community wisdom are equally valuable forms of knowledge. Inspired by Anna Tsing's metaphor, I aimed to be a "hair in the flour," introducing productive tension into dominant planning discourses.

Stakeholder Engagement: Navigating Polyvocality

A key feature of this methodology is its commitment to **polyvocality**—the idea that infrastructure planning must draw from multiple knowledge systems and value sets. Although TPAC represents an institutional site where various municipalities and interests converge, its structure and

processes rarely prioritize participatory justice beyond agency representatives. For this reason, my engagement strategy aimed to amplify voices beyond those typically represented in TPAC proceedings, underscoring the need to democratize infrastructure governance more fully.

While technical professionals offered insight into constraints and innovations, operators and maintenance staff illuminated the emotional labor, improvisation, and resilience required to keep the system functional. Meanwhile, Johana's community-centered lens reminded me that infrastructure is never neutral—it distributes risks and benefits along lines of race, class, and geography.

Engagement tools included:

- Stakeholder mapping across internal and external groups
- Storytelling-based interviews
- Aspirational planning for participatory design workshops using visual tools

These engagements were guided by the principles of recognitional justice, which treat all forms of knowledge—lived, professional, indigenous, and bureaucratic—as worthy of consideration in shaping infrastructure futures.

Methodological Challenges

This approach was not without limitations:

- Access to external community voices was limited due to time and

institutional gatekeeping. Future phases may require public records requests or partnerships with EJ organizations.
- Participatory design tools were envisioned but not fully implemented, partly due to capacity constraints.
- Ethical questions surrounding anonymity, influence, and advocacy persist, particularly given my dual role as both practitioner and researcher.

However, I embraced these challenges as opportunities for growth. They exposed the structural barriers to inclusive planning and underscored the need for future work that moves beyond analysis into co-creation.

Conclusion: Toward Just Infrastructure Practice

This methodology is more than a set of tools—it is a political stance. It asserts that wastewater planning must go beyond metrics to ask: *What systems are we reinforcing? Whose futures are we prioritizing?*

By integrating systems analysis with narrative insight, participatory intent, and self-reflection, this project positions methodology not as a neutral scaffold but as a site of transformation. I hope that these methods—and the commitments behind them —contribute to a broader conversation about how infrastructure can become not just more efficient, but also more equitable,

relational, and just.

Results and Discussion: Treated But Not Resolved

A justice-oriented reading of infrastructure modernization at the San José–Santa Clara Regional Wastewater Facility

Infrastructure doesn't just treat water—it also reflects and reproduces power. And unless we change who gets to shape it, the treatment will always stop short of resolution.

What emerges when a wastewater facility becomes more than its pipes and permits—when it is viewed through the lived experiences of its workers, the policy frameworks that shape its design, and the communities it surrounds? This Results and Discussion section distills the findings I discovered through field visits, stakeholder interviews, systems analysis, and sustained engagement with the literature on infrastructure justice.

The framing question remained constant throughout:

Who defines, and what is defined as, "improvement" in the design and delivery of sustainable water infrastructure?

By integrating MESH principles—**Engineering, Sustainability, and Health**—I sought not only to evaluate infrastructure outcomes, but to uncover the power structures, narratives, and relationships that make those outcomes possible or impossible.

What I Set Out to Learn

This project began with a deceptively simple question: **How can the capital improvement program (CIP) at the RWF be restructured to reduce environmental injustices and mitigate the negative impacts on ecosystems and human health due to climate change?** At its core, this was a challenge to technocratic assumptions—namely, that infrastructure upgrades always equate to progress, and that compliance is synonymous with justice.

What emerged, however, was a more complicated story—one of **hidden labor, institutional inertia, operational wisdom, and enduring community harm**.

What I Discovered

Operational Staff Know More Than We Think

In multiple interviews with long-tenured operations and maintenance professionals, I was struck by the **depth of tacit knowledge** that shaped their perspectives. One operations manager, Alex, emphasized how trust, responsibility, and experience influence daily decision-making. He described cogeneration upgrades and odor control projects as improvements not just for the plant, but for worker morale and community relations.

Alex Rodriguez, Operations Division Manager, personifies what infrastructure theory often misses: the embodied, experiential knowledge of those who keep

127

systems running day and night. His interview traced a trajectory from warehouse worker to operations leader, revealing a culture in transformation.

"We were scared to make mistakes," Alex said. *"Now I tell my team: Make the decision. That's how you grow."*

For Alex, sustainability is about continuity—retaining institutional memory, ensuring plant uptime, and maintaining safe, efficient processes. His praise for cogeneration (Cogen) systems, which provide two-thirds of the plant's energy, was tempered by a warning: without reliability, green systems fail under pressure.

His vision for a new RWF focused not on flashy innovation, but enclosure of tanks, reduced chemical use, odor control, and community integration. The environmental vision was inseparable from cultural memory—his grandfather poured concrete at the plant decades ago. "Full circle," he said.

"You don't get sustainability if your team is burning out. We make this place run, not the specs." —Alex, RWF Operations Division Manager.

This grounded voice contrasted sharply with top-down assumptions about what success looks like. Where city planners saw progress in energy metrics, operators saw fragility in design choices that overlooked maintenance and safety.

Maintenance and Materiality: Durability as Sustainability

If Alex offered an empathic perspective from operations, **Robert Cuellar**, Maintenance Division Manager, brought a hard-edged pragmatism rooted in decades of mechanical experience. He viewed many capital upgrades with suspicion.

"We're just painting over wallpaper of a Victorian house with failing bones."

Robert's skepticism reflects a **durability ethic** often overlooked in sustainable design. He pointed out how legacy infrastructure from the 1970s still outperforms some modern replacements. "New DAF tanks fail in two years. The old ones? Still working."

He was also candid about the organizational challenges—procurement delays, safety compliance gaps, and a lack of respect for frontline experience. Yet, amid the frustration, there was hope, mentorship, team cohesion, and a deep sense of responsibility for future generations of workers.

Robert, a maintenance supervisor, revealed the tension between past and future infrastructures. In his words, *"the new stuff breaks faster than the old stuff."* His critique was not anti-modernization, but instead a call to **honor longevity and usability**—to move away from designs that fail under field conditions. He provided several examples of recent equipment failures, unstaffed maintenance needs, and contractor errors that have not been adequately addressed in planning documents. This raises concerns not just about infrastructure resilience, but

organizational accountability.

Planning and Policy: Institutional Logics and Constraints

A third voice—referred to as *Johana* for anonymity—spoke from the strategic level of the CIP Management Team. Her insights reveal the **systemic constraints and political trade-offs** that define what's feasible in capital planning. She described a department navigating **conflicting agency priorities, budget ceilings, and regulatory mandates**, all while trying to maintain community trust:

"We're doing everything right, but we still worry people will only see what's wrong."

Her comments illustrate the **tensions between transparency and control**—between the desire to share complex decisions and the fear of public misunderstanding. While equity and sustainability goals were acknowledged, they often took a backseat to cost containment and technical compliance.

"Sometimes, equity depends on how much a partner city is willing to spend."

Johana's strategic role is situated within the broader institutional ecosystem, shaped by TPAC, which advises on a range of matters, from rental agreements to capital contracts. However, the influence of TPAC is both significant and constrained—it reinforces inter-agency negotiation while remaining advisory in nature. Decisions ultimately rest with the San José City Council, reinforcing Johana's concern that even well-structured internal planning may feel opaque or insufficiently accountable to the broader public.

Cross-Cutting Themes and MESH Reflections

The interviews and observations yielded multiple themes that cut across roles, revealing more profound insights into the justice landscape at the RWF.

	Alex (Operation	Robert (Maintenance)	Johana (Plannin
Sustainability	Cogeneration; Reduced chemic use	Equipment reliability; Maintenance strategy	Energy transitio plans; Budget limitations
Health	Staff well-being Off-shift communication	Safety complianc Mentorship	Regulatory compliance, od complaints
Equity	Empowerment culture; Legacy Pride	Lost institutiona knowledge	Funding disparities; Publi trust
Justice	Staff recognition design	Voice through action, not title	Procedural avoidance of controversy

Interpreting Divergent Voices in the RWF Ecosystem

Treated but Not Resolved: Mapping Justice Across Technical Terrain

As I continue to analyze the three interviews conducted at the San José–Santa Clara Regional Wastewater Facility (RWF), I notice that each participant's perspective reflects a distinct facet of the MESH framework. Although they all operate within the same system, they interpret sustainability, health, and justice in divergent ways, highlighting the complexity

of managing and constructing large-scale municipal infrastructure in a just and equitable manner.

This project diary builds on my central capstone question: Who defines, and what is described as, 'improvement' in the design and delivery of sustainable water infrastructure? How do frontline communities and facility insiders perceive these outcomes? I aim to explore how MESH principles—Engineering, Sustainability, and Health—function not only as planning metrics but also as tools for critical reflection and justice.

symptoms of inequity without confronting deeper systemic issues. This framing pushes me to ask: What unresolved issues underlie even well-intentioned projects? Who bears these burdens?

Divergences in Focus: Technical, Operational, and Strategic Lenses

Alex, the Operations Division Manager, emphasized the importance of long-term operational reliability and institutional memory. He grounded his responses in practical knowledge—what he called "boots-on-the-ground logic"—and

Contrasting Approaches in Wastewater Infrastructure

	Technocratic Approach	Community-Led Approach
Sustainable Wastewater Infrastructure	Focus on technical efficiency and centralized systems	Decentralization prioritizes lived expeience
Environmental Justice	Equates justice with outcome disparities	Redefine justice to include voice recognition
Community Governance	Expert-driven, top-down planning processes	Participatory models include plural knowledge and power oditics

This review not only reveals thematic gaps but also frames a methodological imperative: the need to understand infrastructure not just as a technical system but as a sociopolitical terrain shaped by conflict, cooperation, aned contested futures.

The title "Treated but Not Resolved" plays on both the facility's technical function and the lingering social questions behind infrastructure planning. Just as treated wastewater may still contain contaminants, infrastructure planning may address

prioritized design decisions that protect staff safety, maintain plant uptime, and preserve legacy know-how. He focused firmly on management and health, particularly occupational health and continuity, and he advocated for procedural justice by urging

designers to include staff voices.

Johana, who works more directly in planning and design, emphasized the importance of efficiency, permitting constraints, and the need to balance environmental goals with practical timelines. Her perspective centered on technical and managerial concerns, aligning with the environmental and sustainability pillars of MESH. However, she approached justice more abstractly, often equating it with compliance or feasibility rather than equity or lived experience.

Johana, who engages in community outreach and policy development, strongly emphasizes justice as a form of recognition. She described the lack of access to clean water infrastructure among marginalized communities and envisioned the potential for transformative change when equity stands at the center of MESH applications. For her, sustainability must extend beyond ecology and include the social question: Who benefits, and who bears the burden?

Throughout these conversations, I also reflected on my assumptions. Johana especially challenged my belief that technical excellence naturally produces a public good. I began to question how I define "progress" and "feasibility," and realized that even well-managed systems can fall short in their moral and social responsibilities.

Tensions and Takeaways

These differences don't signal contradictions but rather distinct entry points into the same ecosystem. Together, they reveal how large municipal projects become fragmented when stakeholders lack shared goals. For example, Alex's concerns about staff scheduling during commissioning phases may appear disconnected from Johana's focus on marginalized communities. Yet both issues raise questions of justice: Who receives protection, and who bears the risk?

Johana often used "feasibility" to set boundaries—what we can accomplish within the current permitting and budgetary frameworks—and asked whether those boundaries themselves uphold justice. That tension deserves attention in discussions of environmental justice and governance, as it opens pathways beyond technical rationality and toward inclusive, deliberative processes.

Johana's focus on justice as recognition also led me to explore theoretical frameworks that support this idea. Nancy Fraser's work proves especially relevant, particularly her argument that recognition is not a supplement to redistribution but a condition for it. In *Rethinking Recognition* (2000), Fraser explains how misrecognition prevents equal participation, which directly impacts infrastructure design. If planners fail to recognize communities in the early phases, those communities won't benefit from the outcomes.

Integrating MESH with Social Justice in Design

The RWF modernization project

involves more than engineering—it initiates a social negotiation. The interviews reinforce the need to elevate social justice across MESH principles. For example:

- Improvements must go beyond efficiency and incorporate equitable workforce policies, inclusive decision-making processes, and strategies for retaining institutional knowledge (Alex's concern).
- The environment must address more than emissions or discharge—it must protect communities' rights to healthy living spaces (as Johana highlighted).
- Sustainability must force us to ask: Sustainability of what? And for whom? This concern was raised in all three interviews.
- Health must move beyond occupational safety to include public health, especially for those living near outfalls, digesters, or truck routes (a point Johana made, and Robert largely overlooked).

Each perspective offers partial insight, not in a limiting sense, but because of each participant's position and responsibility. Their voices gain clarity when placed in conversation, weaving a more complete picture of what justice in infrastructure might look like.

Thematic Analysis: Core Findings from Fieldwork

From my interviews, policy reviews, and on-site observations, I distilled five major themes that respond to the research question and deepen our understanding of justice in wastewater infrastructure.

Theme 1: Institutional Definitions of "Improvement" Are Misaligned

City agencies and consultants often define success in terms of metrics, such as reduced emissions, lower energy use, and shorter capital delivery timelines. But inside the facility, success is **relational**: does it reduce exposure? Does it last? Can we maintain it?

"I would say the biggest challenge that I have is the hoops, the Red Tape? It takes a long time to get all parties to agree, right?" —Robert

Environmental gains at the RWF, such as reduced odor emissions and the implementation of cogeneration systems, reflect a sincere institutional commitment to climate-responsive planning. However, without community-based environmental indicators—such as how odor or noise are experienced at the fence line—these gains may not benefit the surrounding communities equitably. Additionally, the facility's relationship with local ecosystems remains transactional, rather than regenerative. A justice-aligned environmental strategy must consider cumulative impacts, cultural ecological values, and indigenous relationships to water and land.

"We don't get asked until after the system's installed." —Robert

This disconnect leads to upgrades that are technically sound but fail in real-world applications, especially when they sideline operator expertise.

Theme 2: Sustainability Is a Social Contract

Sustainability is often portrayed as an engineering outcome (e.g., LEED certifications, carbon offsets), but at RWF, sustainability also encompasses **maintaining staff cohesion, knowledge transmission, and community trust**.

Traditional sustainability at RWF is assessed through energy use reduction, infrastructure longevity, and compliance with LEED-equivalent metrics. Yet, interviews made it clear that sustainability is also about people: retaining talent, avoiding burnout, and mentoring the next generation. Robert's comment that "the new stuff breaks faster than the old stuff" reflects not only a poor material choice but also a misalignment between procurement logic and the ethics of care and maintenance. A MESH-grounded approach would redefine sustainability as the capacity to endure—not only in materials but in relationships and institutional memory.

"I'm trying to give them pathways to grow themselves and then be able to manage people, but also helping them, you know, deal with some of those personal issues."
—Alex

Alex's commitment to team building and his concern about burnout point to a deeper interpretation: you can't build

sustainable systems with **unsustainable labor practices**.

Theme 3: Community Impacts Remain Uneven and Under-addressed

Despite substantial investments in odor control, complaints from the neighborhood persist. Many of these frontline residents belong to historically marginalized communities.

Public health and occupational health remain siloed within current planning documents. Workers describe symptoms such as fatigue, exposure to extreme conditions, and stress resulting from under-resourcing and irregular working hours. These are not isolated grievances—they represent systemic health gaps. Moreover, community health concerns related to air quality and odor remain poorly documented or formally dismissed. A MESH-aligned health approach would triangulate occupational exposure data with community feedback, integrating both into

environmental health assessments.

A planner acknowledged this contradiction: *"We've spent millions on upgrades, but some people still think we're dumping sewage into the Bay."*

This quote reflects a deeper failure, not of engineering, but of **public trust and participatory communication**. The absence of clear, sustained dialogue has led to persistent misconceptions and a lack of ownership over environmental gains.

Theme 4: Environmental Health Requires Expanded Metrics

My review of air quality reports and odor monitoring logs reveals a narrow regulatory lens. Compliance with state and regional air standards is regularly achieved; however, workers report experiencing headaches, fatigue, and other symptoms during periods of peak operational activity.

Taken together, these findings suggest a deeper integration of MESH into capital planning processes—not just as a post-project evaluation tool, but as a guiding framework that spans from ideation to ribbon-cutting. This approach could redefine infrastructure not merely as a set of physical systems, but as a living network of relationships, responsibilities, and rights.

"We succeed in energy usage when our cogens are working, and we are minimizing our chemical use." —Alex.

This gap between reported data and lived experience aligns with Nixon's concept of **"slow violence"**—harms that are diffuse,

delayed, and difficult to measure. It also suggests a need to include **subjective well-being and mental health** in environmental health impact assessments.

Theme 5: Procedural Justice Remains Elusive

The planning staff I spoke with expressed genuine commitment to sustainability and justice, but also voiced **institutional fears** about transparency.

"We can't afford another lawsuit. So, we don't share too much." —Robert

This risk-averse culture has stymied procedural inclusion. Rather than involving community members or frontline staff in early-stage planning, decisions are often made behind closed doors and only "socialized" once funding is secured.

This confirms earlier findings in the literature: procedural justice is not just about meetings—it's about **when and how people are invited to participate in shaping decisions** (Walker 2012).

Linking Findings to the Literature

Each of these themes aligns with, complicates, or extends current scholarship on environmental justice and infrastructure:

- **Fraser's model of justice as recognition** (2000) is echoed in how operator knowledge is dismissed or sidelined.
- **Schnaiberg's "treadmill of production"** (1980) is reaffirmed: the push for capital expansion

outpaces capacity for inclusive governance or ecological recovery.

- **Nixon's "slow violence"** framework (2011) is crucial for understanding odor, fatigue, and worker strain.
- My framework, developed through MESH, proposes that justice requires **convergence between engineering, sustainability metrics, and health equity.**

Did I Answer My Research Question?

Yes—and uncovered deeper layers. The question was whether CIP projects at the RWF could reduce injustices and improve ecosystem and public health. The answer is: **they can, but not yet.** What matters is not just what is being built, but **who defines improvement, who is heard, and who is protected.**

I asked Alex, "How do you define the environmentally responsible operation of the RWF?"

"Protecting the environment, community, residences, and wildlife." —Alex

In current practice, infrastructure success is primarily defined by capital budgets and delivery timelines. But my findings show that justice-aligned infrastructure must also value:

- **Operational continuity**

- **Community relationships**

- **Worker well-being**

- **Local ecological recovery**

Why This Matters Now

As climate change accelerates, wastewater systems are under pressure to become more efficient, sustainable, and resilient. But without structural change in how projects are scoped, designed, and governed, we risk reinforcing old patterns with new tools.

This project shows that **justice is not a checkbox in the project scoping form—it's a process that must be embedded in every phase of infrastructure development.**

Infrastructure doesn't just treat water—it also reflects and reproduces power. And unless we change who gets to shape it, the treatment will always stop short of resolution.

What I'm Proud Of

What excites me most about this project is that it has remained grounded in people, in place, and in the messy realities of how infrastructure works—not just on paper, but in practice. The interviews I conducted with operations staff, maintenance personnel, and project managers weren't just data points; they were invitations to listen differently. To recognize wisdom in nontraditional forms. To acknowledge that a wastewater facility, often rendered invisible or inert in public imagination, is a dynamic, living system that reflects our social values—our priorities, our exclusions, our potential.

I'm proud that my project doesn't treat sustainability as a buzzword. It interrogates sustainability through the lens of health, labor, racial equity, and intergenerational ethics. It attempts to tell a

more complete story—one that includes those who clean our water, who walk the tunnels, who carry the institutional knowledge, and who will inherit what we leave behind.

This aligns with my values as a scholar-citizen, a title I am now unpacking more deeply. What does it mean, and what responsibilities does it carry? To me, being a scholar-citizen requires both rigor and humility; it means seeking knowledge that serves the public good, even when that requires holding tension or surrendering the idea of being the "expert." I want to be part of work that doesn't just mitigate harm but actively expands justice—work that seeks not only compliance, but care.

Where I Feel Uncertain

And yet, with that hope comes unease. I remain unsettled by the proximity of my project to the very systems it critiques. How do you interrogate capital improvement logic when you are also working within and benefiting from it? How do you propose justice-oriented infrastructure changes without co-opting or sanitizing the struggles of those you claim to represent?

I worry about speaking for instead of with. I worry about the distance between language and action. I worry about whether anything I've written will be truly legible—or actionable—to the people whose experiences shaped this work. I also worry that despite my best intentions, the institutional inertia of large public works projects might render these findings merely symbolic.

Perhaps the deepest ethical tension I feel is about impact. Is publishing a compelling, well-researched capstone article enough? Should I have pushed harder to translate this into policy briefs, union support materials, or community zines? Was I rigorous enough in asking whose knowledge was centered—and whose was still missing?

This tension has reminded me of Dwyer and Buckle's (2009) concept of the "space between"—the reality that researchers are often both insiders and outsiders simultaneously. My positionality carries contradictions. Even when researching communities, I consider my own, the "researcher" identity inevitably introduces power relations. Yet, this in-between space can also present opportunities: the ability to translate across worlds, to elevate voices that have been rendered invisible, and to question the dominant narratives that frame infrastructure decisions.

Sitting With the Paradox

I don't have tidy answers to these questions, and I'm learning to live with that. As my instructor reminded me, much of research involves learning to sit with discomfort and uncertainty, being willing to relinquish the title of "expert" and instead listen deeply to the opinions and experiences of others.

I think the ethical work of research isn't about arriving at purity or

certainty—it's about becoming a more trustworthy participant in collective change. My Capstone Project is imperfect. It reflects my learning curve, my limitations, and my subject position. But it is also earnest, rigorous, and deeply felt.

If anything, this tension—the simultaneous pride and doubt, alignment and friction—is what makes this work real. I don't believe we move toward justice by avoiding discomfort. We move through it. We stay accountable to it. We let it sharpen our analysis and expand our sense of what's possible.

I also recognize that impact is not always immediate or straightforward. As my instructor pointed out, sometimes impact is found in shifting discourse and understanding itself—**challenging narratives** and making visible the forms of knowledge and labor that are often erased. That is difficult to measure but can be a powerful force for change.

Summary

The San José–Santa Clara Regional Wastewater Facility (RWF), one of the largest advanced treatment plants on the United States' West Coast, is undergoing a multi-billion-dollar capital improvement program. Yet, behind the technical upgrades lies a deeper challenge: how to ensure that this transformation also advances environmental justice, public health, and climate resilience. This project applies an interdisciplinary MESH framework—Engineering, Sustainability, and Health—to critically examine how the RWF's infrastructure decisions reflect (or fail to reflect) community-centered values. Through systems analysis, stakeholder interviews, policy review, and ethnographic observation, this capstone examines what is defined as "improvement," who determines the decision, and how frontline communities perceive the outcomes. Findings suggest that even the most sophisticated infrastructure can perpetuate inequity if lived experiences, historical injustice, and socio-ecological feedback are ignored. By leveraging infrastructure, this project reimagines what wastewater planning might look like in an era of climate disruption.

In this project, I examined the intersection of sustainability, social justice, and wastewater management, with a focus on the San José-Santa Clara Regional Wastewater Facility (RWF). Through interviews and analysis of existing literature, I explored the challenges faced by frontline communities and facility staff in addressing environmental and social sustainability within the facility's operations. The findings highlight the importance of integrating long-term, context-specific knowledge into planning and decision-making processes. Additionally, the research identified systemic barriers that hinder the effective implementation of sustainability principles particularly in terms of equity and climate resilience. Further work is needed to refine solutions that bridge these gaps, ensuring that future wastewater management systems are not only efficient but also socially just and resilient to climate change.

Going forward, advisory bodies like

TPAC must evolve beyond compliance and efficiency oversight to embrace models of co-governance that reflect environmental justice and intergenerational accountability. Only then can wastewater planning fully embody the values of MESH.

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Climate, Energy & Carbon Futures

"We are the first generation to feel the effect of climate change and the last generation who can do something about it."

- Barack Obama, Former U.S. President

The Silent Burden of Clean Energy: Incorporating New Voices Into the Narrative Surrounding Lithium Ion Battery Storage in California

Nina Aliamus

Abstract: California's Lithium History At a Glance

The renewable energy transition is frequently framed as a positive. However, the infrastructure needed for this transition, such as lithium-ion battery storage facilities, can create burdens and unintended impacts for host communities. This paper is framed using an environmental justice lens to analyze the impacts of a proposed lithium-ion battery storage facility in Slugville, CA (a pseudonym). Through interviews with residents and an expert witness electrical engineer, this study investigates the often-overlooked community concerns and technical risks associated with battery storage facilities. The findings from the three interviews revealed community anxieties surrounding catastrophic events, water pollution, fire risk, and an overall lack of procedural justice. The expert witness testimony echoes many of these concerns, highlighting key specific issues with the way lithium is stored. This dialogue with residents challenges the exceedingly positive narrative around the clean energy revolution. Without equitable community engagement and local input, even "green" energy projects can prolong environmental injustices.

Lithium-Ion Battery Storage: Why Does It Matter?

My project examines the concerns of community residents surrounding a proposed lithium-ion battery storage facility in California. To protect the identity of local community members and expert witnesses interviewed in this project, the location and details of the proposed lithium-ion battery storage facility will be kept confidential. The community or area of interest in this report will be referred to as "Slugville". The overarching research question and problem statement that have guided my research are stated below:

Research Question: How might the opinions of community residents surrounding a proposed lithium-ion battery storage facility expand the dialogue about the renewable energy revolution?

Problem Statement: California remains a global leader in the clean energy sector. California is pushing solar integration and electric vehicles, which depend on lithium

battery technology. This in turn, has led to the development of large-scale lithium infrastructure within the state. While corporations and governments tend to promote the benefits of increasing lithium infrastructure, the voices of those most closely impacted are often marginalized. As a society, we cannot guarantee the extent to which residents are included in the planning and development conversations. This project will investigate the (potential) disconnect between the promises of green energy and the realities of the people most closely impacted, using an environmental justice lens.

I have used the following process to conduct my investigation:

1. Document community narratives of residents living near a proposed lithium-ion battery storage facility.
2. Document and understand perceived/anticipated impacts.
3. Examine how local voices align with or diverge from dominant energy justice narratives in California.
4. Lastly, interview an expert witness with technical expertise to identify where technical applications may support or differ from community concerns.

To clarify, these are research aims, not things I am attempting to prove or disprove. These objectives helped me understand how residents interpret the implications of the facility concerning their own health, safety, and quality of life.

The Foundation of California's

Energy Transition

This project does not focus on the lithium industry, electric car manufacturers, or large energy corporations; those perspectives are widely accessible and well-resourced. Instead, this project focuses on community testimony and aims to explore what environmental justice entails in the context of local energy infrastructure. We will hear from people who are often left out of conversations that will directly impact their neighborhoods, health, and safety. I have also interviewed an expert witness who works in electrical engineering and battery storage. By incorporating a variety of voices into this report, I aim to introduce an aspect of polyvocality and accurately depict the fears, concerns, voices, and realities of those impacted by lithium-ion battery storage in California.

In California, residents of Slugville are [actively protesting a proposed lithium battery facility](#), which is set to break ground in 18 months. My friend "Wanda" called me recently in a panic, wondering what the implications would be for her and her home if this lithium storage facility goes in. Her concerns are well-validated: earlier this year, a different local power plant caught fire due to a lithium battery reaction. The idea of an entire facility dedicated to the storage of lithium-ion batteries just steps away from their home is terrifying to her. I took immediate interest in this issue, and just a few weeks after she came to me in distress, I discovered that a lithium battery storage facility was being proposed in *my* own

neighborhood. This information fueled my interest in this topic, now that it has become something that directly impacts me.

I discovered the proposed battery storage facility while running through my coastal California neighborhood. I decided to take a run after work as I typically do, and ended up on my usual route. My typical running path takes me from my house down to the bay, loops around the bayfront, and then I run uphill, 100 feet of elevation, back to my house. I make this loop about twice a week, but this week I discovered something new. On my run, I passed a first sign that read "no batteries by the bay", shown below.

Not thinking too much of it, I continued for about 10 more minutes until I looked over and saw a similar sign in front of another neighbor's house. After passing

the second sign, my curiosity grew, and with a newfound rush, I completed my loop back home (my pace ended up being a little quicker than usual). When I arrived at my door, I intended to immediately begin research on the proposed facility in my very own city, but I instead ran into my next-door neighbor, whom we will call "Brian". I mentioned that I saw the two signs outside of our neighbor's house while on my run. Seeing that caught his interest, I began to pick his brain about it, outside of the street that connects our houses, in the chilly Morro Bay mist. He informed me that the proposed facility would be located in a decommissioned power plant, fondly referred to by the town as the "three stacks". Morro Bay as a whole is commonly referred to as "three stacks and a rock," and you'll see why in the photo I snapped while playing

with friends below.

Brian mentioned that the stacks have not produced electricity for a long time (decommissioned around 2014). When the city attempted to have them removed, the public fought back earnestly, stating that the stacks were a monumental part of the Morro Bay skyline, a relic and a piece of history to be maintained. This proposed lithium-ion battery storage facility would use the existing Morro Bay power plant as its home and is proclaimed to have no impact on any agricultural lands, residences, or land intended for other purposes.

While this proposed facility may not have a direct impact on the land, the signs and my neighbor's comments demonstrate clearly that there are public concerns about environmental impacts to the coastline, the industrialization of a scenic area, and diminished tourism. Much like in Slugville, my neighbor Brian referred me to active campaigns against the proposed facility. In speaking with Brian, he referenced the same previous lithium-ion battery fire in his reasoning against it, citing fire safety as his main concern about the proximity of this plant to our homes.

My conversations with Brian and Wanda began to inspire a new research question for me. These lithium facilities are being constructed in the name of clean energy, but how are the voices of those most impacted being heard and respected?

As a civil engineer in California, I am familiar with the domestic lithium industry and am actively working on a

project on the shores of the Salton Sea. It will be fully powered by a geothermal energy plant just a few hundred feet away. The project is run by Controlled Thermal Resources (CTR) and is underway. [Lithium was recently discovered in the Salton Sea](), and some are referring to it as California's second gold rush. More of these facilities are expected to arise in the coming years, paving over hundreds of acres of shoreline in the Imperial Valley. A plant of this scale and caliber has significant implications for the surrounding communities and environmental justice. All of this is being done in the name of "clean energy", but I ask myself, what are the true implications for the local ecosystem and the residents? Now was my chance to find out.

The proposed lithium-ion storage facility in Slugville is in the early stages of development. While construction is still over a year away, public opinion is already strongly opposed to this project, with well-formed groups already voicing their concerns and citing previous disasters, [like the Moss Landing Battery Fire]().

[The lithium industry is essential for the United States to meet its electrification goals](). To make progress toward our electric car, solar energy, and off-grid capacity goals, lithium is essential. We use lithium-ion batteries in thousands of everyday appliances, ranging from smartphones to cars, laptops, watches, to vacuums. Domestic lithium operations were inevitable due to their massive, and still increasing, demand.

Domestic lithium production and storage increased due to rising demand and facility needs. As the electrification of our infrastructure increases**,** and we strive to meet state or national goals, such as "all electric cars by 2030", the need for lithium skyrockets. These facilities have specific needs, such as lithium-infused brine and geothermal energy, in the case of lithium extraction at the Salton Sea. The lithium storage facility is proposed in Slugville because it is an identified weak point in the PG&E grid, and is also close to the existing substation.

Understanding the Existing Narrative: My Approach

How are the voices of community members who are most impacted by lithium infrastructure shaping the dominant energy justice narratives in California? Energy justice representatives typically portray a positive outlook on domestic lithium production and storage. Common arguments are that we need lithium-ion batteries to achieve our all-electric goals by 2045, or that we need to be able to store energy in order to decrease demand from non-renewables, which are slowly killing us and our planet. While this may be true, a large number of people impacted by these lithium operations are not necessarily being considered in the overarching conversation. The interviews in this paper focus on the perceived fears and impacts of these people, and work to identify the primary concerns of residents, the basis for these concerns, and any additional concerns they may have

regarding the potential integration of a facility like this. The addition of expert witness testimony will help us understand the real risks that truly appear with the integration of this lithium battery storage facility.

The Importance of this Inquiry

Incorporating community voices helps close the knowledge gap between community concerns and published data in renewable energy. Much of the research done on the potential risks of lithium-ion battery storage facilities is performed on a macro level and does not necessarily focus on the impacts on community members. Involving local voices is a sustainable and ethical way to practice research, and introduces polyvocality by bringing in new and relevant personal testimony data. Local voices can often challenge corporation-based narratives, and this case is no exception.

This is important because, currently, lithium-ion battery storage is essential to ensuring a future of sustainable energy. The United States is sprinting towards an electric future, and lithium-ion batteries are the most effective technology we have. This is an emerging issue that will only become more relevant as time goes on. Understanding how local communities view these developments and addressing their concerns will help us pave the path for a more equitable journey to sustainable energy.

The Investigative Toolkit

I have identified potentially impacted

residents to gain background knowledge and insight to set up personal interviews. I have conducted three interviews: two with local community members affected by the issue and one with an expert witness in the battery storage and electrical engineering field. Because I grew up locally in Slugville, I had the ability and insight to identify key community members and longtime residents who are involved with a local nonprofit organization; they are open to sharing their voices and concerns.

Looking Through an Environmental Justice Lens

This project will be analyzed through an environmental justice lens. Environmental justice is a topic so popular that it is sometimes referred to as "EJ".

Environmental justice tells the story of disproportional environmental burdens upon different communities. It states that an equitable transition, or a "just" transition to green energy, is one that includes inputs from all stakeholders, including the voices of local community members. The importance of sharing lived experiences and personal testimony is highlighted when documenting research through an environmental justice lens. In both the case of the storage facility in Slugville and the extraction plant in the Imperial Valley, we are facing examples of marginalized communities forced to be at the forefront of the green energy transition.

Relevant forms of environmental justice include distributive, procedural, and recognition justice. For distributive justice, the interviews focus on understanding potential health risks, economic benefits, and who benefits and who is harmed in this situation. In terms of procedural justice, the interviews address transparency of communication to community members, access to information, and public participation. Lastly, in terms of 'recognition justice', the interviews uplifted quieted or ignored voices.

Closing the Information Gap: Framing my Interview Questions with Background Knowledge

The proposed facility in Slugville will serve as a case study in policy and scholarly literature, as a place that has overlooked community concerns. The proposed lithium-ion battery (LIB) storage facility highlights the importance California places on domestic lithium operations. California has a goal of becoming all-electric and carbon-neutral by 2045. In order to become successful in this goal, California needs to drastically increase its lithium production and capacity. And, California is not the only state to develop goals like this. Global lithium demand has increased exponentially over the past years, due to the green energy transition. This transition that we are in the midst of places heavy importance on electric vehicles, energy storage platforms, solar power, and grid expansion. All of these systems require lithium to operate, and in a world where we see headlines such as "The World is Racing Against a Lithium Shortage" or "Facing the Tightening Lithium Supply in 2025", the

world is well aware of lithium's role in the green energy transition.

I drafted the image below, with the help of Paul (the expert witness whom you will meet later on in this paper), which depicts some of the benefits of LIB storage, allowing the energy produced by renewable sources to be directly linked to the grid for on-demand use.

Facilities like the one in Slugville would enable more energy to be stored within the power grid, in a way that utilizes "green energy" methods. Paul opened up about the benefits of lithium-ion battery storage and the role it plays in green energy. He explained that power inverters allow non-grid voltage and frequency power to connect to the grid. Without lithium-ion batteries, there is no way to store the energy produced by renewable sources, such as solar and wind. Solar and wind are both weather-dependent and do not meet the on-demand needs of the modern-day power
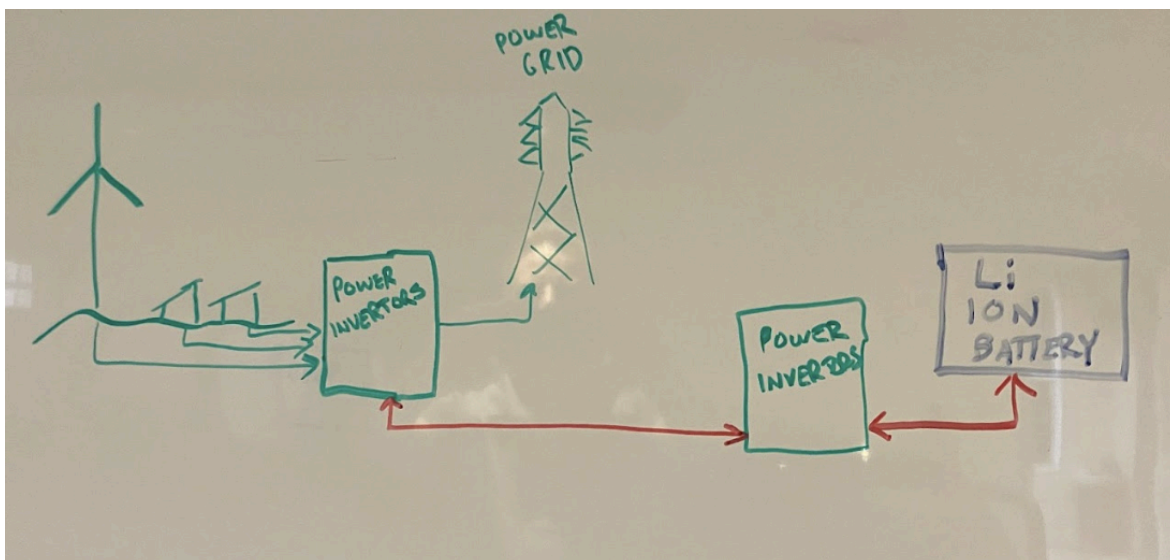
grid. Lithium-ion batteries have bidirectional power inverters, which allow energy to enter, be stored, and leave, all on demand. The bidirectional connection enables renewables to charge when there is sun and wind available and discharge into the grid when they are not. This two-way flow is a game changer for the grid, making the entire system much more flexible and allowing for the storage of renewable energy, even when the sun isn't shining or the wind isn't blowing.

The published press is overwhelmingly in favor of the LIB storage. Articles and research focus on the need for domestic lithium production and storage, and its crucial role as the United States transitions to a clean energy society. It's true that in order to reduce our consumption of non-renewable resources, we must pivot towards renewable energy, and lithium-ion batteries have proven to be a very successful way to do so.

For example, the press surrounding the Salton Sea lithium mining operation mentioned in the introduction of this paper highlights the need for domestic lithium production. It emphasizes how we are moving away from outsourcing our labor to areas like South America for lithium mining. The accessible narrative involves creating new and local jobs, reducing reliance on foreign imports, and sustaining our energy needs within our own country - the proposed Slugville storage facility follows a similar narrative. The article emphasizes the need to reduce reliance on fossil fuels, increase grid capacity, and decrease reliance on external

energy sources, like coal, natural gas, and oil. This lithium-ion battery storage facility would allow the residents to mitigate the risks of rolling blackouts due to energy overconsumption.
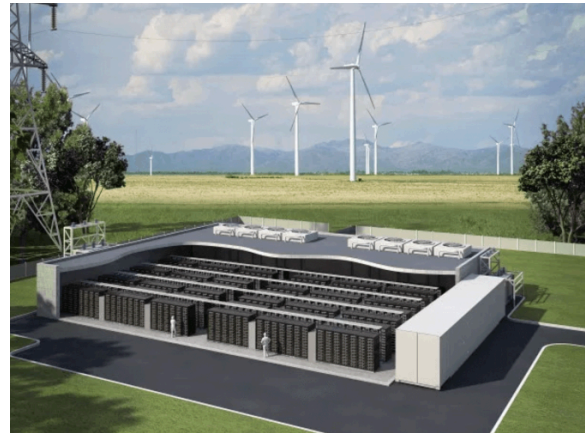
An inside look into a stylized LIB storage facility, with a connection to renewable energy, Source: https://www.criticalrisksolution.com/blog/understanding-large-scale-lithium-ion-battery-energy-storage-systems

By curating a foundation of understanding in the industry, I was better able to connect with the people most impacted. Lithium mining is a huge industry in South America. By understanding the historical implications of lithium operations in other parts of the world, we can begin to develop a big-picture understanding of the global impact.

The extraction of raw materials keeps South America in a weak role in the overall financial scheme of lithium production. Extracting raw lithium is no different from extracting other raw materials and plays a large role in the exploitation of South America's resources. We are witnessing a recurring pattern in exploitation and inequality within countries that can

provide raw materials needed by other countries to produce more high-end technology, and a lack of sovereignty for these South American countries that are rich in lithium. The themes explored in the article linked above contribute to an understanding of the lithium industry in California, as it touches on inequalities between governments and communities, financial and environmental implications of lithium extraction, and how local communities can be excluded from the conversations that most greatly impact them. While there is a negative bias evident throughout this article, it does take a fairly logistical approach by comparing historical events to modern-day operations. The article appears to be written from a political economy perspective, and can be used to better understand the global distribution and supply chain implications of lithium production. The lens through which it is written connects power, economics, and community. Understanding the potential negative implications of lithium production to local communities in South America can serve as a representative example to understand what could happen here in California.

Taking a more local perspective on the United States' lithium economy provided insight into the economic and fiscal need for lithium production in the United States.

Author Hasan, in "[Advancing energy storage: The future trajectory of lithium-ion battery technologies](#)" emphasizes the need for collaboration between all stakeholders within the lithium industry, including

engineers, manufacturers, users, policymakers, and scientists, directly addresses the fears and potential health impacts from lithium-ion battery production and storage, which are directly related to the stories of the voices I am including in this report. From my understanding, this article is written from an environmental justice perspective, speaking towards the potential environmental impacts and the environmental benefits of advanced lithium-ion battery storage. It addresses impacts to all stakeholders, including those impacted by facilities and mining operations, as well as the issue of end-of-life waste and disposal, which is an important issue when talking about the sustainability of energy sources. These topics framed my interview questions with the expert witness.

Missing Stories & the Information Gap

A vast majority of the media surrounding both of these lithium operations are positive. As stated above, they emphasize the benefits of moving towards electrification in California by reducing reliance on non-renewables and strengthening our own domestic energy production. However, there may be a missing voice here. With so much positive press surrounding domestic lithium operations in California, it is easy to overlook those who may be most impacted. There is very little accessible data surrounding local communities and the impact that these operations will have on them. In reality, the people living nearest to

these operations will be heavily impacted by their implementation. Both lithium extraction and lithium battery storage facilities can take up thousands of acres of previously utilized land. There are concerns surrounding surface water runoff, air pollution, groundwater contamination, fires, noise pollution, and soil pollution. The local residents of the proposed LIB storage facility have a similar concern. A battery fire occurred earlier this year, destroying thousands of acres and killing wildlife and pristine habitat.

are extremely relevant, they are not always heard. These voices of local community members and impacted stakeholders are missing from accessible research and data. When you Google "lithium extraction Salton Sea," the first thing that comes up is a Controlled Thermal Resources (CTR) website highlighting the need for their product and the prosperity that will come from their facility coming online.

Bridging the Data Gap Through Community Testimony

The fire was found to have been caused by the explosion of a lithium-ion battery. With this fresh in mind, residents are concerned for their own safety and the well-being of their environment and their surroundings with the integration of a new lithium-ion storage facility. Local residents are hyper-aware of battery storage safety in terms of fire risk. They also have a history of environmental marginalization, as the local population is largely made up of farm-worker communities that have battled with pesticide use and water contamination for years. Of the interviews I have conducted, it is clear that these residents do not feel as if this is a necessary integration. While these concerns

Renewable energy cannot be fully sustainable without honest community input. The attached personal testimonies, interviews, and quoted articles will attempt to identify the gaps in the available literature surrounding lithium operations in California. The available literature on this topic fails to show and display the voices of those in closest proximity and therefore most highly impacted by the integration of these operations. There is ample data surrounding the environmental and economic benefits of domestic lithium mining and lithium-ion battery usage. However, what is missing is personal testimony and the voiced concerns of those impacted. A majority of the accessible literature, at first glance of a

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Google search, will often be backed by companies in economic favor of lithium operations, such as electric car companies, lithium mining companies, geothermal energy companies, and lithium battery affiliates.

Interviews with local community members help address environmental justice concerns, such as unequal exposure to environmental harms, the financial and racial makeup of the community in question, and other concerns that are not necessarily presented in an article that would push domestic lithium operations. Through interviews with impacted community members, I have discovered that one of the major concerns relating specifically to Slugville is the issue of how the residents were notified, specifically the limited notification radius. Only residents within 300 ft of the lithium battery storage facility's location were informed of its implementation. The report given to those few residents noted that the selected area was "predominantly agricultural land located in a Spanish-speaking neighborhood". It forced the residents to consider why their community was selected. Further concerns from residents include potential home price decreases, an overall lack of faith in fire prevention measures, a worry about the impact on undocumented workers, and the belief that the project is already viewed as a "done deal" without sourcing community input and overriding current zoning regulations. This data, sourced directly from these community members, along with articles put out by local nonprofits fighting the storage facility, will provide a large piece of the missing information in this industry.

Much of the relevant data on both the Slugville battery storage facility and the Eastern California lithium extraction facility pertains to regulations set forth by both state and National agencies. A significant concern surrounding Slugville is that local community members believe there is a potential that the company proposing the LIB storage facility will seek state-level approval and go over the heads of local County governments in order to make this happen. They believe that there's a chance the lithium storage facility will be able to forgo current zoning regulations. The State of California is also responsible for many land and resource-based websites that will provide relevant data regarding current regulations, populations, and advancements in industry. There are also relationships between environmental agencies and the companies at hand. Understanding perspectives of both the Environmental Protection agencies and the profiting corporation will allow for a broader understanding of lithium operations in California.

The Interviews

Below, you will find interviews with three people, all with different ties to the Slugville battery facility. The first two interviews were conducted with residents of Slugville, who have their own set of concerns and ideas, which we will explore together. The third interview was conducted

with an expert witness in the battery industry, who will help us delve deeper into the technicalities of the concerns identified by the residents.

Interview 1: Local community member who owns a home within 500' of the proposed facility, *Wanda*

I had the opportunity to interview a community member who was directly impacted by a proposed lithium-ion storage facility in California. My roommate walked into the house in the midst of a heated phone conversation with her mom - if I looked closely enough, I could see steam coming out of her ears. When she hung up, she turned to me and said, "They're proposing a lithium battery storage facility 1,000 feet from the house I grew up in (where her parents still live), and no one told us". She explained that this facility only notified residents within a 300-foot radius. She added that all this was occurring in the wake of a catastrophic fire caused by lithium-ion batteries that damaged her hometown just earlier this year. Knowing that my thesis was centered around lithium operations in California, she immediately asked me to share everything I had learned thus far. Throughout this interview, I will refer to her as "Wanda".

Wanda immediately identified that Slugville was facing community outrage with how residents were notified (the aforementioned limited notification radius) and the facility's location, as compared to more affluent areas where sites were originally proposed and then rejected.

To Wanda, the risk of fire is real, especially in light of the previous Moss Landing fire, specifically a lithium-ion battery fire. Many other risks are worrisome, including earthquakes (the proposed location is near a fault line) and groundwater contamination following potential fires. There were concerns about the facility's proximity to the designated area, which serves as the County's emergency evacuation center. If a fire were to break out at this lithium storage facility, Wanda wondered where residents would evacuate to if it were so near to where the "safety zone" is supposed to be?

Wanda emphasized that community members believe there is a lack of straightforward information from the company, with many members having suspicions about where revenue is going. It seemed every PR effort from the company was specifically designed to counter community concerns.

Lastly, she expressed concern about how home prices could decrease dramatically; overall, there is a lack of faith in fire prevention protocols due to previous experience, and about the impact on undocumented workers and how this proposal will impact those with even more limited voices than her own.

In this and the following interviews, I incorporated one of [Kathryn Roulston's six conceptions of interviewing](#) to represent my own experiences and goals: "Interviewing as a narrative practice". Wanda established a foundation with me through storytelling. She

described her perceptions and impactful events through lived narratives that involved people, places, and events relevant to her and her community. Because we share a similar background and grew up within 30 miles of each other, we were able to connect on a deeper level than just a surface-level interview. Her identity as an activist in the community shaped the story she told me - it wasn't just what she said, but it was how she said it, with emotion, passion, and power in her voice and her stories. In her interview, she and I both focused on dominant narratives in the media and how those differ from those promoted within the community. She gave background, a clear presentation of past, present, and future outcomes for the community, encouraging me to hone in on "interviewing as a narrative practice".

Wanda provided an alternate perspective to the narratives we often see published in the news surrounding green energy initiatives. The narrative we might see on a day-to-day basis likely pushes the need for greater lithium-ion battery storage in order to promote renewable energy, such as solar and wind, and allow us to move away from fossil fuels. We might see how necessary this is to reach our electric car goals, to reduce reliance on oil and gas, and to limit greenhouse gases. What you may not typically hear about is the impact these facilities can have on local community members, the ones who live with the plans every single day. This community member provided us with a perspective that often goes unheard, and one that I am attempting to bring to light through personal testimony and interviews.

Interview 2: Local community member who owns a home within 1 mile of the proposed facility, *Pete*

I had the opportunity to interview another community member in Slugville. We will refer to this person as Pete. Pete and his wife live in a home about a mile from the proposed facility, and both of their adult children have moved out. They are self-referred to as "empty nesters" and are enjoying their life in Slugville. I posed the same interview questions to Pete as I did to Wanda. I came across Pete's name when speaking with a family friend. My family friend had let me know that there was a community member involved in some local activist groups and would be more than willing to sit for an interview with me to share his own thoughts, feelings, and impacts surrounding the proposed lithium battery storage facility in Slugville. Excited to learn more about Pete's experiences, I reached out, and just as expected, he was excited to share his thoughts with me.

Pete's story was a little different from Wanda's. Right away, I could tell that he had more curiosity towards the proposed facility and a lesser sense of opposition. Before I was able to begin interview questions, Pete opened up and said, "Look, I don't want this thing so close to my house, I honestly think it's going to catch on fire and burn this whole neighborhood down, but I'm going to be honest, I think we need it. We can't keep using coal and gas forever, and this seems like it's our only other alternative. So I'll

fight it, but I do think that we need it. I just don't like where it's at."

This quote from Pete provided great perspective for the rest of his interview. We moved on to the interview in a more open forum type of discussion, rather than a question-and-answer interview. While I followed my questions, they worked themselves into a greater conversation surrounding the safety of lithium battery storage, rather than pointed questions and direct answers.

Many of Pete's experiences and beliefs matched Wanda's. One of the first items we discussed was the previous Mass Landing fire, which was caused by a malfunction at a lithium plant. Pete made a point to say that this proposed facility was coming at a bad time, when this fire was still fresh in people's minds, and people still feared lithium battery storage so close to their homes. As he mentioned, and as previously mentioned in this report, this fire occurred less than a year ago, causing great destruction to this very area and destroying acres and acres of surrounding land. Pete chastised the lithium battery storage facility proposed to go into Slugville. He told them to "read the room", in other words, take into account the feelings and emotions of people who have been severely impacted by a similar facility catching on fire just earlier this year.

Pete expressed his frustration at the company for not warning people in a larger radius. He emphasized that if they had notified people in a wider radius, people might have been more understanding of the idea. But from the get-go," it seems like this company has something to hide," in the words of Pete. He suggested that if they had been more straightforward and open from the beginning, people would be able to place more trust in their hands.

Pete took issue with the proposed location. He believed it was essential to note that the location of the proposed facility is in existing agricultural land, which would change its use and have the potential to pollute groundwater. He also noted that it's very near a neighborhood, his own neighborhood. He thought that these types of facilities should be required to be placed a certain distance away from residential areas to promote safety.

Pete worried about the price of his home and the decline in value of his neighborhood due to the integration of this lithium battery storage facility. "No one wants to live at the base of a giant fire hazard," he noted as we discussed his own home's proximity to the plant location. He pondered this issue, asking both me and himself, "Well, should I sell my home now, [and] try to get some money out of it, or hold on to it and hope that this thing doesn't go in?"

Before we concluded the interview, Pete wanted to make one thing very clear. "We *are* proponents of clean energy in [Slugville]. We want it more than anything; We know what it takes and what we all have to sacrifice to get clean energy, we know that. What we don't need to settle for is a

plant going into our own neighborhood. There must be hundreds of other places that can go, I don't know why it has to be in a residential area, taking up agricultural land." Before closing, we discussed his attendance at a grassroots movement meeting, and he emphasized that "what we really want is more time to put the right restrictions in place. We're going to want more fire hydrants, and we want more fire safety in place." He then referenced a similar facility in Morro Bay, finding it encouraging that they were able to pass city legislation that gave them 2 years to come up with stronger safety protocols before a LIB storage facility moved in.

Interview 3: Expert Witness, Electrical Engineer, *Paul*

After reaching out to and interviewing a community member impacted by the integration of the Slugville plant and understanding their safety concerns, I decided to consult an expert witness in the electrical engineering and battery storage world. I found this person through my workplace, as I work in civil engineering and development and have access to many members of different specialized engineering communities. This electrical engineer was able to help address and expand upon concerns set forth by local community members in the Slugville area. I wanted to provide a trustworthy information source to those who this plant will impact, so they can better understand the true concerns that they will be facing. I felt it was important to include expert witness testimony to do my part to contribute to

addressing the concerns of the community members that my capstone project focuses on.

I created a list of questions based on my previous interview with a local community member. I wanted to develop the questions based on her primary concerns, as well as common fears voiced by local nonprofits. Below are my notes and takeaways, including a few relevant direct quotes from this expert witness. The full list of questions is available in the Appendix.

I wanted to start with a background assessment of his qualifications. This expert witness is an electrical engineer with over 35 years of experience in the field. He holds a bachelor's and a master's in electrical and computer science, and has conducted research on lithium-ion battery reduction in storage over the last 10 years. He is also located locally, about 35 minutes from Slugville. He possesses both technical expertise and local understanding. Throughout this paper, we can refer to him as "Paul".

We began the interview with my candid admission of my lack of knowledge of how a lithium battery storage facility operates. This bit of understanding helped me address and approach the concerns of the community members. Paul went on to explain that all chemical energy storage systems are relatively low-density; essentially, they take a lot of volume to store a little bit of energy. Consider the time it takes to charge an electric car versus filling up a gas tank, time-wise. Electric cars weigh

1000-2000 pounds more than gas cars, mainly due to their large batteries. As a society, we need inexpensive and expansive land areas for energy storage facilities. LIBs are charged during the day (when the sun is out/wind is blowing). They are then being charged and drained as demand fluctuates. When I asked about the sustainability and lifetime of LIBS, Paul explained that high-end LIBS can last up to 15 years.

I then asked how LIBS contribute to the storage and distribution of green energy, aiming to determine what role they play in the energy transition. He explained that batteries are trying to reduce the peak generation demand of electrical power plants, so we don't have to overbuild them. If we can store more energy produced, we can generate less energy. We reduce peak demand, and we decrease the amount of excess generation capacity coming from non-renewables. When we need energy quickly, we turn to non-renewables because most renewables are weather-dependent or time-consuming (temporally dependent). LIBs can allow us to store renewable energy and then use it on demand, without waiting for ideal weather patterns. Paul closed this question with a powerful statement: *"We need energy storage. That is a non-negotiable. But what we can talk about is where, and how, we can store it."*

I then addressed concerns brought to me by local residents, inquiring about how risks such as fire and water pollution could be mitigated. Understanding why LIB storage facilities are a risk can help us understand the deep-rooted concerns of

residents. Essentially, short-circuiting of the battery releases a large amount of energy, and LIBS get very hot, very quickly. Lithium is a flammable metal; it will burn until there is no lithium left. We use lithium because lithium-ion phosphate chemistry is a much more stable battery than our other options. However, what causes more dangerous situations is putting too many of them close together. To promote safety, we must create physical separation so that if one catches on fire, it does not catch its neighbor on fire. Therefore, you need more separation space to increase safety. So, for the local residents of Slugville, a larger facility with widely spaced batteries with a central fire suppression system is a safer alternative than what is currently being proposed. Paul emphasized that *"You can never say your lithium-ion battery plant will not catch on fire. That is not possible. However, metal separators can increase safety,"* directly addressing the concerns outlined in the previous interviews.

We then moved into the environmental benefits of lithium storage. Both community members emphasized that they were pro-renewable energy. Neither had any opposition to the green energy movement; in fact, they both full-heartedly supported it. Their concerns lay elsewhere, but I still found it important to understand the benefits of LIB storage. Paul explained that large-scale LIB storage, like the one proposed in Slugville, can reduce the use of carbon-based fuels. Living near lithium-ion battery storage will not kill you over time, unlike coal plants. Paul commented

regarding the safety of LIBS versus other "renewable" energy sources, claiming, *"I'd rather live next to a nuclear plant than a lithium-ion storage facility"* in response to this question.

In response to how residents were notified about the proposed plant, Paul articulated that a 300' radius is *"completely inappropriate and inexcusable,"* claiming that this information radius is a failure mechanism. He expressed concern that the LIB company was not engaging the community and that it was the wrong approach.

Through my interviews with Wanda and Pete, I noted that a large part of their concerns surrounded the disconnected relationship between technical work and public trust, as well as the corporation's perceived hesitancy for public input. To this, Paul responded as an engineer, putting himself in the shoes of the LIB company. *"We hope that the public understands that we peer review our processes. We run them by similarly qualified people from all walks of engineering. We guide our actions based not on our own thoughts, but from our community of qualified engineers."* In response to this question, Paul responded with his thoughts on the American education system. Ultimately, his perspective was that the American public has a poor science foundation. *"Those who chose to use science to advance technology for the greater good of humanity have spent their lives understanding technology. Therefore, it is our job* [the job of engineers] *to build safe facilities, AND it is our responsibility to educate them. Stay out of the white gown, go into the streets, and educate the public. That is part of the job."*

We then moved more specifically towards the energy future of Slugville and how a facility like this would impact the energy network of the community. The platform of the LIB facility reinforces the idea that there is not a lot of current energy generation in Slugville, and the terrain is very challenging. Historically, they lose powerlines in the tough winters, routing around downed lines. Slugville is a tough place to serve from a utility supplier standpoint (overhead lines and bad weather with low local generation). A LIB storage facility could create more energy independence *if done correctly,* Paul emphasized the need for this argument. *"People should rightly be scared and defend their property values. But at the same time, if we keep burning coal, we will all die."*

Lastly, I wanted to address the perceived impact of the previous Moss landing fire, which was started by a LIB explosion. This last event raised concerns for both Wanda and Pete during their interviews. Lithium-ion cobalt batteries caught on fire and spread to all the other neighbors. Paul claimed the facility was created at too high a density (as he mentioned the importance of this earlier on in the interview). Paul emphasized that *"you can never say your lithium-ion battery plant will not catch on fire. That is not possible. However, metal separators can increase safety"*.

A safer alternative would be to store 100MW over 10 acres, rather than consolidating it all in one place. That increases the danger of fire spreading. If one of these places catches on fire, groundwater will be contaminated. Paul recommended installing a large catch basin to store contaminated material in the event of a fire. In closing, Paul emphasized that you cannot guarantee that it won't burn down. Safety mechanisms must be in place, and he recommended that Slugville require a plan that shows how groundwater contamination will be prevented in the case of a fire, adding that his advice is to never accept the argument that there will not be a fire. He closed with a grateful expression, thanking me for being interested and bringing light to such a relevant topic: *"This issue is relevant to anyone who is using energy."*

(Informal) Interview 4: *The Author*

As I mentioned, I learned (throughout my research) that a proposed LIB storage facility was moving into my own hometown. As I was drafting interview questions, I couldn't help but ask myself the very questions I was presenting to others. I found myself relating more to my interviewees than I felt as a third-party observer. My attempt to remain unbiased and approach this topic as an observer became exceedingly difficult. I found myself developing opinions and beliefs that contradicted the points I was initially trying to prove. As I face the prospect of the installation of a LIB storage facility in my neighborhood, I will make sure my voice is heard, just as I worked to emphasize the

voices of those included in this paper. This realization also forced me to consider the presence (or lack) of procedural, recognition, and distributive justice in the way that I would be impacted.

In Summary: Connections to Environmental Justice

This is the research question at hand: how might community narratives surrounding a proposed lithium-ion battery storage facility complicate the dialogue with existing energy justice narratives in California? And building upon that, how do the interviews of impacted community members and an expert witness relate to environmental justice?

Procedural Justice:

Both interviewees, Wanda and Pete, mentioned that they took issue with the 300-foot notification radius. To them, this was an apparent failure of procedural justice. The expert witness, Paul, also addressed this, claiming it was both "inappropriate and excusable". Both the community members and the expert witness could agree that this proposed facility highlighted a failure in procedural justice.

Distributive Justice:

Both Wanda and Pete expressed concerns about the declining value of their home and the safety of their neighborhood. This outlines a "perfectly imperfect" example of unequal distribution of burdens in the green energy revolution.

Recognition Justice:

I hope that this paper helps to elevate ideas of recognition justice. By amplifying the voices of Wanda and Pete, I aim to increase the impact of recognition justice and highlight how residents' concerns (which may have been previously dismissed by public media) are now being brought to light.

Closing Thoughts

When I had the opportunity to present my capstone project to a board of academics, course organizer Willy Oppenheim posed a question to me:

"To the extent that you've picked up on resistance/skepticism from community members, is this 'classic NIMBYism,' or is it a sign of some bigger weaknesses in the dominant model of transition to clean energy? Or, in other words, how can your project inform broader conversations about decarbonization (in [California], and beyond) in our current political landscape?"

This is a thought-provoking question and one that deserves consideration. "NIMBY" or "Not In My Own Backyard" refers to the opposition to projects that can be perceived as beneficial, but are located in an undesirable area, for example, in a neighborhood, or somewhere that impacts residents directly. I took a long time to consider Willy's question. I eventually concluded that this is not an example of classic NIMBY-ism, but something deeper: community members upset with the fundamental issues and mistrust of their government, ideas of environmental racism, and a lack of community inclusion. Their concerns seem to go beyond annoyances of local inconveniences, and instead reveal deeper flaws with how the energy transition is disproportionately affecting different groups of people. Both of the local community members whom I spoke with wanted to emphasize that they were full proponents of the green energy transition. What they opposed was not only the location of the proposed facility, but also the lack of community involvement, outreach, and education, and overall the mistrust they had in the process due to prior disasters. Using the insight provided to me by these community members, I can conclude that no matter what type of energy we are introducing, it must be done with respect, dignity, education, and inclusion of those most impacted: the local communities.

Both of these community members presented narratives that differed from those typically presented by traditional green-energy media. With the interviews I conducted, I was able to embrace polyvocality and bring an often-ignored voice in the green energy revolution to light. The impacts and benefits of green energy are not distributed evenly, as we know. Hardships often fall upon those who benefit least. Hearing the voices of those impacted by the less-discussed aspects of green energy is crucial to understanding the whole story of the clean energy revolution. I also hope that the expert witness's interview can directly address some of the concerns of residents and air the real issues faced by residents to the readers of this paper.

Appendix & References

Interview 3 Question List:

Question 1: "*Can you walk me through how the battery storage system works on a day-to-day basis*?**"

Question 2: *"How is energy stored and released in response to demand in this region?"*

Question 3: *"What kinds of failure scenarios do these types of facilities usually plan for, and how are risks (like potential for fire) mitigated?"*

Question 4: *"Can you identify some of the environmental benefits and environmental costs of a large-scale storage system like this?"*

Question 5a: *"Can you talk about the relationship between technical work done by publicly serving engineers and public trust of community members*?"

Question 5b: *"Why might community members be hesitant to accept public input?"*

Question 6: "*How do you see this facility shaping Watsonville's energy future? Do you find it necessary?*"

Question 7: *"Can you tell me about the perceived impact of the previous Moss landing fire, started by a LIB explosion?"*

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The Social Ecosystem of Carbon Offset Projects: An Exploration of Trust, Transparency, & Candid Communication

Amanda Friedman

Offsetting Reality

Carbon offsets have become an increasingly utilized tool in the pathway to reduce greenhouse gas emissions, leveraging a capitalistic methodology to drive funding to preserve or restore nature-based carbon sinks. As yet, in practice, offsets have been plagued with issues that have hindered actual reduction of emissions. Whether due to bad actors, flawed monitoring and reporting, or the deepening of systemic inequities, the implementation of carbon offsets has been beset with problems. This research goes beyond click-bait headlines and quantitative analyses that exist in abundance, to examine the inner workings of carbon offset projects and the relationships between the individuals creating them. Through in-depth interviews with climate action professionals, this research explores the nuance and complexities involved in the creation of effective carbon offset projects. Social relationships underpin this complex strategy and immense collaboration must occur in order to establish the necessary trust, transparency, and co-creation for successful projects. Negative media coverage and valid criticisms of carbon offsets have fostered a culture of caution and carefully curated statements around involvement in carbon offsets. Key findings indicate that a culture of learning, iteration, and candid communication is necessary to improve carbon offsets as a sustainability strategy.

Social Dynamics of a Technical Strategy

Over the past several decades, carbon offsets have emerged as a central strategy in the pursuit of "net zero" emissions, particularly within corporate sustainability ([Carbon Brief, 2023](#); [Wall Street Journal, 2025](#)). This scheme utilizes market forces to drive funds toward projects that capture and store carbon, often nature-based solutions, preventing greenhouse gasses (GHG) from entering the atmosphere and further driving global warming. If we imagine the world's atmosphere as one enormous bathtub, then carbon projects would serve as the tub's drains (commonly referred to as "sinks"). Organizations that emit greenhouse gases would constantly run faucets. Climate change is ultimately being driven by an excess of running faucets and a diminishing of sinks. Many natural systems of the world are powerful carbon sinks. For example,

old-growth forests, soil, and oceans are all crucial to carbon absorption and storage ([Nasa Earth Observatory, 2021](#)). However, many of these ecosystems have been disrupted and degraded through human activities ([Li et al, 2022](#)), thereby releasing carbon and failing to continue to function meaningfully as a carbon sink. Carbon offset projects are one potential solution to protect, restore, and preserve these natural carbon-storing environments. Examples include: forest management projects, wetland restoration, and mangrove conservation. These carbon offset projects sell one carbon credit for each ton of CO_2 (or equivalent GHG) stored and prevented from entering the atmosphere ([Michaelowa et al, 2019](#)). Funds generated from credit sales can be utilized to maintain the nature-based system, with the long term goal of continued carbon storage and the mitigation of climate change.

Governments or corporations make up the lion's share of GHG emissions ([EPA.gov](#); [Financial Times, 2025](#); [The Guardian, 2024](#)), as well as of carbon credit purchases ([CarbonCredits.com](#)). These credit purchases are frequently utilized as a strategy to reduce net emissions. Within the carbon credit framework, the purchasing entities should first evaluate current operations to develop a plan of action to reduce GHG emissions prior to the purchase of carbon credits. The purchasing entity should determine the quantity of emissions that are not currently feasible to reduce, whether that be due to a lack of technology to support reduction or due to budget

constraints. These remaining emissions can be "offset" through the purchase of carbon credits sold by a verified carbon project. At face value, carbon offsets drive funding to protect natural systems essential to mitigating climate change. However, this popular strategy has been beset with problems. Whether it be bad actors corrupting an imperfect and largely unregulated system or inaccuracies in measurement and reporting, carbon offsets have been widely scrutinized as "greenwashing" ([ProPublica, 2019](#); [ProPublica, 2021](#); [John Oliver, 2023](#)). Given that some of the world's largest polluters are also among the top consumers of carbon credits, the strategy certainly warrants scrutiny. Carbon offsetting is rife with corruption and yet, is also generating meaningful progress toward emissions reduction and driving funding towards projects doing the work to mitigate climate change and preserve natural ecosystems. For example, over 15 million tons of carbon credits were purchased in 2023 by vetted buyers (i.e. those demonstrating action on internal emissions reductions) on projects that met or exceeded high-quality criteria ([Carbon Direct, 2023](#)). Whether we should or should not engage in carbon offsetting is a much debated question and not one that this study aims to answer. However, the reality is, this strategy is widely employed across both corporate and government sectors and is here to stay for the foreseeable future. The global voluntary carbon market was valued at approximately $2 billion in 2021 and is projected to grow to $250

billion by 2050 ([Ecosystem](#) [Marketplace,](#) [2021](#)). This scale of projected growth forecasts a widespread adoption by corporations–corporations that have an outsized influence on moving the needle (in either direction) in the fight against climate change.

My capstone explored an often-overlooked aspect of carbon offsetting: the relationships between the many individuals who work together to create, fund, and manage carbon projects. My research takes a human-centered approach to better understand the lived experience and the relationships that design and drive carbon markets. This social lens is important because it depicts carbon offsets not only as a technical strategy, but also as a socially-created practice. This social practice involves power, trust, accountability. This practice also holds the potential for exploitation, error, and meaningful collaboration. My core research question aims to delve deeper into the nexus between these individuals and asks what is the experience of climate action professionals at two different nature conservation organizations in the United States working towards emissions reduction through carbon offsets? And how might the experiences of these two individuals help us to understand the roles that trust, power, and accountability play in shaping the integrity and outcomes of carbon offset projects? To achieve this, I conducted in-depth interviews with two sustainability professionals responsible for driving carbon projects forward, both with firsthand experience

managing relationships across each of the key players within carbon projects. This network of connections is significant, as they are often connections across power and responsibility, and between the success or failure of a project.

There is a dual reality in carbon offsetting, a coexistence of both corruption and contribution. As critics rightly question the legitimacy of certain offset projects and the motivations of corporate buyers, it is essential to remember that many who engage in this strategy are earnestly working to do good within an imperfect system. This project does not seek to answer whether carbon offsetting should exist. Rather, it takes the current state of the offset market (the good, the bad, and the ugly) and seeks to better understand how this system is lived, navigated, and possibly transformed by those driving it forward.

My research involves in-depth, semi-structured interviews with two individuals weaving the web of people who come together to create, and continue to manage, a carbon project. This process intended to understand the roles that these professionals hold within the ecosystem of a carbon project, what challenges they face, how they interact, and how these interactions shape the efficacy of carbon offset strategy. Carbon markets have come under fire in recent years for many inaccuracies and failed outcomes. Yet the strategy still has enormous potential to reduce greenhouse gas emissions on a global scale. Areas where there can be improvement in transparency,

accountability, and shared understanding between the relationships within carbon offset projects is therefore a key area for exploration. While carbon offsets are a technical tool that can be utilized to mitigate climate change, the strategy is run on social relationships. These relationships are the key to building transparent, ethical, and effective carbon markets. This study highlights challenges and opportunities within the social relationships that construct carbon markets.

My own positionality informs this project in critical ways. I currently work in corporate responsibility. My lived experience has generated both understanding and bias. I understand the internal pressures, trade-offs, and bureaucratic hurdles that shape corporate climate action. However, throughout the research I conducted for my Master's program, I have learned a great deal about the systemic issues within carbon offsetting and know the widespread criticism to be valid. If I were not working in this space, I might approach this issue from a place of absolutes, as "right" or "wrong". Having developed an understanding of the internal challenges to achieve even the smallest steps towards progress through my lived experience, I deeply believe in the necessity of utilizing every tool in the toolbox (however imperfect they may be). While the tool of carbon offsets is flawed and, likely, inadequate, it is still a tool that can potentially generate meaningful progress <u>now</u>. I also recognize that my upbringing and lived experience in the United States—a country responsible for

roughly 15% of historical CO_2 emissions and a major buyer in the voluntary carbon market—shape my perspective in the engagement in carbon offsetting ([Global Carbon Project, 2023](#)). The U.S. and other wealthy nations often outsource the work of emissions reduction to countries that have played a limited role in producing global emissions. Throughout the capstone process, I have aimed to broaden my epistemological lens by remaining open to unexpected findings and perspectives that diverge from my own. The level of trust, accountability, accuracy, and effort across a project ecosystem deeply influences the outcomes and efficacy of carbon markets. Given that immediate progress towards net zero emissions is critical to achieving sustainability goals, these relationships are an important and understudied component of the fight against climate change.

Potential vs. Payoff

An abundance of research demonstrates the wide array of issues surrounding carbon credit projects. For example, recent research shows that unmanaged forests may reduce more emissions than managed ones ([Badgley et al., 2022](#)). That is, a forest that came under management through a carbon project may actually reduce *less* carbon than if the project developers had simply left the forested area as it was. Other projects experience "leakage," in which the carbon project reduced emissions within the scope of the project, but the activities generating emissions were shifted to outside of the

project's scope and ultimately still entered the atmosphere (Haya, 2022). An example of this could be the preservation of one forest as a carbon project while the lumber company instead harvests the same amount of forest in some other location, resulting in the same amount of carbon ultimately released into the atmosphere whether the project existed or not. In addition to poor project design, some projects have been intentionally misleading, providing false information to credit purchasers (Gill-Wiehl, Kammen, & Haya, 2023). Furthermore, research by Greenfield (2023a, 2023b) reveals the human cost of poorly designed and mismanaged projects, such as the displacement of indigenous communities in Peru due to forest conservation schemes supported by corporate actors. These cases suggest a pattern of environmental injustice and highlight the need for rigorous project evaluation and community involvement, especially when carbon projects are still early in the design phase. However, there are many instances where carbon reduction projects are effective at GHG reduction and beneficial to surrounding communities. For example, The Okhla Compost Plant is located just outside of New Delhi, India. This initiative diverts organic waste from landfills, where the waste would release methane into the atmosphere, and instead, converts the organic waste into compost for farmers. The composting plant reduces emissions but also benefits public health by reducing the frequency of burning trash, thereby improving air quality (Environmental Defense Fund, n.d.;

Cabrera, 2023). These mixed outcomes call into question whether or not carbon markets should exist. Nonetheless, carbon markets are a strategy that is currently active and humanity must take action now to mitigate climate change. The work that must be done to mitigate climate change requires significant shifts in behavior within societies contributing most to global emissions, as well as significant cooperation and contribution of resources. In terms of behavioral shifts, both arguments could reasonably be made that carbon credit purchases do and do not encourage shifts in behavior. That is, credit purchasers are often vetted by the project developers who require science-based action plans to determine if the purchaser is undertaking verifiable efforts to reduce GHG emissions. This can drive important shifts in corporate behavior to reduce emissions. However, a lack of oversight means that buyers or credit sellers could potentially provide false information and not actually reduce emissions. For example, Apple's $200 million investment in carbon removal projects faced intense public scrutiny due to carbon-neutrality claims that were challenged for exaggeration (L.S., 2023; McKenna, 2023). In terms of cooperation and resource allocation, carbon projects have both built into the strategy framework. That is, carbon projects require a network to come together to design and carry out the project and credit sales (collecting financial resources) as a function of the project. The climate crisis remains severely underfunded (United Nations, n.d.). Given that over $949 billion

was invested in the purchase of carbon credits in 2023 alone ([Twidale, 2024](#)), this significant stream of funding toward climate mitigation offers an incredible opportunity to combat climate change. The allocation of these funds towards projects that are ethical and efficacious is essential. Thus, carbon markets could drive the necessary action towards mitigating climate change.

One of the many challenging aspects of carbon markets is the global scope of participation. Critics argue that the global and unregulated nature of voluntary markets makes rigorous verification difficult when the purchaser and the project are often located in different parts of the world ([Liabo & Fox, 2023](#)). Greenwashing becomes a real risk when there is little to no communication between credit purchasers and project designers. This study is situated within this gap, exploring how deeper engagement and relationship-building at every stage might influence the integrity and impact of these markets. This study intends to advance the field by shifting focus solely from final outcomes to also focus upstream on essential relationship-building and ongoing communication across the project ecosystem. It examines what questions are asked, what documentation is reviewed, and what types of relationships that exist between the many individuals that come together to create and manage carbon projects. This research may provide insight into how stronger relationships and improved communication could improve project outcomes, reduce greenwashing, and increase overall trust in carbon markets.

The Social Web of Carbon Projects

Initial Methods

To gain a comprehensive understanding of the carbon offset landscape, I first conducted an extensive review of secondary sources. During this exploratory phase, I gathered essential background information that served to frame up my research question. The review of academic and scientific literature provided a mapping of the carbon offset landscape. This mapping also made clear how integrity and accountability are assessed in carbon offset projects, as well as the critical gaps that exist in this area.

In addition to the scientific literature review, relevant sources from popular culture and media were also reviewed. Included in this review are: LinkedIn posts from people working within the field; investigative journalism articles; YouTube videos of webinars and interviews; as well as television segments that delved deeply into the topic, such as John Oliver's Last Week Tonight. Across these sources, several prominent themes are highlighted, including rampant "greenwashing" and social justice issues impacting indigenous communities ([ProPublica, 2019](#); [ProPublica, 2021](#); [John Oliver, 2023](#); [Greenfield 2023a, 2023b](#)). The necessity of integrity and accountability across the space has been the major overarching theme across both academic and popular culture forums. The mainstream discourse shone a light on bad actors and flawed methodologies, leading to systematic over-crediting of millions of tons of CO2

(Bagley et al, 2022). This led me to question who was working on these projects and to wonder how so much could be going wrong.

In parallel with the secondary source review, I conducted outreach to individuals engaged in carbon offset project development, management, and credit purchasing to gauge interest in interview participation. I wanted to understand the experience of climate professionals working in carbon offsetting and to ask them why they engaged in such a flawed strategy. I also wanted to understand if the media was painting an accurate view of the space, or highlighting problems that were not the norm. Were the flawed carbon projects bad apples? Or is the whole orchard infected? I reflected on the lack of transparency in global supply chains, and how a lack of transparency often breeds bad behavior. This drove me towards my questions around the social relationships in carbon offsetting. I wondered whether the buyer and seller had any level of relationship and communication outside of the transaction of a carbon credit sale. In an attempt to reach people who were buying or selling carbon credits in my home state of California, I utilized a database developed by the Berkeley Carbon Trading Project, a research lab out of UC Berkeley that tracks all carbon offset projects, credit issuances, and credit retirements that are listed by the four major offset registries. I conducted outreach to every entity listed as participating in carbon offsets in California from 2022 - 2025. Of the replies I received (two!), none were an affirmative response to my request for an anonymous interview.

Given the abundance of media scrutiny toward carbon offsets in recent years, this was an unsurprising, albeit disappointing, level of response. I also reached out to sustainability professionals via LinkedIn, one of whom agreed to an interview.

Primary Method

The primary method employed was in-depth, semi-structured interviews with two sustainability professionals active in carbon projects. The first interviewee, Avery (pseudonym for anonymity), responded with enthusiasm to my Linkedin outreach. Avery was open and excited to discuss their work and why they were investing resources in carbon offsetting. Avery also introduced me to another sustainability professional, Parker (pseudonym for anonymity), who worked at a different organization. These individuals have both led the design, development, and implementation of multiple carbon offset projects in the United States. They have also conducted relationship-building across all parties involved in carbon offsetting and so have in-depth knowledge of the social ecosystems underpinning carbon offset projects. The interviews aimed to explore how the interviewees develop and navigate these relationships, what challenges they face, and how the interactions between the project developers, credit purchasers, technical service providers, landowners, and surrounding communities influence project outcomes.

Interview questions delved into power dynamics within these relationships and within the carbon offset landscape

generally, how accountability is enacted within their roles, how they experience trust within the relationships, and how they perceive their own roles in establishing that trust and accountability. Avery and Parker were asked to reflect on prior relationships and challenges, and to describe how these experiences were navigated. All identifying information was anonymized to provide the space for open, candid, and truthful discussion. Both participants were engaged and seemed to be very candid about their experiences.

Polyvocality

Voices most present in my dataset are those who are actively engaged in carbon credit transactions within the United States. Voices that are missing include the vast majority of carbon offset project managers and sellers that reside outside of the U.S.. While the majority of credit purchasers are from the Global North, the majority of the carbon credit projects take shape and operate within the Global South. Therefore the interviewees providing perspective on the process of purchasing credits are fairly representative to the experience of many other purchasers, as that role is disproportionately centered within the U.S. and other wealthy nations generating outsized levels of greenhouse gas emissions. The lack of voices from the global community, particularly from across the Global South and from the perspective of carbon project management and credit selling is a limitation to this research.

Fostering Trust, Accountability, and Candid Communication

The sustainability professional I connected with through LinkedIn, who I will call Avery for anonymity and ease of writing, responded to my outreach with interest and enthusiasm to discuss their work in carbon offsetting. The enthusiasm was a welcome change from the wall of silence that I had encountered in my outreach leading up to a response from Avery. We spoke for nearly an hour through a virtual meeting and worked through my interview questions, which I had shared in advance of the discussion. Avery's role is to bring investment and financing into a nature conservation nonprofit. One avenue to bring in this much needed funding has been through the development of carbon offset projects. Our discussion was centered around my research question, which explores the experience of climate action professionals in the United States working towards emissions reduction through carbon offsets, and how their experiences may help us to understand the roles that trust, power, and accountability play in shaping the integrity and outcomes of carbon offset projects.

My interview with Avery began with their journey that led to carbon offset involvement. Avery struck me as a very passionate, intelligent, and straight-to-the-point communicator. They explained that working to mitigate climate change was something very important to them and when the opportunity to join a

conservation-focused nonprofit arose, Avery joined the team. Yet they were surprised to find that the organization, like many others, did not directly take climate action. Rather, as Avery explained, many conservation organizations consider the carbon capture and storage that occurs as a result of conserving natural ecosystems to be the entirety of the organization's climate action plan. Avery wanted to take this work further, to take direct action instead of leaning on the beneficial byproduct of the organization's existing conservation work. When a private donor challenged Avery's organization to dedicate resources to direct climate action, Avery raised their hand to help build the strategy.

"I was disappointed in that we weren't doing anything on climate specifically... I wanted to figure out what specifically we could do. And I wanted to be able to quantify it in a meaningful way to track progress."

"...at the time, I knew very little about carbon markets or how they worked. I had a vague idea that there were credits that you could create, but I couldn't tell you the first thing about it. We were trying to get funding from people who cared about climate to allow us to do things that would create climate mitigation... My initial feeling was, well, that's [carbon markets] not what we want to do, both because I thought it was too technical and too difficult. And I didn't know if it was a real thing...and over time, I learned a lot about carbon markets. I came to appreciate that the markets, their infrastructure, their core theory, are just so much more efficient at doing that job than a

philanthropic frame and this is the more important part, just so much more scalable. Philanthropy is just not going to get to the scale of the problem-- and markets have not yet, I don't want to claim that they have-- but they are capable of doing so. And in fact, I think they're the only instrument that is capable of doing so."

Avery has spent years delving into potential pathways for climate action and has come to the conclusion that carbon markets are a meaningful mechanism to make forward progress, eventually at the scale needed to mitigate the dire consequences of a warming planet. One thing Avery constantly circled back to though, was that this was all still new and being figured out through trial and error. Avery cautioned anyone to claim that they are an expert in this area, as the body of knowledge is still being tested, built, and discovered. One thing that I found to be refreshing was the openness with which the nonprofit Avery works at has approached this work. Avery shared that the explicit directive throughout the organization is that they are all learning out loud and in public. The work in carbon markets is a new thing for humanity, and the data is all open to the public, Avery noted. This leads to a lot of mistakes, public scrutiny, and critical feedback. Avery takes the position that feedback, regardless of how critical, can be utilized to improve mechanisms generating progress.

"One reason why it's easy for these media and academic stories to come out on carbon markets is because anyone can go and just

download the data and then run an analysis on it, right? Can you imagine if oil and gas producers had to do that? ...so that to me is sort of what I meant about the learning frame. So long as we're clear that that's what we're doing, we're doing open source learning and improvements, then we shouldn't get bent out of shape by these negative articles. We should be like, yeah, of course. Of course there's going to be over-crediting– we don't know how to do this. Thank you for pointing it out…"

"You have to be transparent about what you're doing, what you think you've got right, what you think you've got wrong. You have to have a very thick skin when people tell you their criticisms, you can't take it personally, you can't leap into defense mode. Feedback is a gift, right? And in that way, you learn and you get better over time. And one problem with [carbon markets] today is too many people show up with the 'we've solved it' kind of positioning. And that just creates unrealistic expectations on the part of everyone. We will never have fully solved it. When part of your math depends upon knowing what happens in an alternative universe, guess what? Perfection is literally impossible, right? So better for us just all to admit that and be as open as we can about the shortcomings that we have and how we're trying to get better."

I found Avery's framing of "what happens in an alternate universe" to be a helpful way to understand one of the core issues of carbon credit projects. Carbon projects are only relevant if they are removing and/or storing carbon that would

otherwise be released into the atmosphere. While it is possible (though challenging) to measure the carbon removal and/or storage of an existing project, it is not possible to measure what would have occurred without it, because that is not the reality we exist in and are able to measure. At best, it is an educated guess. This raises the critical importance of Monitoring, Reporting, and Verification (MRV) within carbon projects. At the organization where Avery works, there is a team of "co-designers" that fill these roles within the projects. Part of the MRV work is utilizing methodologies to estimate baselines of what emissions would be released into the atmosphere without the project. Without accurate methods of MRV, projects will end up misreporting progress and outcomes, which can jeopardize and call into question the entire framework of carbon markets. The issue of inaccurate reporting, whether intentional or occurring through flawed MRV methodologies, continues to plague the carbon crediting landscape.

"[You need] a good method for approximating the baseline – What would have happened in the absence of the project? And a good method for measuring what is happening in the project itself. That's quite difficult because the project itself you can measure in this universe. But the baseline only exists in another universe, so you actually can't go measure it. So there's a lot of science, but also almost philosophy involved…"

Another point of learning for me during the interview was to find out that this nonprofit (and many others) actually vet the

carbon credit buyers. Avery notes this is one of many points where a carbon market does not function as a typical market. Avery questioned, "In what other business area does the seller of a product have to vet the buyer?" It was new information to me and we delved further into the topic of vetting buyers. Responsible organizations selling carbon credits will require would-be purchasers to provide science-based action plans that demonstrate how the purchaser is reducing greenhouse gas emissions. The project developers evaluate the plans to ensure that the purchaser is conducting the work on their end to reduce emissions where possible, and then purchases credits to offset remaining emissions. Avery also discloses that some organizations have a blanket policy to not sell carbon credits to buyers from fossil fuel extracting companies. However, Avery points out that this policy could be doing more harm than good, as Avery believes it is critical to bring the biggest polluters to the table, vet their climate mitigation plans, and engage in forward progress. This is certainly a controversial and nuanced topic, as fossil fuel extractors are actively driving global warming, putting humanity at risk. Moreover, many fossil fuel companies have spent decades spreading misinformation to seed doubt on the progression and impacts of global warming and their direct role in causing it ([Lopez, 2023](#); [Supran et al, 2017](#)). How can these companies be trusted in claims of emissions reductions, given all that the public has learned of past deception and ongoing actions resulting in devastating harm to the environment and public health? To Avery's point though, how can we make forward progress without their participation?

"...that's the point of carbon markets, right? Is to make the transition for heavy polluters affordable. We're not going to save the planet by all going around and selling these things to Patagonia and the good actors of the world."

When we discussed the crux of my research, which initially had focused solely on the relationships between buyers and sellers, I had already gained a more nuanced understanding that illuminated an over-simplification in my initial research question. Often, carbon projects are deeply complex. I learned through this interview that it is rare for it to be a simple two-sided equation connecting a buyer and a seller. Avery had described to me the network that must come together to make these projects work. In the framework that Avery works within, the conservation organization serves as the "project developer". The project developer is responsible for identifying locations that have nature-based carbon storage and removal capabilities that could function to store more and release less carbon if supported and managed more strategically. The developer is the project designer, which includes either the development of, or utilization of existing, methodologies to provide MRV services. The developer must also source technical assistance providers to carry out the improved management and support services for the nature-based carbon sequestration. Additionally, they bring in funding to keep

the project supported long-term (including through the sale of carbon credits).

"...the core of project design is the involvement of all the stakeholders... So a carbon project, when you think about it's a multi-stakeholder collaboration, right? Buyers, investors, regulators, stakeholders, landowners, technical assistance providers, they all have a role to play, and the project is that trusted intermediary between all of those groups."

In this model, everyone is engaging with the project developer. That is where the trust and accountability must land. If the project design is flawed, if projects overstate impact, the responsibility will ultimately fall on the project developer. When I ask Avery about the engagement between the contributors of the project with each other, specifically in this model of the credit purchasers and landowners, there is a thoughtful pause. Avery reflects that this is not an area where there is much connection, as the developer serves as the intermediary, but that this is an area their organization could look at more closely for improvements. We discuss the potential for improved outcomes when relationships are transparent and in close proximity–as opposed to the opacity and opportunity for bad actors when there are many links in the chain, distancing the buyer and the seller. Avery describes the interactions that currently exist in their model. They will select several landowners and arrange tours with some buyers, but note that these interactions are fairly staged and not the level of relationship that we have been

discussing as important for trust and accountability. I can tell that Avery is already considering how this might be improved, and they begin to discuss ideas as well as potential barriers to achieving this deeper connection of the project network. One of those barriers is due to the negative blowback about carbon offsetting that has occurred in recent years across public media ([Karhunmaa et al, 2023](#); [Zhang et al, 2019](#), resulting in guarded silence from many who are involved in these projects.

"...they [buyers] are just so afraid of getting called out that they will not talk to anyone. They'll barely talk to us when we're like, hey, we're literally selling you carbon credits, can you tell us about your opinions of how we're doing? 'We'd rather not go on the record about that.'"

This rings true of my experience conducting outreach, and I share that observation with Avery. I also express my gratitude for the willingness and openness to discuss this work with me. The phrase "sunlight is the best disinfectant" comes to mind as I'm reflecting on this. Yes, carbon markets are flawed. However, as Avery has described, flawed strategies can be improved upon by sharing data and accepting feedback. Carbon projects are required to share data publicly so that anyone can download and run their own analyses. As Avery stated in the interview, this is a good thing. It is also something corporations and other organizations contributing to climate change are not subjected to. I found myself wondering, how much further progress could be made if everyone working for or

against climate progress had to lay their cards on the table as carbon offset projects do?

The second climate action professional participating in this research, who I will name Parker, works at a small-scale organization that partners with landowners to restore ecosystems and manage land. The organization aims to increase biodiversity and improve climate, while also providing financial benefits to land owners. These are tough outcomes to achieve in tandem, and are the linked goals that drove Parker to engage in carbon markets. In theory, land owners that choose to invest in reforestation (or other nature-based carbon projects) can generate income through the sale of carbon credits. Parker described the many learnings they have had across multiple attempts to bring these projects to fruition. The most significant seems to be the challenge of up-front project development costs without the ability to sell carbon credits for many years until the projects have matured and are storing enough carbon. There is a critical gap in funding as projects are getting off the ground and not yet able to sell credits. Carbon markets are intended to be a long-game solution for providing climate funding. When it comes to nature-based carbon credit projects, specifically reforestation, projects may not generate credits until around 10 years after new forests are planted. Planting requires significant up-front costs. For example, nurseries must be paid for seedlings and a significant labor force is required to plant.

Most investors and credit purchasers are not willing to provide these upfront costs for projects that will not become tangible for their bottom line until a decade into the future. According to Parker, this has crippled some of their organization's ability to bring projects into mature stages where meaningful climate impact can occur.

"...for reforestation, which is what we're focused on, you don't have any income from credits for at least five years after your trees are planted. So, almost all of your costs are up front. That's way too much for any project developer to front. For reference, I think we were looking at planting around 2500 acres in [State], and that was going to be like a $4-5 million project and you don't see any money back for five years. So there's pretty much no small entities that can just front $5 million for a long time. So you have to bring on a funder up front to carry you through through the initial sales, or get a grant. So like our [State] project, we're doing 2,000 acres and we have $2 million from [a] grant. So it will just cover the planting. But at least that part of it is covered so you can kind of get up and go without having to bring in an outside investor. Some of that is specific to reforestation. Like if you do improved forest management plans, those costs are a lot lower because it's really just inventory (like seeing how many trees are in the forest and then doing some modeling work) but you're not doing any physical work usually on the front end so...there are project developers who can front that cost until you sell your first round of credits. But for reforestation…

our [State] project's going to be like a decade before we sell any credits because it's in a dry area of [State]. So you just will be out millions of dollars for 10 years. So it's just very hard to make it."

"...it's very hard to make work because very few investors have a 10-year timeframe. They're like, I want my money back in three to five years. I'm like, cool, but the tree is this big. The tree hasn't generated enough carbon credits.... I don't think there was enough confidence in the long-term market for people to really want to pay that much. It's also hard because with reforestation, or any nature-based project, there's a risk that those trees will not be there in 10 years. And then you just prepaid all that money for something that burnt down or died from drought or any other terrible thing that can happen with climate change."

The more Parker shared, it slowly occurred to me that Parker had serious doubts about carbon markets. I asked, "I'm curious, obviously you're working in this field, so I'm assuming yes, but do you have trust that the market is going to be here in 10 years?" They responded, "No. I know, that's terrible. I don't." I was a bit stunned by this response and was not expecting it. My assumption was that professionals working in carbon offsetting believed the system would work in the long term and were investing in a longer term vision. Avery did communicate this optimistic view to me. Parker did not seem as certain.

"We honestly got to the point...where we stopped doing a lot of outreach to landowners for carbon projects because we felt like...I wouldn't sign any contract I'm going to put in front of you right now because the market is such a hot mess. And there are so few companies willing to put money into it early that you're asking the landowner to bear so much of the risk of a nascent market. So we just kind of got to the point where we're like, I don't want to go talk to landowners anymore, try to convince them to sign up for a carbon project when I don't even know if the market is real. So, from a trust standpoint, there's a lot of very skeptical landowners right now, understandably so. So I don't quite know what the right answer is, how to increase trust there, but somehow we have to increase trust that the market is going to be here in 10 years because otherwise, why would you sign up to lock your land up for 40 years?"

A key theme that has emerged across the two interviews has been the participants questioning whether the market is "real". While Avery posed this question at the beginning of their deep-dive into whether or not to utilize carbon markets as a sustainability tool, Parker questioned the reality and longevity of the market deep into their participation with it. Parker also brought up the necessity that people in the mainstream, outside of the sustainability space, needed to see carbon credits as a reality. They explained to me that most of their friends and acquaintances have no idea what "net zero" and "carbon credits" are– a significant barrier when attempting to convince for-profit companies to invest in attaining net zero emissions. If consumers

will not spend more for "net zero" products, why would the businesses spend money to reduce the carbon footprints? Of course there are many reasons why companies *should*. These reasons might include: preventing environmental collapse; mitigating risk to supply chains; and contributing to a livable world for future generations. However, it seems short term profit trumps long term self preservation in the minds of business leaders. Parker points to this lack of confidence and lack of consumer awareness as major limitations that threaten the future of carbon markets.

"I'm not saying it doesn't make sense in the world that I want to live in. But, from a financial standpoint, it doesn't make sense...we would talk to big oil and gas companies and they would say, 'my competitor isn't going to do this. If I do this, I go out of business because I'm no longer cost-competitive to my customers. Like I now have to...charge them this extra fee to be carbon neutral. They don't care if I'm carbon neutral. My stockholders don't care if I'm carbon neutral.' No one cares enough to pay the premium. So I think the other way is like, somehow, you have to convince consumers that they want to pay more for a carbon neutral product, and I don't see that yet. I mean, maybe that is coming and I hope so."

Parker and I spent a significant portion of the interview discussing pitfalls of market confidence and how the lack of confidence has impacted their ability to secure up-front funding. Another area impacted by the lack of up-front funding in

carbon projects is the initial community engagement. Parker assures me this initial period is essential groundwork to ensure the success of a project. As I learned in my interview with Avery, a carbon project requires significant input at the design stage. Parker describes how projects can completely fall apart if the initial stages of design and community outreach are not thoroughly thought through and talked through. At the organization where Parker works, they have found that–to be done well–this process takes two years. That is two years of groundwork that requires time and resources, with no dedicated funding. These projects move at the speed of trust, and with the shaky confidence in carbon markets, that trust has to be established by the project developers.

"We have just learned that you really need to do the community engagement work well at the beginning of the project to get community buy-in and to get long-term buy-in from your land owners. And it's really easy to skip that part because honestly, no one wants to pay for it. Like, funders don't want to pay for it because you do all of that before you even have a project design. So like before you would even have a set of documents an investor wants to see, you need to have done all that community work. So I think there needs to be more appreciation for how important that upfront work is because what we've seen is without that work, you get a year into a project and it falls apart because you didn't actually design a project that the community wanted or there's bad blood or there's just, you

underestimated you were going to need 10 people to work at the nursery and no one lives in that county in the middle of nowhere and like you didn't do your work to like understand what was really needed to make the project work functionally."

"...it takes two full years. Like, if you are not from the place, it takes two full years of conversations with people in the area to gain trust, [you have to] figure out who your early adopters or like linch pins are... who are the people in the community that people look to and they're going to follow their lead, and then can try to convince them...it just it takes two years. Before you even planted anything. Just the relational part."

The other key takeaway about project design that I gained from my interview with Parker, was that when dealing with landowners, the solution that the project developers propose has to solve a problem that the landowner already has. While it is obvious that climate change is a problem we all have and will impact landowners in the longer term, that has not been a strong enough incentive to gain the participation of the people that Parker has reached out to. When designing carbon projects, the developers have to conduct discovery to find out what the cares and concerns the landowners and surrounding communities have. If the project does not alleviate any of their cares and concerns, it will likely be too challenging to convince them to adopt it purely to help alleviate the climate crisis.

"...you really have to be solving a problem that already exists in the space that you're trying to go into. So it's going to be very hard to–at least for nature-based projects–to convince any landowner or land manager to do something that doesn't solve a problem they already have...otherwise you're just adding inconvenience in exchange for maybe dollars, which they don't want to do. So what we've found is if you can find the landowners, like the [Company] in [State] who had 10,000 acres of wildfire burn area that they were not making any money off of, okay, we helped them solve a problem. Or in [Country] where we were working, the soil was super degraded. The cattle farmers were not able to continue to graze, so they were cutting down more trees and then grazing there. So by creating this system with trees and grass and what we call fodder that the cow can eat, we were solving a problem for them. They could keep more cows and have more livelihood, while also benefiting the environment. ... trying to find ways to basically build problems that address the needs of the community you're in versus just coming in from the outside and saying, 'Hey, here's a solution.' And they're like, 'I didn't have a problem.' ...what we would call co-designing the project. So as much as possible, instead of coming in with a fully baked project design and handing it to a landowner, [we are] building it with them. And then we're trying to do this part, but this part is hard. Like also trying to co-design with your financers or your funders. So bringing them in earlier so that they are more aware of like, these are the challenges and let's let's build this program

together as opposed to like, 'Hey, we built this whole project and now we need $10 million,' and they're like, 'We don't really like what you built.' ...Trying to get everyone aligned from the beginning on what the design is instead of bringing someone in later and down the road and then it doesn't really work out. So, alignment of project goals from the beginning."

My interview with Parker illuminated the necessity of groundwork and relationship building in the early stages of carbon projects. Given that there is no guaranteed source of funding for this early work within the financial model of carbon crediting, other sources of funding must be secured. Parker notes that in the projects they have seen achieve success, this initial funding was secured through grants. It seems that this financial gap must be addressed in order to increase confidence in carbon markets and improve project outcomes. This point reminded me of my discussion with Avery who described the necessity of mechanisms, such as government subsidies, to support these projects while the markets are still nascent. When I raised the question of government intervention to Parker, they claimed to not be "a big government person" and thought that a carbon tax imposed by the government would be too "unwieldy". However, they suggested that if the government would step in to certify carbon credits (similar to USDA organic certifications on food) that would likely increase trust from companies to consumers and benefit the strategy as a whole.

After my interview with Parker, I reflected on my research question, which asks how the experiences of these sustainability professionals might help us to understand the roles that trust, power, and accountability play in shaping the integrity and outcomes of carbon offset projects. From Parker's perspective, it seems that carbon projects need more of three things in order to succeed: relationship-building (shared power); trust; and dollars.

"...if you can bring them [funders] into relationships with the people who are actually going to be doing the projects, I think that will help. I haven't seen anybody actually doing that in the U.S. So this is a theory to figure out– how could we get funders to be more connected to the projects they're doing? So that it's more real. And so... when hiccups come up or time frames take longer than normal, you're thinking about real people, not just a gantt chart that's messed up."

Cultivating a Culture of Openness

The quality of communication, curiosity, and transparency between all parties engaged in carbon projects should properly illuminate the efficacy of a project, while also providing the opportunity for questions and insights. This deeper inquiry could open the door to identifying potential pitfalls or consequences of the project, particularly in the early design phase. The relationships across the participants of carbon projects can significantly drive progress toward GHG emissions reduction, making these relationships ripe for deeper

evaluation. Mistakes have been abundant and offer a rich pool of learning. A culture of transparent dialogue and disclosure must continue to be fostered in order to improve carbon offset projects. The current media environment is a significant barrier to developing this culture of openness and iterative progress. While offsets drive funding into nature-based solutions, offsets also face immense difficulties getting projects off the ground without up-front funding. Investors and private donors must be included in the essential groundbuilding within the ecosystem of a carbon project, particularly in reforestation as projects do not begin meaningful carbon reduction until reaching maturity. This research demonstrates the necessity of upfront investment, transparency across key relationships, and community engagement. Carbon offsetting faces significant hurdles to overcome lack of confidence in the markets, to drive further investment, and to build trust and transparency across participants. Through focusing on the social structure of these projects, this research provides insight into how to face those challenges and further the continued iteration to improve an imperfect system.

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Identifying Key Barriers and Enablers to Sustainable Development in San Diego's Commercial Real Estate Sector

Sydney O'Connor

Abstract

In San Diego, factors such as population growth, rising costs of living, and environmental risks make it increasingly challenging to integrate sustainable strategies into the construction process. This research analyzes how these challenges impact the commercial real estate sector and identifies both the barriers that hinder progress and the enablers that can drive meaningful change. By understanding these dynamics, the study aims to offer practical insights for advancing sustainability and resilience in San Diego's built environment. This research incorporates a literature review to identify both general barriers and enablers within the construction industry, as well as those specific to San Diego. The review revealed that San Diego enforces strict sustainability requirements for both new and existing developments. It also highlighted the city's proactive efforts to enhance sustainability through initiatives, such as the Climate Action Plan, the Green Building Program, and others aimed at decarbonization, net zero emissions, and improved energy efficiency. These frameworks provide a foundation for sustainable development, but their implementation still faces practical and systemic challenges within the commercial real estate sector. While these requirements and initiatives offer many benefits by reducing environmental impact, they pose a different set of obstacles to the construction industry. To build upon the literature, several stakeholders were interviewed about their personal experiences when it comes to integrating sustainability into their specific roles. The interview participants represented both sustainability teams and construction teams. Each person was given the same set of open ended questions, in hopes that they would provide their own personal, creative responses. The result of the stakeholder engagement part of this project was incredibly insightful and valuable to this study as many of the responses, although they were from different people in different roles, overlapped and highlighted the need for systemic change in the project process, From these findings, the key barriers identified were associated with cost and uncertainty, whereas the key enablers were associated with stakeholder engagement and optimizing revenue generating opportunities. The methodologies used throughout this project helped reveal the concerns and needs of construction teams,

emphasizing the importance of establishing a framework to support smoother integration of sustainability within the broader scope of project planning and execution. Building more sustainable and resilient communities requires systemic change and stronger collaboration between sustainability and the construction industry.

Driving the Sustainability Imperative in Construction

The built environment has a substantial impact on our surrounding ecosystems, quality of life, communities, and many other critical aspects of our everyday lives. The process of shaping and developing our communities requires a deeply intentional and thoroughly planned out approach, especially when sustainability and resilience are prioritized throughout the decision making process. This project focuses on sustainable developments, specifically in the city of San Diego, California. The construction industry is one of the top contributing industries for both waste and carbon emissions. Reducing the impact of this industry is difficult considering it takes such a large scale effort with so many different stakeholders involved. This challenge is also exciting because the benefits of implementing sustainability into projects can

Photo via ICLEI

help protect the environment, strengthen surrounding communities, and also provide potential revenue generating opportunities.

My project will address the following research question:

What are the key enablers and barriers to implementing sustainable developments in the commercial real estate sector in San Diego, and how can we use those insights to cultivate sustainable, resilient communities?

This topic is important considering that California has enforced some of the U.S's most ambitious goals related to sustainability and has set some very strict regulations for both new and existing developments. While this is great for the planet and our communities, it cannot be ignored that this can be challenging for construction companies and other stakeholders to adapt to. San Diego and many other coastal communities in California are heavily populated and face certain barriers due to spatial constraints and the overall high cost for construction. This capstone aims to provide some more insight into these barriers to help identify feasible solutions, while also making the case to stakeholders that sustainable initiatives and regulations are both necessary and beneficial.

The following

sections of the study examine key factors influencing San Diego's built environment by analyzing regulations and programs that both facilitate slow down the advancement of sustainable construction. In addition, the study explores how these methodologies engage relevant stakeholders within the industry. The stakeholder insights offer valuable perspectives on challenges and personal experiences that are often overlooked in existing California regulations and programs. This analysis also emphasizes the importance of improved stakeholder engagement and cross sector, collaboration, illustrating, how identified barriers and enables can inform more effective, inclusive sustainability practices

Contextualizing Sustainable Construction Through Existing Literature San Diego Development Case Studies

ULI Case Studies provides numerous case

studies of real estate projects specific to the San Diego region. There are several developments in this resource that provide key information of commercial developments that saw both financial success, while also having sustainable attributes. For example, one case study discusses a 250 unit apartment complex that offered affordable housing units and was LEED certified. This is located in Downtown, San Diego, which is highly populated and typically has a high cost of living. This specific study helps identify both opportunities and barriers the developers might have faced during the process, and provide a real life example of how this project benefited the surrounding community. This is a supportive document that builds the case for sustainable developments and how specific opportunities have already been carried out.

San Diego's Climate Action Plan

The San Diego Climate Action Plan

Photo via the City of San Diego

outlines the city's key initiatives for sustainable development. Their priorities include building decarbonization, energy efficiency, climate resiliency, waste reduction, and increasing the quality of life in communities. The CAP focuses mostly on environmental goals, this is beneficial in certain aspects because it encourages the commercial real estate sector to pursue sustainable projects as it discusses renewables, mixed use developments, helpful incentives and regulations, and decreased utility costs. While it is a great resource to outline priorities, there are some identifiable gaps including strategic considerations for construction companies. This may make the feasibility of these priorities seem more challenging, however, this capstone project may help bridge this gap considering it will include considerations related to aiding high construction costs and revenue generation opportunities sourced from sustainable developments.

Instances of Environmental Injustice

A part of this study seeks to assess matters of environmental justice in connection to San Diego. Identifying current instances in this area can help determine areas of improvement for the solutions proposed and work towards an inclusive, participatory approach when planning out new developments. When starting out the research on this topic earlier in the program, it was found some cases in which environmental racism

was present in certain parts of San Diego and were perpetuated due to redlining and zoning laws. Pulido argues that white privilege perpetuates environmental injustices including redlining, zoning laws, racial capitalism, and other factors. White neighborhoods are usually at both a geographic and economic advantage, whether it is intended or not. In San Diego's case, zoning laws pushed industrial and highway pollution (out of predominantly white neighborhoods) and into areas like Barrio Logan. "For decades, the working-class, historically Mexican-American and immigrant residents have fought uphill battles against junkyards, ship yards, and industrial repair shops that moved into the barrio, creating air pollution, noise pollution, and numerous other conditions that would never be tolerated in San Diego's more affluent surrounding

Estimated* Social Vulnerability Index by Subregional Area, San Diego County, 2022

187
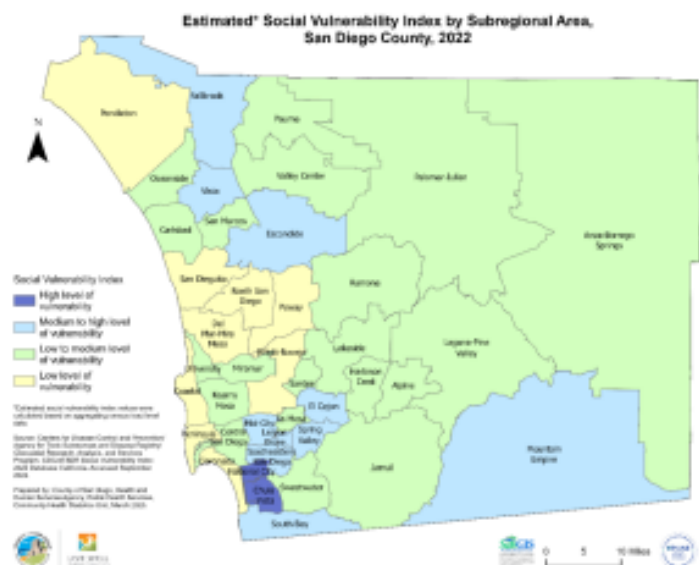
residential areas. It's no coincidence that Barrio Logan is one of the most polluted areas of San Diego—the area is also more than 70% Hispanic, and about 20% of residents live below the poverty line" (Camacho, 2022). (O'Connor, 2024, Module 4 & 5 Case Study Portfolio). While these sources don't necessarily build on the barriers or enablers of sustainable developments in San Diego, they are an important component considering they emphasize that environmental justice needs to be considered during the development process and in order to do so, we need to understand mistakes that have been made in the past. These resources can bridge the gap by including social aspects that most of the other resources do not include.

California's Title 24

Title 24 is part of California's Code of Regulations. There are 12 different parts including standards for building codes, energy efficiency, existing buildings, and the CALGreen (green building standards) code. Title 24 consists of both mandatory and voluntary codes and is updated every few years. These standards have a huge impact on sustainable development in the state. In the context of waste reduction, one specific example of this is part of Part 11's CALGreen code that 65% construction and demolition waste must be diverted from landfills through either recycling or reuse as long as the materials are non hazardous. Title 24 also provides guidance on selecting materials (by considering recycled content and product life cycles), how to recover

materials, and voluntary zero waste standards (O'Connor, 2024, ESH 521 Magazine). This is a strictly regulatory, informative document that builds context for the reader. It does not cover trends or recurring biases that may be discussed or identified in the capstone. The purpose of including Title 24 in this project is to emphasize the impact these regulations have on commercial projects, how this increases sustainable aspects of buildings, and provide context on how this adds to potential barriers and opportunities. From my own observations, California developers find that Title 24 has some great objectives, but often there are challenges associated with cost and the availability of resources that make it very difficult for companies to meet its requirements.

Some highlighted requirements from Title 24 include:

- For multi-family projects, Title 24 requires that 10% of spots are equipped with a level 2 EV charger and 40% must be EV capable (meaning it has a conduit so it is easy to install chargers in the future).
- All new commercial, multifamily, residential developments must have solar panels. The amount is based on building size and projected energy usage.
- In the context of waste reduction, one specific example of this is part of Part 11's CALGreen code that 65% construction and demolition waste must be diverted from landfills through either recycling or reuse as

long as the materials are non hazardous.
- Title 24 also provides guidance on selecting materials (by considering recycled content and product life cycles), how to recover materials, and voluntary zero waste standards (O'Connor, 2024, ESH 521 Magazine).

The Green Building Program

San Diego's Green Building Program serves as a complimentary resource that is well aligned with the Climate Action Plan. Its core objectives include lowered electric and water utility costs, environmentally effective use of building materials, enhanced health and productivity, long-term economic returns, and reduced environmental impact. A notable aspect to this resource is that it looks at the financial components of green buildings, which can help support the enablers section of the capstone project while also providing potential solutions to the barriers section when applicable. This program is very environmentally focused, similar to the CAP, so it does have components related to affordable housing, considerations associated with environmental justice, and the inclusion of strategic methodologies for developers on how they might accomplish these programs.

Community Outreach & Engagement Plan

The Midway Community Outreach & Engagement Plan outlines a strategy for community engagement and public participation for a Sports Arena redevelopment project in 2021. While this project is not in scope of the key focus of this project, the main purpose of this resource is to support my focus on the importance of community engagement/participatory approaches during the development process, to help bridge the communication gaps between the involved stakeholders. This helps mitigate the risk of various barriers including public opposition, lawsuits, displacement, etc. While also helping identify opportunities by evaluating public demands. Overall, I favor the structure of this outline, and it serves as a valuable reference for the capstone project. It highlights the use of public meetings, consistent communication through newsletters and emails, and meaningful engagement with stakeholders from the early planning stages through to project completion. I look at this also from a critical lens, not just to understand what is currently working, but also to identify areas where communication, inclusion, or process transparency can be improved in future projects. This approach allows for a more well-rounded analysis that acknowledges effective strategies and emphasizes the need for more equitable and sustainable practices moving forward.

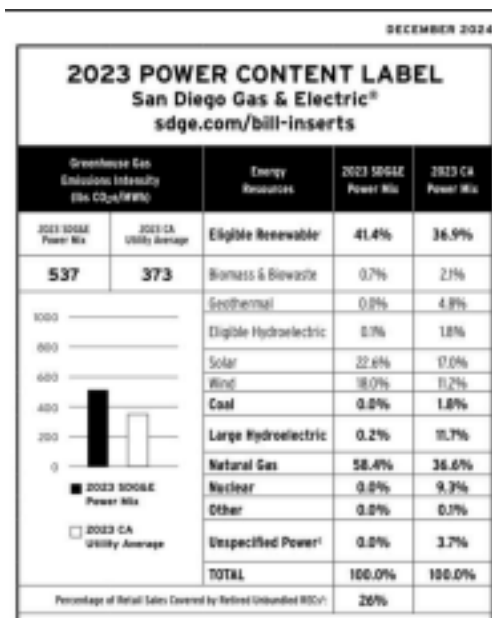## The Rising Value of Sustainability in Commercial Real Estate

This article by LPA discusses the value of sustainability in commercial real estate. This is a more broad source, however, I have used it in previous courses

as it identifies several reasons why sustainable developments are worth it on projects. This is not a neutral article by any means and it will be used to support my argument in the opportunities section. I also look at this article with the intent to identify barriers, while simultaneously using additional resources and conducting interviews to gain deeper insight. This article offers an overview of the various benefits, particularly highlighting the financial opportunities tied to operational

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Greenhouse Gas Emissions Intensity (lbs CO₂e/MWh)		Energy Resources	2023 SDG&E Power Mix	2023 CA Power Mix
2023 SDG&E Power Mix	2023 CA Utility Average	Eligible Renewable	41.4%	36.9%
537	373	Biomass & Biowaste	0.7%	2.1%
		Geothermal	0.8%	4.8%
		Eligible Hydroelectric	0.1%	1.8%
		Solar	22.6%	17.0%
		Wind	18.0%	11.2%
		Coal	0.0%	1.8%
		Large Hydroelectric	0.2%	11.7%
		Natural Gas	58.4%	36.6%
		Nuclear	0.0%	9.3%
		Other	0.0%	0.1%
		Unspecified Power	0.0%	3.7%
		TOTAL	100.0%	100.0%
		Percentage of Retail Sales Covered by Retired Unbundled RECs	26%	

cost savings and investment tax credits (ITCs). I appreciate its fiscally driven approach, as that aligns well with the priorities of the target audience in this industry. While the article does acknowledge key barriers and nuances, it does not necessarily include direct solutions to them. This gap presents an opportunity for this project to explore how these challenges can be addressed through systemic changes,

integrative strategies, and further collaboration amongst stakeholders within the industry.

Building Decarbonization & San Diego Community Power

As part of San Diego's Climate Action Plan, they have built out programs to improve Building Decarbonization. This resource provides insight on how the city plans to reduce emissions within their communities by transitioning to renewable energy. It gives insights into their San Diego Community Power Program. San Diego Community Power is a community driven, not for profit public agency that provides clean energy to various cities in San Diego County. SD Community Power offers different service plans, for example, my local community is enrolled in the PowerOn plan, which provides at least 50% renewable energy. SD Community Power Energy mix consists of solar and wind energy. From there, the remaining energy mix is provided through SDG&E's Power Content Label (PCL) below. This resource provided more context as to San Diego's current initiatives that are already in place and plans on how they can be facilitated. This builds upon this project because it provides the context needed to understand San Diego's current initiatives and plans for facilitation.

Building Energy Benchmarking

The Building Energy Benchmarking Ordinance is part of San Diego's municipal code. The ordinance requires commercial buildings over 50,000 square feet and

multifamily and mixed-use buildings greater than 50,000 square feet and with 17 or more residential accounts to submit energy data to the City of San Diego into the Energy Star management system annually. The Energy Star platform allows for buildings to track their usage and building performance, and it provides a scoring system for those who wish to become Energy Star certified. This resource was found when analyzing San Diego's Climate Action Plan. This is a supplementary source for building owners and property managers as they can also use this as a tool to decrease the buildings carbon footprint, allowing for them to reduce their environmental impact, receive a certification, and increase property value. For this project, this resource builds upon the argument that San Diego does have resources that help facilitate their requirements, while also differentiating themselves in the market and building the company's reputation as a sustainable developer.

Dominant Trends & Gaps

Trends	Gaps
Strict Regulations & Commitments to Sustainability	Lack of discussion amongst stakeholders
Environmentally focused goal setting	Lack of support regarding the feasibility and strategic methodology to meet goals/requirements
The demand for ITC's to reduce the cost of projects to attain compliance	
	Some resources do not address the affordability aspects of projects related to materials, construction, or housing for residents.
Increasing market demand and property value for sustainable projects	
The prioritization of building decarbonization, energy efficiency, climate risk mitigation, and zero waste	There needs to be a greater emphasis on the return on investment (ROI) & revenue generating opportunities (RGO) for sustainable projects/green buildings

The literature reveals that San Diego, and California more broadly, has implemented legislation, programs, and goals aimed at advancing decarbonization, energy efficiency, climate risk mitigation, and waste diversion services. Between the strict requirements for the construction of new and existing buildings and the growth in demand for sustainable building features, there has been an increase in need for resources and financial support, such as incentives and tax credits, to offset project costs. However, there were systemic gaps also identified. Project teams are expected to comply with state and local mandates, yet often lack the necessary guidance, frameworks, and tools in order to do so. Another recurring theme is the need for more accessible resources that clearly depict

the financial value and long term return on investment and revenue generation for sustainable building integration.

Project Methodology and Approaches

Industry Experience:

Currently, I'm working on the sustainability team for a construction company and a portion of my research has come from that experience. During this time at my company, I've learned a lot about California regulations, sustainable materials, building certifications (like LEED), climate risk mitigation, and the overall processes to design, build, construct, and operate buildings. On one hand, my professional experience provided an initial advantage in identifying key focus areas for this project. However, I was also aware that my positionality could introduce internal biases during the data collection in the analysis process. To mitigate this, I made a conscious effort to ask neutral research questions in approach, interviews, and data collection with an open mind. This allowed for a more comprehensive understanding of the potential barriers and enablers, while also ensuring the integrity and inclusivity of the research process.

Literature Review:

Throughout this program, the capstone project and major assignments were tailored to align with the construction industry, and in subject courses, such as sustainable energy, environmental justice, zero waste, and the built environment.

Information and resources were gathered that can help build context for the capstone project. The main goal of the literature review was to seek out resources more relevant to the San Diego area. From this, case studies and examples that are relevant to the subject courses and to help identify specific opportunities and barriers were found. The proposed literature provides insights into a lot of key components of this project and support either project barriers or opportunities; however, this capstone project can add to these works by making it more specific to the San Diego region. My project will attempt to address the gaps listed in the section above, especially the ROI and RO component, by conducting research on San Diego's existing practices and projects, and interviewing involved stakeholders in the construction industry

Stakeholder Engagement:

For this project, I interviewed several stakeholders in the construction industry who have experience with different roles, projects, and stages of construction. In total, 9 stakeholders were given the same prompts in the same order. Participants were briefed prior to the interview on the research question, however, they were not provided any more examples or context outside of the questions provided so that they were not indirectly inclined or swayed to give a certain answer or conform to a certain bias. The purpose of these interviews was to gain insight on the key barriers that they face when helping develop sustainable projects. For the most part, I received some great insights which were reassuring that the

prompts were an effective strategy to get personalized responses. Some respondents were asked to clarify or expand on their answers if they did not provide enough context for the intended audience of this paper. A few of the interviewees were on a sustainability team within their company; these participants have more bias towards the benefits of sustainability and have a good understanding of the key enablers associated with a reduction in environmental impact, revenue generating opportunities, low emission materials, and increased property values. The remainder of the interviewees fell into more standard construction roles and shared some frustrations with sustainability due to various factors including cost and prolonged project timelines. After conducting all of the interviews, I kept note of all responses and created a list of recurring themes or factors. I also noted if certain responses were already mentioned in the literature review or if they had presented entirely new concepts. This helped develop the summarized table, and areas for expansion and future research.

Present/Missing Perspectives:

Overall, my research and supporting literature provides a well rounded and inclusive representation of all the stakeholders relevant to my research topic, including members of the construction industry, sustainability professionals, representatives of city governance, and concerns voiced by community members. Each of these perspectives plays a critical role in creating valuable, feasible solutions. While I will be considering all viewpoints,

my primary focus is on stakeholders in the construction industry, as they are the key audience for this project. They will also serve as the main subjects for my interviews and industry engagement efforts. This will help me understand their decisions, processes, challenges, and opportunities to integrate sustainable practices into their projects. However, I do recognize the importance of obtaining a border context and polyvocality, which is why my research will incorporate insights from many stakeholder groups, through literature reviews, case studies, and policy/regulatory analysis.

My research and supporting literature provides a well rounded representation of the stakeholders relevant to my research topic; focusing on sustainability and construction teams. However, there are some key stakeholders that were not involved in the engagement process. For example, representatives of city governance, utility companies, manufacturers/suppliers, and community members. Each of these perspectives plays a critical role in creating valuable, feasible solutions. While I do believe all viewpoints should be considered, my primary focus is on stakeholders in the construction industry. They served as the main subjects for my interviews and industry engagement efforts. This ultimately helped me understand their decisions, processes, challenges, and opportunities to integrate sustainable practices into their projects. However, I do recognize the importance of obtaining a broader context and polyvocality. While my stakeholder

interviews did not cover this scope, my research incorporated insights from many stakeholder groups, through literature reviews, case studies, and policy/regulatory analysis.

Stakeholder Insights: Bridging Sustainability and Construction

1. Stakeholder Engagement: Key Points & Response Examples

As part of the research and engagement portion of this project, questions were asked to several stakeholders in the construction industry who hold different roles and contribute in different ways to the implementation of sustainability on projects. Considering that their responsibilities and backgrounds vary (some are more involved in sustainability, while others have very little to do with it), questions were intentionally made to have a broader scope so that they were applicable to all interviewees. The question prompts are geared to help address the research question through the lens of different stakeholders given their roles, responsibilities, and positionality. Below is a synthesis/summary of the interviewees responses and key quotes or points of emphasis are highlighted.

Question 1: What is your job title?

Each participant has a different role in the industry to help achieve response diversity. Some interviewees held roles specific to sustainability. Examples of interviewee roles include Chief Sustainability Officer, a Senior

Sustainability Program Manager, a Director of Sustainability, a Sustainability Construction Program Engineer, etc. Other interviewees held more traditional roles relevant to the various stages of the construction process. For example, a Developer, Procurement Manager, Preconstruction Manager, Estimator, etc.

Question 2: How is your role related to, or impacted by, sustainability?

This question, while it may seem broad, was intentionally included to account for the diverse range of participants interviewed for this project. Some individuals hold positions that are centered around sustainability, with responsibilities that align with a corporate strategy, materials, design, etc. Others, however, may interact less with sustainability based on their role, but are impacted by it through working with sustainability teams, ensuring compliance legislation and green building codes, or participation through other scenarios. This question ensures that roles are clarified and their perspectives are welcomed regardless of how much or how little they interact with sustainability.

"I compile the preliminary construction budgets that ultimately get entered into the development program to determine if a project is financially feasible."

"My role is centered on supporting our design team through sustainability discussions with all projects and all clients around the country."

"My entire role centers around advancing sustainability in construction. I focus on integrating sustainable strategies into our projects and business practices in a way that maintains — and often enhances — quality and performance. Each decision I make is grounded in balancing environmental responsibility with constructability, cost-efficiency, and client goals, helping drive meaningful progress without compromising project outcomes."

"Developing housing relates and is impacted by sustainability in many ways: where we build (urban vs suburban), what we build with (material selection), how our homes operate, balancing costs with sustainability goals, etc."

"Primary responsibilities include strategy development/management, public affairs, communications, reporting, innovation, governance, capability development, government relations, business development and leadership of the national sustainability team. These responsibilities cover the priorities of climate protection, decarbonization, water stewardship, sustainable materials, circular economy, natural capital, biodiversity as well as the social benefits of these programs."

Question 3: What are the biggest obstacles you face when trying to implement sustainable initiatives on projects? Please expand on your response. For example, if you mention cost, explain what specific costs are associated. If you mention project delays, provide general examples of how sustainability efforts have affected the schedule.

The following responses from participants were very insightful. The primary concern prior to the stakeholder engagement phase was that participants would respond with common answers, particularly those centered around cost.

While financial considerations are undeniably significant, the objective was to retain thoughtful, honest responses that went beyond surface level factors, ideally incorporating less commonly acknowledged perspectives and real world. Examples sourced from their own experiences. The following summary outlines the key themes identified by the stakeholders, which will be further analyzed in relation to the construction industry in the following

analysis section of this paper.

<u>Response Examples:</u>

- Cost
- Uncertainty associated with roles and responsibilities
- Reluctance to change
- Difficulty keeping up with code compliance and updates
- Integration challenges
- Lack of framework within the project process

Question 4: Have you encountered communication gaps between stakeholders (e.g., utility companies, city agencies, suppliers, clients, internal teams) that hinder sustainability efforts? (Yes or No. If yes, please explain. Bonus: If you have ideas on how this could be improved!)

Everyone said yes, which is great to hear in terms of finding room for improvement, but a few common themes stood out across the responses. One was that stakeholders have different "whys" - meaning they each have their own reasons or interests driving certain project demands. Because of this, sustainability teams need to take the time to understand those motivations and communicate in a way that aligns with them. Another big takeaway was that sustainability needs to be more seamlessly integrated into projects; it should be something that is automatically included rather than treated as an extra step. A recurring challenge mentioned was the lack of coordination and unclear allocation of responsibilities between teams. Often, no

one takes the lead or initiative on specific tasks, which leaves things unresolved and can make scheduling difficult and drawn out.

Question 5: Have you been involved in any projects or tasks where sustainability was successfully integrated? What factors helped make that possible? What were some of the benefits you observed (e.g., revenue generation, cost savings, environmental impact reduction, building certifications, increased property value)?

A majority of the responses said yes and shared that they experienced successful projects due to certain factors like strong communication which allowed for client goal alignment, team collaboration (early on in the project process), and the demonstration of skill sets (the sustainability team was able to showcase skillsets). However, a few responses stated that in their specific position, there were no benefits as sustainability made their role and project process more complicated and expensive.

Question 6: In your role, if you had no budget limitations or technical constraints, what's one sustainability related feature, process improvement, or idea you would include in your projects/tasks? For example, a material, a building feature, a change in the planning or discussion process.

Although this question was intended to be more lighthearted in comparison to the others, it was also aimed to reveal the interests and priorities of the interviewees. This gave them the opportunity to respond

creatively, while also highlighting their priorities.

Response examples: Mass timber, low carbon concrete, implementing a carbon budget, a universal carbon tracking tool, starting projects out by asking/determining if they are net zero feasible to start the efforts early on, various design considerations, fiscally focused business value models, green roofs, and clean energy on all job sites.

Overall, I appreciated the variety of responses, which aligned well with the barriers and opportunities participants discussed in previous questions. Some responses focused more on physical resources, such as low emission or sustainable materials. Others emphasized process related resources, such as implementing biomimetic or climate resilient designs, and technical resources like financial tools and other supportive mechanisms.

Stakeholder Engagement: Response Analysis & Connection to Literature

Key Barriers

- Cost: For teams, cost is commonly associated with labor and impacted schedules, billable hours, purchasing products such as solar panels or EV chargers, purchasing more sustainable materials.
- Uncertainty associated with roles and responsibilities. In some cases, roles may not be allocated for specific tasks, this can create confusion and a lack of initiative.
- Reluctance to change: Some may oppose sustainability due to factors related to the barriers listed or may feel that integrating new principles into a project process can be risky.
- Difficulty keeping up with code compliance and update: For example, many participants stated that California's Title 24 imposes some impactful requirements, but there is a lack of explanation on the methodology and strategy that comes with it, on top of the increased cost to meet these requirements. For sustainability teams more specifically, codes, incentives, and building certifications are always being updated, which requires effort or consulting to gain a better understanding.
- Integration challenges: this pertains more difficulties related to the overall construction process and alludes to systemic changes.
- Lack of framework within the project process: There is not necessarily a standard for implementing sustainability into projects aside from policies and building codes. This can make it difficult for teams to determine best practices for each step.
- Citywide Limitations: San Diego is experiencing a housing crisis considering there is a housing shortage, high construction and land acquisition costs, and a vastly

increasing population.

The most prevalent and common barrier both discussed in interviews and identified within literature was cost. This was not a shocking barrier as cost is associated with many factors within this industry. To gain some surface level context, one must consider the many costs associated with labor, materials, equipment, subcontracting, and property management. However, there are also additional costs to integrate sustainability into projects. For example, sustainable materials often come at an increased cost due to the expenses to produce and transport them. On top of that, often sustainable materials can impact project timelines. For example, low carbon concrete takes longer to cast and requires more time and labor. It is also very difficult to balance costs and sustainability mandates with the housing economics in San Diego. For example, as part of Title 24, projects must implement a certain percent of solar and EV charging options based on the size and scale of a project. However, this can be very costly and also raises an issue of affordability. One interviewee shared a perspective that really resonated with this point, "Energy code requirements and solar mandates drive the cost to build housing up while we are dealing with a housing affordability crisis. What is more important...ensuring folks have an affordable roof over their head *or* requiring every new home to have solar which adds $25,000 to the purchase price." This brings up its own set of questions and considerations regarding how to reduce the

cost of building attributes, like solar and EV chargers, through incentives and tax credits, policy change, scaling out domestic production, and building out company wide capabilities that utilize net metering or implementing strategies, cost efficient programs internally (within the company.

There are also many systemic factors that make this process more complex. Many of the responses alluded to the fact that it is very difficult to integrate sustainability into projects due to a lack of framework (which is something that needs to be built out internally. Another aligning barrier was a general reluctance to change or fear of change due to uncertainties and the need for the necessary skill sets. Sustainability does take effort, which can be intimidating to teams and building owners taking on large scale projects, especially with potential profits involved. Uncertainty, a lack of process frameworks, and integration challenges all require one key component; communication amongst internal stakeholders. This requires time, collaboration, and work considering teams need to work together, identify their own personal barriers/enablers, create a cohesive process that identifies their roles and responsibilities, and obtain adequate resources and financial support. Another effort might be to shift the mindset of stakeholders who might find that sustainability is too challenging, costly, etc.

This is when it becomes essential for sustainability teams to build out the capability to discuss the enablers of sustainable developments and be able to

learn to speak towards a variety of audiences.

Key Enablers

- Increased asset or property value: Properties with features are more desirable to tenants in some cases. For example, tenants may appreciate if a property has EV chargers on site.
- Market differentiation: This allows teams and companies to demonstrate their capabilities which can attract attention and bring on future projects.
- Revenue generating opportunities: early integration of sustainability, supported by strong analytics and stakeholder collaboration can increase asset value, generate revenue and manage climate risks while also providing cost savings to end users.
- Early and effective engagement amongst stakeholders (communication with clients early on, allocating responsibilities): This was expressed the most. This means integrating sustainable materials or requirements into project specifications and requests for proposals.
- Reduced environmental impact: Many strategies help reduce a project's carbon footprint, water footprint, waste, etc.
- Obtaining building certifications: Building certifications are not only an achievement for the project, but also for teams, as they are able to

showcase their skillset to clients. Also completing these make the process to get another easier in the future and can attract future projects with clients seeking to obtain these certifications.
- Established policies, goals, and outlines: San Diego has helped outline sustainable initiatives through their state and local regulation, the climate action plan, and the green building plan.

Over the last decade, the real estate industry has experienced a growing demand for sustainable projects. Many of the interviewed stakeholders emphasized how policies and market trends have contributed to this shift. Their insights aligned with the findings from my previous research in the ESH 521 magazine, which looked into the reasons behind this increased interest. The following factors, drawn from that research, help contextualize participant responses.

Accountability

As more and more individuals gain both education and awareness on climate change, they realize that it will continue to be a threat for people and the planet unless we do not take action and transition to alternatives. A push for policy and change on behalf of the people has increased the amount of environmentally related regulation and policy. We have seen this in California and more specifically San Diego especially within the construction industry and the built environment, through Title 24, which is only one of many effective and

impactful codes.

Shift in the Market

The real estate industry has shifted its interest as there's been a growing demand for sustainable real estate. Companies who have committed to taking responsibility or ESG related initiatives have requested developments that consider net zero carbon and zero waste goals. The built environment has seen the consequences of climate change due to extreme weather patterns, which has shifted the overall demand for climate resilience and risk mitigation planning.

Industry Goals

In addition to the market shift and taking accountability, companies are setting ambitious goals revolving around sustainability. There are a wide variety that entertain many ESG topics, but the three core goals include energy efficiency, material circularity, and certifications (LPA, 2024). As we've reviewed, the built environment concerns all three core goals, which gives companies the opportunity to grow as a reputable sustainable developer.

Supporting Statistics

- Premium on Sustainable Features: Properties with sustainable features often command higher market values. For instance, a study by the Building Owners and Managers Association International indicated that buildings with LEED certifications can achieve up to a **10% premium** in rent over

non-certified counterparts.
- Growing Investor Demand: There is a clear trend of investors prioritizing sustainability. A recent survey by the Urban Land Institute found that **74% of investors are willing to pay more for buildings with sustainable features** due to their reduced environmental risks and potential for higher returns.
- Reducing Operational Risks: Sustainable buildings are designed to **minimize resource wastage and optimize energy use,** which not only reduces operational costs but also mitigates the risk of obsolescence (LPA, 2024).

From the interviews, the most common response was that the most effective enabler was early and effective engagement amongst stakeholders. This approach is applicable throughout the various phases of construction, from initial planning through design and implementation. Insights drawn from both the literature, particularly the ULI case studies, and personal/participant experiences emphasize that one of the most critical stages is the early engagement of project clients or property owners. This early dialogue allows teams to identify sustainability requirements, determine the desired level of code compliance (meeting or exceeding code minimums), and adjust project specifications and timelines accordingly.

This strategy is also cost-effective, as it reduces the likelihood of future retrofits,

which are often significantly more expensive than integrating sustainable features during initial construction. For example, if a property owner decides to install additional electric vehicle chargers, retrofitting may require removing flooring to lay new conduit, upgrading electrical systems, and navigating costly permitting processes. These expenses, alongside the cost of the chargers themselves, can be substantially higher as opposed to installing conduit or ensuring that parking spaces are EV capable or EV ready during construction. Early planning and engagement not only aligns with client and company sustainability goals, but it also presents a strong financial case by minimizing costly modifications.

Response Examples

"We saw increased asset valuations and the opportunity to derive greater profits when sustainability was approached holistically from the very beginning of a project. The key was early engagement on sustainability, coupled with sophisticated business case analytics and stakeholder willingness to do things differently. There is significant business value to gain from this type of approach. Also, a more holistic approach, started very earlier in the project development process is also key if increasing climate risks are to be successfully managed."

"We are implementing a program on a development where we are able to generate solar energy cost effectively, provide it to our residents at a discount to what they would be paying the utility company, and capture a reasonable spread/profit in the process. It's a win-win solution for everyone that leverages the benefit of clean sustainable energy."

"Early integration, team alignment and team buy-in were what made this success! When we had team buy-in, we were able to set the projects up to succeed, whether it was carrying through sustainability language into the contracts, billing utility information to the same cost code so we knew where to find it, not VE-ing out some of the big hitter sustainability items, etc. Another big win was that the teams were properly

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allocated time to work on the sustainability items that impacted their scope!"

When looking at the interview responses as a discussion, I observed that many of them brought up the same concerns or factors that aligned with one another. Although they are in different positions with differing responsibilities, they would for the most part agree with what the other participants discussed. For example, most of the non sustainability focused roles emphasized cost, whereas sustainability teams emphasized the need for more coordination. I believe this comes down to each participant's own mindset and priorities within the project process, but each side (construction and sustainability teams) discussed these two factors more than once. As reviewed earlier, many participants mentioned their concerns with cost and stakeholder collaboration, but agreed that there were also enablers to help ease this by engaging stakeholders early, especially internal teams, who can help provide the necessary resources, support, and capabilities.

There were some points of contradiction from the major themes discussed. Some of the participants, especially those who did not fall into sustainability focused roles, expressed that the cons outweigh the pros in this case. Their reasoning was entirely associated with project affordability and the cost competitive aspects of less sustainable products and buildings. These responses were expected and appreciated as they shed

light on some very understandable perspectives that I'm sure many others can agree with.

From the responses, I took note that sustainability needs a systemic change in this industry to help reduce uncertainty and ensure proper planning for successful integration. I really liked a few of the strategies the interviewees mentioned on how communication can be more effective if it is catered to the stakeholder and target audience. I think this is often a step that is missed in sustainability and I've learned that if you're not speaking in a way that your audience understands or cares for, you're not going to get your message across and that audience may become closed off. This is something difficult to do because it requires understanding the mindset and perspectives of others, but this program has done a great job of introducing strategies for us to use to do this. For example, community engagement, participatory approaches, polyvocality, etc. It was also interesting that the barriers identified in the interviews aligned well with the dominant trends and gaps mentioned in the literature review. I appreciated that stakeholders were able to confirm these points by sharing their own experiences. Overall, I felt that the interviews and literature review complemented each other while also focusing on different contexts. In this case, the literature review described the processes necessary to implement sustainable developments, whereas the interviews alluded to how these processes can be improved.

3. Stakeholder Engagement: Limitations & Areas for Future Research

Were there any limitations regarding the scope of interviews and are there any areas for future research for this project?

A key component that could add to this project would be broadening the scope of participants. While the interviewees did a great job of covering different topics and perspectives specific to the construction industry's many roles, there are several other stakeholders that should be asked similar questions. All the participants of this survey represent the construction or sustainability industry, however, to expand on these topics, it would also be valuable to gain the perspectives of project property owners to determine their mindset and potential demands for sustainable development, community residents, utility companies, and government entities. These are just some of the important key players in this process and they would definitely be able to add more to this project in order to get a holistic answer to the research question proposed.

Part of my literature review looked at how San Diego has been impacted by environmental justice, this is definitely an area that could be expanded on. I discussed my reasoning for the scope of my project in the present and missing perspectives section. Since my stakeholder interview scope was smaller, my participants had not had projects in the areas specifically exemplified in my literature review (those impacted by redlining and environmental hazards). However, one participant specifically

highlighted that San Diego is experiencing a severe housing crisis and shortage, emphasizing that the city must first prioritize the development of affordable housing to ensure residents have accessibility to a home. They mentioned that addressing these needs, like having a roof over one's head, should take precedence over sustainability efforts. This is a very interesting point and I firmly agree that there should be more research on how we can integrate affordable housing into the San Diego region as it is one of our most impactful issues on the community at this time.

There were also certain topics that could be delved into greater depth regarding sustainable materials. From my research, interviews, and my own experience, I've gathered that there are some great alternatives to our traditional and favored materials. However, many companies are in the early stages of producing these products or may need a better idea of the overall demand for them to incentivize creating a greater supply. An impactful strategy identified in this project was the need to include these materials in project specifications, so that they are presented and considered early on and therefore easier to integrate into projects. It's important for companies to build out their supply chain to include sustainable materials so that they are prepared for when potential clients and project owners ask for certain sustainability goals; for example, a net zero building, materials made up of recycled content, achieving a building certification, etc.

While the interview questions

covered the scope of this project's research question, there were a few other questions that were considered that would help clarify participant perspectives. A few examples of those questions would include:

- What are areas of improvement for team collaboration to help reduce the communication gaps between internal stakeholders?
- To help make your specific role a bit easier, what might be included in a sustainability framework that can be integrated into all projects?
- Do you see any gaps between California regulation and support to build out team capabilities? Can increased community engagement or polyvocality with external stakeholders help support this?
- What have been effective ways to share your perspectives? Have you attended community forums, does your company hold meetings to discuss these barriers/enablers? How might your voice be better heard?

Project Reflection

This project explored the barriers and enablers to implementing sustainable initiatives in San Diego's commercial real estate sector, with the goal of identifying actionable insights that contribute to more sustainable, resilient communities. While California has established itself as a national leader in sustainability with well-defined policies and goals, the path to sustainable development at the local level is often complicated by high construction costs,

limited resources, and the need for continuous stakeholder collaboration. In San Diego, landscape constraints, and regulatory pressures further challenge implementation efforts. Through a combination of literature review and stakeholder engagement this project identified key obstacles as well as opportunities to build a more supportive framework for sustainability in the built environment. The factors in the table below help summarize these findings.

A central takeaway is that sustainability must not be viewed as an additional or extra step to a project, but more so as a requirement embedded into the earliest phases of a project lifecycle. From the stakeholder interviews, it became clear that early and effective engagement, especially with clients/property owners and internal teams, is crucial to aligning expectations, assigning responsibilities, and making the case for exceeding code minimums. This approach not only improves communication in collaboration across teams, but also helps mitigate cost and ease the decision-making process over the course of the project. The findings also point to the need for stronger support structures, clear frameworks, and ongoing engagement/knowledge that helps stakeholders recognize the long-term value and cost effectiveness of sustainable development and design choices.

Ultimately, sustainable development requires more than technical approaches, it depends on collective buy-in and a shared understanding of what's at stake and the value behind certain actions. As

sustainability demands continue to rise in the market, so must the industry's ability to adapt, integrate, and innovate within our teams and processes. Personally, this project taught me the value of listening across disciplines and different sectors. The stakeholder engagement helped identify the diversity of priorities, concerns, and insights shaping the built environment. There are so many considerations, whether it's understanding a resident's interest in net metering, a supplier's projected initiatives for low emission materials, or where internal teams feel most and least supported. Understanding these perspectives are essential and a central component of building truly sustainable, resilient communities.

Research Question: What are the key enablers and barriers to implementing sustainable initiatives in the commercial real estate sector in San Diego, and how can we use those insights to cultivate sustainable, resilient communities?

Barriers	Enablers
Cost	Increased asset or property value
Uncertainty associated with roles and responsibilities	Revenue generating opportunities
Reluctance to change	Early and effective engagement amongst stakeholders (communication with clients early on, allocating responsibilities). This was expressed the most.
Difficulty keeping up with code compliance and updates	
Integration challenges	
Lack of framework within the project process	Reduced environmental impact
	Obtaining building certifications
San Diego is experiencing a housing crisis considering there is a housing shortage, high construction and land acquisition costs, and a vastly increasing population.	San Diego has helped outline sustainable initiatives through their state and local regulation, the climate action plan, and the green building plan.

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Photo: The City of San Diego

Waste, Urban Futures, & Resilience

"Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it's the only thing that ever has."
- Margaret Mead

After Hours, After Thoughts: Night-Shift, Labs, and Sustainability

Mackenzie Ressel

I had mixed feelings about my last day in the lab. I wanted to feel sad, but I just felt free; at the same time, I was frustrated and scared I'd forget all about the things I'll never be able to change. Knowing I can still fight from the outside makes me feel better.

With my background being in ecology and sustainability, I never envisioned myself working in a blood platelets lab. The bright lights, the constant humming of machinery, the smell of the plastic and latex. I was definitely out of my comfort zone, but my desire to try new experiences got the better of me. There was only one catch - I had to work the night shift.

I have always been more of a night person; the calmness, the quiet, the peace that comes with the darkness is comforting to me. Little did I know that my new job would rob me of that, and the sun. But I put on a brave face and walked into my new lab ready to take on anything they threw at me.

My coworkers gave a great first impression. I worked with such a diverse group of people, but the two I worked with the most were "Linda" and "Marcus." Linda is a sassy woman from California who loves to speak her mind, ask questions, and learn through reading. She was a little stand offish when we first met, but have become friends and still regularly see each other. Marcus is a relaxed and funny man who recently has gotten into acting and sings really well. I've gone to a few of his plays and hear updates about his daughters every now and then. I'm not using their real names in my paper for their privacy.

Marcus, Linda, and I all have such different and unique backgrounds, so being able to work with one another was an eye opening experience and really enjoyable to see how different people handle the same experiences. Being able to talk with them again about our shared times in the lab has not only made me reflect on my own story, but being able to see how I've changed. From eating and sleeping different to the knowledge I've accrued throughout this program.

I started this program a year and a half into my two and a half year employment at the nonprofit organization I worked at. Being

able to look back and see how I've changed my view of things or misremembered certain stories because of how I've changed has taken a lot of reflecting.

The style in which I've written this paper is inspired by autoethnographies. Allowing myself to write and reflect on my experiences and apply what I've learned in this program has been a wonderful opportunity for growth and self discovery. My process while writing this paper included me thinking of situations from my job and other interactions and writing as much down about them as I could. The process of remembering these events was essentially my second draft, with my first draft being the event itself.

My second draft of these experiences was compiling all my stories together, ensuring their accuracy and timeline. I also came up with a way for me to have my work "peer reviewed" - I met up with Linda and talked through everything to get a better understanding of my experiences from a neutral, third party view. This also aided in limiting my bias of events.

I have also woven the perspectives from Linda and Marcus into my own work to include polyvocality into this work. Ensuring this paper is as true to the stories as it possibly can be is of utmost importance to me, so this was the best way I could demonstrate that.

One of my earliest memories in the lab started with me walking through the pair of sliding doors. I was enjoying the 80 degree "cool" night air of a Tennessee

summer when I was hit with brisk 70 degree climate control air from the temperature controlled lab. Because our platelet products have to be kept in a certain range to still be viable, the air needs to be kept within a small window so the products don't go bad.

I had been so excited to start shift; I had gotten a good day's sleep and was ready for anything the night could throw at me. I was wrong. I walked into the lab, shrugging on my lab coat and snapping on my gloves, and came face to face with mounds of garbage. The hazardous waste bins were lined up against the wall. I counted seven of them then asked Marcus why we had so many. He responded stating that he wasn't sure since the day shift didn't have a whole lot to do again. As I examined the trash closer, trying not to breathe through my nose due to the smell of stale blood, I could see that more than half of the bins had been ours

from the night before.

Around 35 million tons of hazardous materials are handled in the US annually, showing how important it is when considering environmental contamination (HWH Environmental, 2025). While this study mainly focuses on wastewater, it's still relevant because it shows the necessity for implementing efficient waste reduction strategies is important and applicable in all fields.

We normally take out our trash every morning, usually so we can start fresh the next night as well as being courteous to the day shift, leaving them a clean lab in the morning. However, this was one rare occasion where we got out later than our 7:30 am clock out time so we didn't take out our piles of trash. Since this normally wasn't something we did, we were under the assumption that day shift might have been so kind as to take it out for us.

Nope. They left our bins and their bins for us to take care of at the beginning of our shift that night. I was appalled. Marcus volunteered to take care of it while Linda and I started on the night's products that were trickling in.

I can still smell the metallic blood and sour platelets from the biohazard bins even today. They are not a pleasant thing to be elbows deep ever, but especially not that soon after waking up - it was awful. Looking back though, I think a lot of why I was frustrated wasn't just because the day shift didn't take out our's or their trash, but because looking at all those bins lined up ate at me.

Growing up I had always hated having to throw things away. I understood a wrapper, but I always made a point to recycle bottles and paper whenever possible, sometimes even holding on to them for a while until I passed a blue or green recycling can. Then in college, I had taken a lot of related classes and worked with a lot of other students and faculty that had a similar mindset. Being around like-minded people was positive reinforcement that what I was doing was good for the planet.

When I saw those seven bins lined up knowing they were full of trash, my heart ached. I wasn't happy for a multitude of reasons, but knowing that so much of that was going to the dump or to be incinerated was a heavy feeling. I didn't like knowing I caused so much of that waste to be created and how there was essentially nothing I could do about it.

Whenever I tried talking to my coworkers about it, they would shrug me off and tell me that it's not that big of a deal and

that it's just how this line of work is. I understood that, especially knowing that each of the products we made can save someone's life; we can't have any contamination and the bags aren't reusable because of that. However it still seemed to me like there was just too much waste to be so nonchalant about it.

Night after night we dealt with the squeaky cardboard bins and their various smells and textures of the contents. It was unpleasant but necessary work to keep the lab clean, platelets moving, and lives saved. Marcus and I spent more time doing this since Linda was older than us, so I became all too familiar with the sights and smell of lab waste.

While this was weighing on me, I couldn't help but let my mind wander to think about how my friends and family were peacefully sleeping at this time. Although I like the night time differential, my sleep and my social life suffered, which affected my health. I was always tired and never seemed to fully feel rested. My everyday life habits were flipped over to where I almost stopped recognizing myself.

Lifestyle Factors, Shift Work, and Depression and Anxiety investigates the relationship between night shift work and depression and anxiety. It explains how Night shift drastically alters lifestyles, including physical inactivity, poor diet, and sleep issues - all of which I was suffering from as a result of my shift. Additionally, the work pointed out how decreased social interaction is another lifestyle habit that is altered during night shift that can limit mental health. This work really hit home for me as I was going back through these memories.

Luckily I had my coworkers who I could relate and vent to, but also who helped pass the time. We worked very well together. However, I know they were feeling the effects of night shift too. A few nights here and there were hard for all of us. Marcus usually played music on his speaker and we listened while we worked. I knew it would be a difficult night whenever I walked in and the music wasn't playing. Nights like those I just put in my headphones and went on with my night as best I could.

I could get fairly lonely on nights like that; it was just the three of us in the lab most nights, and maybe two or three other people in the entire building. Inside the lab, the machinery kept noisily chugging along, but when you got far enough away (like the lunch room on the floor above), it was deadly silent. You couldn't hear anything besides your own heartbeat sometimes.

The hum of the equipment became a familiar sound over the time I worked in the lab; this made it all the more concerning when it all of a sudden turned off one night. When I had come in for the night, it was raining, thundering, and windier than I had ever seen before even though I was used to storms like these having grown up in the South.

The three of us knew it was going to be another long, isolated night since not as many people come out during storms to

donate (though they do normally show up after them). My coworkers and I were all settled into our desks and completing our usual tasks, plus the ones left over from day shift. Although we don't mind the extra work on slow nights, it's still irritating to know we're expected to finish our tasks and their tasks and get talked to when it's not all done.

With these added assignments, our night did start to pass quicker since it kept us busy until the work ran out. I kept glancing at the clock hoping to see hours jump by, but not even the minutes were moving. By 1:30am we had finished everything we needed to. This work normally would have lasted us until five in the morning on normal nights, but with the storm, it wasn't a normal night. We still had hours to fill before our shifts finished at 7:30am.

Everyone's moods were less than stellar tonight since the storms had kept us up all day. We also had chatted a bit about how we were all stressed about driving in to work while it was pouring, windy, and dark. Luckily, we had training we could all work on to help kill some of the time and distract us from the weather. I managed to work another hour by focusing on those training sessions. I finally couldn't bear it any longer and went to take my break in the silent lunch room. However, the room wasn't very silent that night due to the whistling wind and the rain pounding on the windows.

I made it back to the lab with only half of my shift left. Everything had been completed, I was ahead on my training, and the lab was spotless. All the trash had been taken out and it was refreshing to look at all the clean bio bins. As I was figuring out what I could do next, a huge flash of lightning followed too closely by a crack of thunder sounded what seemed like right outside the lab window. All three of us jumped and Linda yelped. It felt like we were in a movie. Then it happened, the worst possible outcome for a lab to have when everything needs to be kept moving and within a certain temperature - the power was lost.

In cases of emergencies since we were a 24/7 facility, powerful back up generators usually immediately kicked on and we could go on as normal. This was not the case tonight though. I thought about how I needed to start making a plan for the three of us to make sure that we didn't lose any products. I was internally panicking, but when I had talked to Linda about a year after this experience, she expressed to me how much she was impressed by my cool and calm handling of the situation.

The platelets are usually kept on agitators - temperature controlled machines that are approximately the size of a medium fridge that has shelves on the inside that shake back and forth to keep the platelets in motion. Platelets have to be kept in a narrow temperature range, from about 68 degrees to 73 degrees Fahrenheit. This allows for the tests to come back accurately and preserve them. They need to be shaken because if they're left just sitting, they'll start binding and clotting and won't be suitable for

transfusions. Needless to say, no power is a huge issue for my lab.

I started kindly asking my coworkers to grab things and get into position: Linda was going to be in charge of shaking the platelets on the carts, I was going to be taking the platelets off of the agitators, and Marcus was going to be in between us ensuring that the platelets were gently set on the carts as quickly as possible. Even though all three of us were exhausted from the storm and not getting enough sleep, our cooperation and willingness to help each other to save the platelets was incredible to be a part of.

I was so proud of us for working like a well oiled machine. Even though the storm, lightning, and power outage were not our fault, we came together to save the products. If we hadn't, we could have cost the organization a lot of money and potentially not have the resources needed to save someone's life later on. Those were both heavy thoughts in our minds, but we were able to push them aside to work on what needed to be done.

A resource I had found that explored the estimated total annual cost of waste was *Waste in the US Health Care System: Estimated*

Costs and Potential for Savings. Billions of dollars are wasted on failure to deliver, overtreatment, and administration costs. I saw some similar wastage in my experience working in my lab and the organization of a whole. For example, we had to throw out unused products once they hit their expiration date. Although I understand the medical reasons for not keeping these products, there needed to have been a better system, like first in first out, or simply not ordering as many.

About 20 minutes later, the power finally came back on. This was an enormous relief and weight lifted off our shoulders. We started working in reverse to put all the platelets back on the agitators. The familiar squeaking and hum of the machines was surprisingly comforting after our event. Although our night had not at all gone as we expected it to, we were

relieved that what was hopefully the hardest part of our night was over.

The "bad" news, though, was that the whole event ended up being less than an hour. This was great news for the products and the organization, but that meant that we still had two hours of basically nothing to do before our shift ended. Our impromptu bonding time with each other was a welcome break from the background noise we had been dealing with the rest of the night. The three of us understood how differently that night could have gone if we weren't willing to work with one another and quickly come to a solution.

Once our shift came to an end, I walked over to wish my manager a good morning and explain the situation to her before heading out. She had told me that the power lines right down the street from the lab had been broken and that she was glad we figured out a solution so quickly that we didn't lose any products. Nothing else was ever said about the event until I would later meet up with Linda after having left the organization. It was still raining but had calmed down quite a bit when I went out to my car, but I was so excited to get home and go to sleep I didn't even care.

A few months went by and the sun was rising as I took off my lab coat after another shift. I hung it on my hook labeled with a piece of tape with my name on it. I was exhausted from a busier than usual night; I had to work an extra two hours between training and a heavy intake of platelets from the day before. This was a welcome change from the slow night we had the power outage on.

Although I was tired, this was not a day I could just go home. I would have loved nothing more than to go home, shower, and get in my bed. It was a friday and I was excited for my weekend. But, I had another task that I needed to do before I was finished for the day: go to the Sustainability Club's quarterly meeting. This was my very first meeting and I was very excited. My previous lab did not have a Sustainability club, so once I found out this location did, I signed up as quickly as I could.

Non-standard work schedules can cause various health problems with consequences such as sleep disruption, fatigue, and circadian rhythm disturbances - all of which I experienced. The study *Consequences of Shift Work and Night Work: A Literature Review* emphasizes the importance of addressing these issues in

workplace policies and implementing interventions to mitigate them.

As previously mentioned, sustainability is incredibly important to me. I grew up with an immense guilt any time I had to throw anything away, and wanted to save or recycle everything I could. Signing up for this club meant a lot to me, especially a club within a huge organization. I felt like I'd finally be able to have my voice heard and make a difference within the company.

Of course the meeting had to be the morning after one of the busiest nights we had in a while, but I was excited to give my input for the organization's sustainability goals. I thought long and hard the day before the meeting and prepared some notes and items I hoped to cover in the meeting. They were mainly how we could decrease the amount of waste we produced and the money that we could save if we bought more sustainable options of the products that eventually became waste.

I yawned and headed up the stairs to the meeting room on the quiet floor. The meeting room had no windows, a screen, and a round table with a few chairs around it. I was the first one there so I settled into a chair and waited for the other members to show up. The room made the upper level of the building seem even quieter than it already was, and on top of that, I had just worked all night and more. I was trying hard to distract myself from falling asleep before my colleagues started showing up.

Other employees started trickling in; it was about 9:30am and they were all just starting their days. The club's leader welcomed everyone and we introduced ourselves. I received an especially warm welcome since I had moved from another location and this was my first club meeting. I was excited and ready to listen to what we had planned for sustainability within the organization.

I watched the screen as the slideshow popped up, a bright change of color from the otherwise dark and drab room. The green background wasn't surprising at all as it was a familiar color to all of us in the room. I learned during our introductions that six out of the eight of us had previous sustainability experiences from college, other clubs, or volunteering. Because of this, I could tell everyone wanted to be there even though it was early.

After we got through the formalities and basic information, it was time to start sharing our ideas about how to make the company we worked for more sustainable. I let everyone else go first. Looking back on this experience, it wasn't because I wasn't excited to share my ideas, but because I wanted to hear everyone else' s ideas first so I wouldn't repeat anything someone else already suggested. That way I could also add to my list if one of someone else's ideas aided me in thinking of another.

We shared our thoughts in a circle with the first group member who started off by suggesting a tote bag (which of course would have the organization's logo on it) for the employees to use to bring in their lunches and other personal items every day.

I thought this was a good idea, but it didn't match up with the ideas I had come up with. I chalked it up to maybe they just hadn't understood the assignment.

However, the next person suggested coffee mugs for everyone, but they laughed and suggested it may just be because they wanted some coffee at that moment. The whole group chuckled and nodded along, then kept moving around the circle for the others' ideas.

While they were all sharing, I was listening to their ideas and thinking to myself how confused I was. Some of the items on my list were a green roof and solar energy collecting window shades, nothing at all like what the others were sharing. I was concerned I was the one not understanding the assignment now. My turn was approaching fast and I didn't feel comfortable sharing my ideas anymore since they were so different from everyone else's. I quickly folded up my notes and stuffed them in my pocket. All my ideas seemed like they wouldn't "fit in the budget."

I suddenly realized everyone was looking at me eagerly to share my ideas, so I panicked. I didn't want to ruffle any feathers, especially this early in the morning and with it being my first time joining the group. So, I blurted out "how about water bottles." This interaction has been burnt into my brain because it made me so upset with myself. The two main reasons for this was because 1, it was so similar to everyone else's ideas, and 2, because it was potentially so unsustainable.

When you think about it, how many times have you seen those cheap, plastic water bottles at fundraisers or other events? You take them home, use them once or twice, forget about them in your "cup cabinet" for a year or so, then donate or throw them away next time you clean the cabinet out. And I suggested that as my "sustainable" item. My embarrassment still sticks with me today.

To my surprise, one of the group members said they couldn't believe that they hadn't thought about that. Then someone else mentioned that the company hadn't done something like that before and it would be a great idea. A few minutes later we put it to a vote and my water bottle idea won: everyone at our locations would be getting a cheap plastic water bottle with our organization' logo on it because of me.

I was crushed. I had planned to go in

with an idea that created less waste, not more. Although the idea of a reusable water bottle is to reduce the amount of plastic water bottles, there are other (albeit more expensive) water bottle choices, and most if not all of those choices last a lot longer for a multitude of reasons. I felt like I had failed myself, my organization, and the earth. Everyone else probably either already had a reusable water bottle they used all the time, or figured if they were drinking out of plastic bottles anyways, what's the difference of using this one.

I wasn't sure what to do next. I felt like I couldn't go up to the club's president and suggest something else or try to persuade them to pick a different idea. Everyone else seemed so excited about the water bottles. Since this was my first meeting, I also couldn't tell if they truly thought the water bottles were a good idea or if they were just trying to make me feel included in my first meeting.

I left the meeting feeling dejected and even more tired than I already was. I made it home and set a mental timer for two months - the expected date that our water bottles would show up. And they did. They were cheap plastic and some of them didn't seal properly. They were not at all what I was hoping for, but at least they were reusable.

To this day I still have my water bottle from the organization. However, it sits in my cup cabinet just waiting for me to use it. Sometimes I'll bring it on hikes with me to carry water for my dog, but I don't use it for myself. I have my other water bottles that keep my drinks cool and will last a lot longer that the one from my company ever will.

Not long after my first sustainability club meeting, I was at work one night and actually enjoying my shift. We had the music playing on the speaker, working hard, and all getting along with one another cracking jokes. Suddenly, one of the supervisors from the other labs came over and asked if I was free and that he would like to speak with me. I cautiously said that I

was free but was wondering what could have happened and why I was the one being picked to go to his office.

Once we got to his office, I sat down across from him. I was super nervous; my palms were sweaty and I couldn't tell if it was because I had been wearing gloves or if it was from my anxiety. I felt like an elementary school kid who had just been called to the principals office. He started the conversation with some small talk and I politely played along. We discussed the weather and how good the song that was playing in the lab was.

After I began to feel a little more relaxed, it finally came time for him to get to the point of why he had called me in. We had been basically talking about nothing for nearly 10 minutes. He asked me if I knew anything about the grant program the organization had. I told him no, I hadn't heard about them, but I was curious to know more about them now. He explained how

our organization had Sustainability Grants that employees and volunteers could apply for to make a difference within our company and/or make a positive impact on the local community.

He admitted he knew about my background in sustainability and that the Sustainability Club leader talked to him about my experience. I felt honored that people in positions of power were talking about me to each other; this made me feel like I made a good impression (even after the water bottle situation). He told me he thought that my background and experiences would be beneficial for a grant and asked if I'd want to work with him to come up with something for a grant proposal. I was super excited at this point and no longer nervous about the interaction. Learning about this opportunity and that I would have a partner and support throughout the process to get everything together for a grant was incredible. I told him that I would be

honored to help.

I began sharing some of my ideas with him. Most of them came from the paper I had folded up and stored away during the quarterly Sustainability Club meeting (that I kept my notes and ideas from). I began with my favorite idea: a green roof for the building we worked in. He looked puzzled, so I explained what a green roof was and all the positive things that can come from a green roof, both for our organization and the local community. At this point in our conversation I hadn't even realized my hands weren't sweating anymore, but I did notice I was shaking. I originally thought it was just from excitement, but looking back I remember I had gone to his office before and realized the thermostat was set at 68 degrees.

Once I finished my explanation, he gave me a soft smile with sad eyes. He explained that he hated to crush my excitement, but since our organization didn't own the building we worked in, we would need to find another project to work on. He also added that the amount of money predicted to build a green roof would be way over the grant's budget too.

I was disappointed by this. So many of my other ideas were similar to this one: a community vegetable garden, a compost bin, solar panels - all ideas that required some form of land or space from the building and parcel we were (apparently) renting. I told my supervisor about all these other great ideas I had. He agreed that they were all super creative, but that we wouldn't be able

to pursue them based on the circumstances around owning the building.

Yet again I felt like the one chance I might have had to make a real and sustainable impact for the company and the city I was in had been demolished. I tried to hide my disappointment, but the supervisor saw it immediately. He apologized and mentioned that maybe we could figure out something within the building, like updating the water heaters. I felt my face flush hot from blushing knowing how easy it is to read my emotions on my face. I also noticed I wasn't shaking anymore.

His suggestions sparked an idea in my mind and I asked if I could add something. He gave me a nod of encouragement to share my idea. I explained what happened at the Sustainability Club meeting and the decision to hand out plastic reusable water bottles to the staff; looking back I'm sure he already knew about it, having been in contact with the Club president. He looked over at his desk and laughed, and that's when I saw his water bottle sitting on his desk, still in its plastic packaging. The feeling of guilt from that day washed over me again, but this time I was

going to do something about it.

I asked him if he thought it was possible for us to write a grant proposal for the installation for water bottle refill stations. I explained that this might encourage the staff to actually use our new water bottles, or at least be able to fill up ones they already had on them. He thought it was a great idea and a way more manageable than some of the other ideas, as well as it should fit in the budget.

This raised my spirits a bit. It was nice to feel some progress start to be made, even though it wasn't to the scale I had wanted it to be. However, I know everything starts somewhere. Small steps lead into more. With that settled, we decided I had been away from the lab and worked long enough and I should head back in to continue helping my coworkers.

Once I got back into my lab and wrestled all my PPE back on, my coworkers couldn't ask me fast enough why I had been pulled out by the supervisor. I told them that since I had joined the Sustainability Club, he wanted my input and to work together on a Sustainability Grant proposal. I could see the excitement drain from my coworkers' faces. They told me they were expecting some drama from the other lab or that I was somehow in trouble, definitely making me feel like I was in elementary school again.

Although I was sorry to disappoint their hopes of some high octane news, I enjoyed being able to share that I was planning on working with that supervisor on a grant proposal because it could have a huge impact on the organization. If we implemented something and it worked to the company's satisfaction, other locations could adopt the same proposal but tweak it to fit their needs. This could really start a chain reaction of positive impacts throughout the organization after all. Of course it would take a while to get there, but you have to start somewhere and I think it's at least starting the snowball effect for change.

When I was back into the groove of work, I let my mind wander and was thinking about that interaction with my supervisor. I know these things take time at all stages of the process from idea to its fruition. I was just super happy knowing that I was able to be a starting point and a part of the process. I reminded myself that this is a good thing. I seamlessly flowed back into work like nothing had happened. Later that night, Linda told me I was even brighter eyed and bushier tailed for the rest of the night knowing that I was going to be a part of something positive.

Thinking back on it today, I wish I would have worked on convincing my peers that the Sustainability Grant proposal was still something to get excited about, even if it wasn't drama or trouble. I wished I would have been able to convince them that it is a really good thing for our company to do, not only to save itself money in the long run, but showing that an enormous organization like ours is willing to make even these small changes can create a tidal wave of change in multiple different companies.

I also heard from Linda when we caught up on a walk that my proposal with the supervisor went through and the water bottle refill stations are up and running throughout the building. This was incredible and made me so happy to hear. I felt so lucky to be a part of a movement that was actually for sustainability, even if it wasn't as flashy as a green roof; change is change.

In addition to hearing that my hydration stations were up and running, we also went over a lot of other memories. I asked her to go on a walk through a local park with me to get clearer and non biased views of events in the lab as I went back and reflected on all of my memories. I wanted to see from her eyes how my reactions at the time were different from how I remember them, as well as how I've been interpreting everything looking back on it. I've gone through a lot of changes since working in the lab, including starting and nearly finishing this program, so another viewpoint was imperative.

She agreed to meet up to walk around and have lunch together. What was planned for an hour turned into a two hour hang out, informal interview, and peer review session all meshed into one. Overall we had a great time and were able to focus on a lot of different memories together.

As so many people know, it's been extremely

hot lately in the South. I was sweating just sitting on a bench across from a pond waiting for Linda to show up. I had arrived a little earlier than we had planned, partially because I was lucky with traffic, but also because I wanted some time to go over my notes to make sure I had all the major things I wanted to talk about ready to go.

Once she showed up, we started walking around. This made me feel a little better since most of the trail was shaded. We shared our small talk greetings and noted how we were both so excited to see each other again. We had been doing semi-regular hang outs when I first left the lab, but we both had been so busy recently that it made it hard to find a good time to meet up with one another.

We worked together when I first started this program so she knows I'm in the home stretch. She was always asking me how my classes were going and how much homework I had when we were working together; this walk made it feel like old times. I think this was also her segway into getting to the topics we were going to cover today. She always has a way of beating me to the punch with these sorts of things. She's been super excited and supportive of me throughout this entire process, so I think she just couldn't wait any longer to start discussing our time and experiences together in the lab.

Once we had gotten this far into our conversation, we realized we

had already walked a mile down the trail. We both pointed out how hungry we were already and agreed it was time to get lunch. We decided on a restaurant and sat down to eat. As we were sharing a plate of fries, we started to get deeper into the topics I had made notes about.

I told her how much I was enjoying my classes and was making good progress, but some of the classes or assignments could be tough, but how I never back down from a challenge. She laughed then I explained to her that I wanted my stories for this paper to be as accurate as possible and needed her to add in what she remembered about the situations. She excitedly agreed and asked where she should start. I told her I remembered a time when the software program we used for everything had a scheduled shut down during the beginning of our shift.

She rolled her eyes and took a bite of

her burger while I continued. I told her I remember being so frustrated that the shut downs were always during the night shift, never on day shift. She also added that they were always on the weekends, our busiest days, since more people donated on the weekends than any week day.

Nodding her head, she agreed and began discussing how annoyed the shut downs would make us since we were dealing with "live" products whereas the day shift was mainly focused on the testing and results of the products. Without our software program up and running, we had to do all the tracking and math manually instead of just scanning a barcode or pressing a button on the scale. More math, more stickers, more trash, and more patience than the usual pace we maintained in the lab. We were used to being speedy; logging the platelets manually takes a lot more time.

We were finishing our meal and agreed to continue on the loop trail we had been walking on after we returned our dishes and refilled our waters. She wasn't looking forward to walking in the hot and humid air again, but was looking forward to seeing the flowers in another mile. As we resumed our conversation on the software shutdown, she recalled just how focused I was that day. I told her I remembered feeling frantic and that we may not have the same amount of work done at the time we leave compared to how much we normally did by the time day shift came in. Her argument was that we'll do the best we can, but that they can't expect miracles out of the two of us (since Marcus wasn't there that night)

and day shift would just have to understand our circumstances. She told me how she was always impressed that I was cool, calm, and collected on the outside and would never have known I was so panicked on the inside that day.

At that moment I remember smelling something similar to Christmas; we had just entered an area where there were conifer trees growing. I pointed out the smell to her and she agreed that it smelled wonderful. We had reached the entrance to the flower garden part of the trail. We were surprised there were mainly just orchids, noting that they don't have as strong of a smell as other flowers do (or the trees in our case). I knew she was secretly happy about this because she's very sensitive to certain smells and gets headaches from them easily. We continued on our walk and talk, a little distracted by the beauty of the flowers.

I asked Linda if she thought that the stress we had felt was related to just the software program being down, or if maybe it was also because we had a much higher expectation than the day shift did. She responded that she definitely thinks the program being down was the main issue, but that it could have also been the day shift because even when we completed everything they would still find something to complain about; it could be the garbage not being taken out, not all the products being ready for them, or any other reason they could come up with.

I brought up the garbage specifically, asking her if she ever noticed how much trash the lab accumulated in a night, let alone a week. She expressed that she had never really noticed. She also explained that she also understood that the amount of waste we did produce was all necessary since we couldn't risk contamination and there wasn't a better form of transport for the platelets. She also had the same argument for the constant energy "blackholes" that the labs in our building were. She stressed that even though they do take up a lot of energy, that it's necessary to keep the platelets viable and the test results accurate.

Linda had made some really valuable points; I knew that there wasn't really much we could do about the rate and accumulations of garbage our lab made. However, I did argue that there were better ways to get energy. She told me she already knew that most of our energy came from a nuclear power plant, but I countered by stating we could generate some of our own energy by swapping our current blinds for solar collecting blinds. She said that those sounded too expensive for our company to consider and I told her she was right, but I also stated that we had to start somewhere, and sometimes saving money means it costs a little more up front.

She agreed with me and mentioned how much more lively I was compared to when I was working the night shift with her. I told her that I do feel so much better now between the sunlight, my sleeping schedule, and my new job having less pressure on me. I explained how night shift can negatively impact peoples' mental and physical health in a negative way. Linda agreed it's not the

best schedule to have, but the shift differential she makes keeps her there. I told her that I completely understood.

This made me recall the work that I had read, *Shift Work and Mental Health: A Meta-Analysis of Longitudinal Studies,* which examined how working the night shift increases one's risk of depression. They also found that female night shift workers experienced a higher likelihood of depressive symptoms compared to their male counterparts. I found this work highly relevant to the conversation Linda and I had on our walk.

We were rounding a corner then came upon the pond again. We looked down into it and saw two snapping turtles floating by. I thanked her for her time and for talking with me about our experiences. And for helping me get a four mile walk in on a Saturday afternoon. She thanked me for letting her be a part of my story and expressed that she's excited to see the finished product in a few weeks. We finished out goodbyes and I headed home, excited to incorporate her views into my paper.

Writing this paper, I feel like I have touched on both the mental health effects from night shift as well as the need for increased sustainability throughout all biomedical organizations. Although I was always trying to do my part, sometimes I didn't succeed. There were always roadblocks in the way, with money and ownership as the main culprits.

The associations I made between

some of those nights I was so tired and the reason being night shift was eye opening; while I was living these experiences, I felt that I was fine. But, after Linda and I had our walk in the park and hearing her tell me how much better I seemed, it clicked in my brain. The high pressure environment caused by night shift, few resources, and little to no support created a feeling of detachment in me. This would hit me especially hard as someone who values sustainability in a work environment did not.

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Housing Availability as Climate Adaptation: Opportunities for Regional Resilience in the Indianapolis Metro

Peyton Marshall

Abstract

As climate change reshapes migration patterns across the United States, metros like Indianapolis face a growing challenge: how to expand housing availability in ways that are equitable, sustainable, and resilient. The driving question for this project was: What opportunities exist to improve housing availability in the Indianapolis metro area as a climate resilience and adaptation measure in the face of domestic climate in-migration? While national research has documented the affordability crisis, this paper examines the specific market dynamics, policy tensions, and planning opportunities unfolding in the Indianapolis region amid accelerating in-migration and economic pressure. A detailed literature review grounds the analysis, which is further enriched by four semi-structured interviews with local housing, planning, and sustainability leaders, analyzed using thematic coding. The findings highlight rising financial constraints on families, limited housing diversity, fragmented policy coordination, and a strong appetite for cross-sector collaboration. Interviewees voiced both shared priorities and nuanced disagreements, bringing valuable texture to the discussion. Ultimately, this paper makes the case that housing access must be addressed regionally, not city by city, to meet the scale of current and future demand. It proposes strategies including thoughtful design, flexible zoning, and coordinated regional partnerships. This paper also offers a timely, community-rooted perspective on climate resilience and provides practical guidance for policymakers, planners, and advocates committed to building inclusive, future-ready communities.

Welcome to the Crossroads: Climate Resilience Begins with Housing

Climate change is no longer a distant threat; it's a present and escalating reality. In the coming decades, it's expected to reshape everything from the global economy to

where people can viably live. The United States will not be immune to these shifts. As sea levels rise, droughts persist, wildfires grow more intense, extreme heat waves and hurricanes become more frequent, large portions of the U.S., particularly the West, South, Southeast, and coastal areas, will see waves of domestic climate migration. And the Midwest, with its relatively temperate climate and ample freshwater, is likely to become a key destination, or climate haven.

The Indianapolis metropolitan area is squarely in the path of these impending shifts, but the problem is that in all the regional and municipal climate planning currently being done, this probable reality is nowhere to be found in the current discourse. As a city and metropolitan area, we haven't really asked ourselves what it
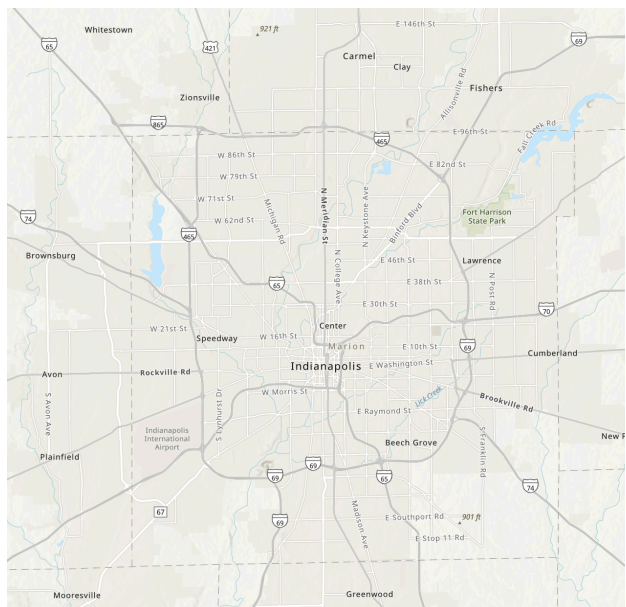
means to be a "receiving community" for climate migrants, nor have we planned intentionally for it. In many ways, our housing system is already under strain, and

the prospect of tens or hundreds of thousands of new residents over the coming decades raises important and urgent questions. My capstone project is centered around one of the most pressing: *What opportunities exist to improve housing availability in the Indianapolis metro area as a climate resilience and adaptation measure in the face of domestic climate in-migration?*

This topic is important to me because I have lived through housing instability firsthand, not having a permanent home from the time I was 12 years old through my 19th birthday. I have seen how instability can have profound effects on someone's life. I also care because I have spent the last couple of years working at the intersection of compliance, public health, environmental sustainability, and community trust. The common thread through all of this has been: people are vulnerable when systems fail them. And housing is one of those systems that, when it fails, sets off a cascade of other issues — job instability, educational disruption, worsened health outcomes, increased exposure to climate hazards, and more. So when I think about climate resilience in our context, I'm not thinking first about more greenspaces or reduced energy usage. I am thinking about people and where they're going to live.

What makes this research question important is that it forces us to connect dots that are often treated separately in public policy. We talk about housing affordability, climate resilience, and migration. But rarely are those three pieces synthesized and

addressed in concert, and that's a huge missed opportunity. If Indianapolis is going to remain livable and welcoming for both existing families and future ones, we need a plan. We must expand housing availability now, not after the migration starts in earnest. And we need to do so in a way that doesn't repeat the same cycles of disinvestment, exclusion, and gentrification we've seen in the past.

My primary focus is on low- and moderate-income families who already live in the Indianapolis metropolitan area and are struggling to afford housing. For these residents, the crisis isn't hypothetical — it's already here. The influx of new people moving into the area, as a result of climate migration or otherwise, is likely to exacerbate existing housing shortages, drive up prices due to demand, and make it even harder for these families to stay in their homes and neighborhoods. For many, even a basic quality of life could soon be out of reach. That's why this work matters, not just as future planning, but as present-day protection.

Drawing on qualitative interviews with community leaders, developers, academics, and urban planners, along with a close review of policy literature and present-day planning frameworks, this research uncovers several opportunity areas that could position Indianapolis to both adapt and lead. Chief among them are the need for a coordinated regional housing partnership, a renewed emphasis on thoughtful design and community-oriented development, and zoning reforms that allow

for a broader range of housing types. Together, these strategies offer a path toward climate resilience that is not only practical but inclusive, shaping a future where growth does not come at the expense of equity.

While each of these interventions is important on its own, they are most powerful when pursued together; when housing isn't just a standalone issue, but a strategy for climate resilience, economic prosperity, and social justice.

The rest of this article is organized into five key sections:

- A review of the literature on climate migration, housing resilience, and urban planning in the Midwest
- A methodology section detailing the realist–essentialist coding and qualitative interview process
- Thematic findings from the interviews, with common, unique, and contrasting insights
- A discussion of how these findings connect to national and local policy debates
- Recommendations for action to ensure that Indianapolis can be a city of welcome and belonging, for both longtime residents and future ones.

By bringing together voices from across the housing ecosystem, this project aims to help Indianapolis prepare for what's ahead — not by fearing change, but by building for it.

Literature Review

Improving Housing Availability and Affordability in Indianapolis Amid Climate In-migration

Introduction

Climate change is increasingly reshaping migration patterns within the United States, prompting Americans to relocate from regions vulnerable to extreme weather events, sea-level rise, and prolonged droughts toward safer and more financially viable inland cities such as Indianapolis. This phenomenon, known as climate migration, presents considerable challenges and opportunities for urban planning, infrastructure, and community stability. As coastal, southern, and disaster-prone areas become less viable, populations are expected to seek refuge in cities historically unaffected by severe climate risks, putting Indianapolis in a strategic position due to its relative environmental stability, economic opportunities, and previously more affordable housing market.

However, Indianapolis now faces significant pressures from anticipated

increases in population, compounding

existing housing affordability and availability issues. This potential influx of climate migrants may exacerbate competition for limited housing stock, disproportionately impacting low- and moderate-income households already struggling with rising costs. Homeownership opportunities (aka the "American Dream"), once attainable for moderate-income families, are becoming increasingly inaccessible, creating broader implications for economic stability, community resilience, and equitable urban development.

This literature review examines how national climate migration trends, Indianapolis's housing market pressures, and equity-driven policy frameworks intersect, as well as what gaps remain in preparing the region to adapt. The first thematic area looks at the literature on climate migration and receiving communities.

Climate Migration in the United States

Climate migration refers to the internal relocation of populations driven primarily by environmental stressors such as flooding, wildfires, hurricanes, and droughts (Hurdle, 2022; Milman, 2022). The increasing frequency and severity of these events significantly influence domestic migration patterns, reshaping demographics in receiving communities. McCabe and Sandweiss (2020) suggest Indianapolis, which saw hundreds of permanent relocations following Hurricane Katrina in 2005, offering a preview of its role as a potential climate haven, could proactively

position itself as an attractive destination for climate migrants through targeted marketing, climate mitigation initiatives, and relocation incentives. They highlight potential economic growth and community revitalization benefits but caution that without careful planning and adequate infrastructure, particularly housing, the influx could exacerbate existing inequalities and affordability issues.

Despite the growing significance of domestic climate migration, existing scholarship primarily focuses on coastal or wildfire-prone regions, neglecting Midwestern cities like Indianapolis. This gap leaves Midwestern metros underprepared for substantial climate-driven population shifts. Understanding migration drivers and early indicators can help policymakers forecast demand more accurately, yet due to a lack of integrated coordination, current data and planning tools are limited.

Indianapolis Housing Market Dynamics
Investor Ownership and Housing Affordability

Investor ownership dramatically shapes Indianapolis's housing landscape. The Fair Housing Center of Central Indiana (FHCCI, 2023) reported that in 2022, over 40% of single-family home sales in Indianapolis were made to corporate entities,

primarily LLCs. This extensive corporate activity significantly reduces housing availability and affordability, driving housing prices upward and limiting homeownership opportunities for traditional buyers, particularly impacting low- and moderate-income households. Historically affordable neighborhoods such as Martindale-Brightwood face rapidly escalating home prices due to investor speculation, contributing to housing insecurity and displacement risks.

The FHCCI estimates that corporate investors currently own approximately 27,000 single-family rental (SFR) properties in Marion County, with around 13,000 owned by out-of-state entities. Each month, between $15 and $20 million in rent payments leaves Indiana due to these external investments. Unlike local landlords who typically view properties as long-term investments, out-of-state corporate investors often buy and sell properties rapidly, with less investment in property maintenance and tenant stability. This pattern contributes to declining property conditions, increased code violations, and instability for tenants.

The scale of corporate ownership is often masked by complex networks of LLCs, with the five largest SFR owners in Indianapolis collectively operating over 250 entities, and in some Far Eastside

and Southside neighborhoods, out-of-state ownership exceeds 75%. These areas have significant populations of Black and Hispanic residents, who disproportionately experience the negative effects of corporate ownership, such as increased eviction filings and poor housing conditions. From 2021 to 2022, eviction filings by large out-of-state investors grew rapidly, reaching significantly higher rates than local landlords, particularly impacting neighborhoods of color. This trend intersects directly with climate resilience planning, as increased investor control over housing stock not only reduces the availability of stable, affordable units for incoming residents — especially climate migrants — but also worsens housing access and economic stability for current residents.

Historical Inequities and Persistent Segregation

The enduring impacts of discriminatory practices like redlining, exclusionary zoning, and structural racism continue to shape Indianapolis, driving persistent segregation and disparities in

housing access and quality (Nowlin et al., 2016; Roisman, 2021). Current outcomes include disproportionately high eviction rates, substandard living conditions, and limited pathways to homeownership in historically marginalized communities, barriers that long-standing socioeconomic divides. A recent example illustrates this. In March of 2020, Carlette Duffy, a Black homeowner in Indianapolis, had her home appraised for $125,000. Purchased in 2017 for $100,000 and located in a historically Black neighborhood, Duffy believed her home was significantly undervalued given recent price increases. A second appraisal in May came in even lower at just $110,000 (Planas, 2021). Suspecting bias, she ordered yet a third appraisal, this time removing all visible elements that would indicate that a Black woman owned the home including photos and even had a white friend pose as her brother to stand in for the appraiser's visit. The result: $259,000, nearly 1.5x higher than the previous valuation (Planas, 2021). The stark disparity confirmed Duffy's suspicion of racial discrimination by the all-White mortgage providers handling her case.

Such cases have occurred elsewhere in Indianapolis and nationwide. Combined with "white flight" to the suburbs and euclidean zoning, which prioritizes large single-family homes on large lots while blocking out lower-cost family housing, these practices effectively excluded many Black families from higher-opportunity areas. In Indianapolis, the median income for Black households (not to mention other

marginalized groups) $41,970 compared to $71,142 for white households (SAVI, 2024), limiting access to neighborhoods with better schools, infrastructure, and clean air and water.

The broader point is clear: discriminatory housing practices past and present continue to shape today's market. Studies such as Perry et al. (2018) found Black-owned homes appraised for 23% less than similar white-owned homes in 2017, costing Black homeowners $156 billion in lost equity nationwide that year.

The intention behind sharing Duffy's story and others like it is not to deepen division or assign personal blame. It's to underscore that these inequities are still with us. The disparity she experienced is difficult to dismiss and reflects the lingering impact of policies like redlining and exclusionary zoning. If we want to chart a better future for the Indianapolis metro, we must start with a shared understanding of how we arrived here and of the barriers our neighbors face today. Only then can we create housing policies that enable all residents to build stability, pursue opportunity, and contribute to the region's growth.

Eroding Affordability in the Indianapolis Metro

Housing affordability in Indianapolis is increasingly strained. According to the Self-Sufficiency Standard (SSS), approximately 34% of households in Marion County cannot afford basic necessities such

as housing, food, healthcare, childcare, and transportation on their current income (Kucklick & Manzer, 2022). That's tens of thousands of families living on the edge, highly vulnerable to displacement as housing costs climb.

The burden is not evenly shared: nearly half of Black and Hispanic households fall short of that SS benchmark, compared to roughly 22% of white households. This gap underscores both the inadequacy of traditional poverty measures and the persistence of racial economic inequities, leaving many households above the official poverty line unable to achieve economic stability.

For these families, the inability to meet basic needs consistently makes saving or investing in homeownership nearly impossible, perpetuating cycles of poverty and insecurity. Rising housing costs compound the problem, limiting housing options for existing residents and reducing availability for new arrivals at precisely the time when regional demand is projected to grow.

Looking beyond the SSS, both national and local trends show just how sharply buying power has eroded. Older generations often point out that they purchased homes at much higher interest rates, but those rates applied to homes that cost a much smaller share of the average household income than they do today, a gap that has widened dramatically over time. Nationally, the median home price in 1985 was $84,300, about 3.6 times the median

household income of $23,620. By 2023, that ratio had climbed to 5.3, with incomes up 241% but home prices skyrocketing up 408%. In Marion County, the gap has widened even more quickly in recent years: between 2016 and 2023, median household income rose only 18% from $53,670 to $63,450 while median home prices jumped 60% from $163,180 to $260,200. This mismatch, compounded by higher interest rates, has sharply reduced affordability for households across the income spectrum.

Environmental Justice and Equity Concerns

Climate mitigation and urban improvement projects, though beneficial, can also trigger environmental gentrification — improvements in environmental quality that drive up housing costs and displace lower-income residents (Schusler, Krings, & Melstrom, 2020). Indianapolis' "Thrive Indianapolis" plan includes climate mitigation measures, but anti-displacement and equity safeguards are not prioritized. Without them, resilience initiatives risk deepening existing inequities, pushing out vulnerable residents, and undermining long-term stability.

These pressures increasingly extend beyond traditionally vulnerable groups. Rapid housing price increases, driven by investor activity and urban revitalization, are making homeownership and stable rentals harder to secure for moderate-income households once considered relatively safe. Economic strain is spreading up the income ladder, widening the pool of residents at risk of being priced out.

To counter these risks, resilience planning must make equity a core priority. This means embedding anti-displacement measures, equitable development frameworks, and genuine community engagement so impacted residents shape the decisions that affect them. Policies should preserve existing affordable housing, expand housing options, and invest in infrastructure that strengthens neighborhoods for current residents as well as future ones.

Policy Frameworks and Housing Strategies
State and Local Housing Initiatives

Indiana's statewide Priority Climate Action Plan (PCAP), developed by the Indiana Department of Environmental Management (IDEM), focuses primarily on climate mitigation, with little attention to climate adaptation or housing. At the local level, drafts of Indianapolis's 2025 Action Plan and Housing Equity Plan acknowledge the need for affordable housing, proposing about 1,000 new units. However, given the current affordability crisis outlined by the Self-Sufficiency Standard and projected population growth from climate migration, these proposals fall far short.

The gap between proposed solutions and actual needs underscores the urgency for more ambitious, integrated interventions. Marion County already has tens of thousands of households unable to meet basic needs, along with many such families

in the other eight counties across the metro, making it essential that housing affordability, supply, and stability be addressed together in anticipation of further population pressures.

Central Indiana Housing Study Insights

The [Central Indiana Housing Study](#), conducted by the Indianapolis Metropolitan Planning Organization (IMPO), further emphasizes the scale of Indianapolis's housing challenges, projecting the need for tens of thousands of additional affordable housing units over the next two decades. It calls for diverse housing types, mixed-income developments, and targeted strategies to reduce segregation and displacement. Key recommendations include zoning reforms, increased density near transit hubs, incentives for affordable housing development, and comprehensive tenant protections. These strategies aim to create balanced communities that accommodate various income levels, reduce displacement risks, and promote long-term housing stability. The study also calls for targeted investments in infrastructure and supportive services to enhance community resilience and expand economic opportunities for all residents, particularly those vulnerable to economic pressures and displacement.
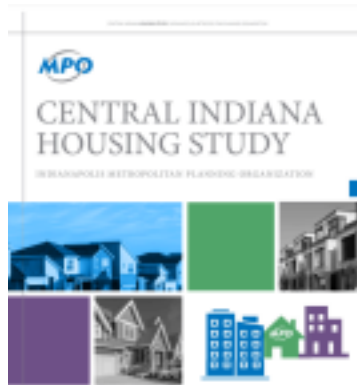
Shane Phillips' "Three S's" Framework

Shane Phillips proposes a robust, comprehensive approach to housing, termed the "Three S's" — Supply, Stability, and Subsidy. This framework emphasizes locally tailored, multifaceted solutions:

Supply encourages diverse strategies for increasing housing stock, such as zoning reforms, incentives for multifamily housing, transit-oriented developments, accessory dwelling units (ADUs, small secondary units on the same lot as a primary home), and adaptive reuse projects (converting existing buildings for new housing use)

Stability targets tenant protections, eviction prevention programs, rent stabilization, and legal assistance services to secure stable housing for vulnerable populations

Subsidy focuses on financial assistance mechanisms, including affordable mortgage programs, down-payment assistance, rental subsidies, and support for community land trusts to preserve long-term affordability.

The beauty of the Three S framework is its open-endedness. Rather than prescribing a single path, it offers a menu of policies, incentives, and market tools that have worked in other markets

around the country to alleviate housing challenges. It is in the framework's flexibility that I find the potential applicability in addressing Indianapolis's unique housing challenges. Later, this paper draws on some of Phillips' case studies as well as another success story from another metro in our own state of Indiana (and my hometown) — the City of South Bend — to explore how similar tools could be creatively applied in the Indianapolis metro. I also had the opportunity to interview Phillips to gain additional insights.

Funding and Integration Challenges

Indiana's dependence on federal funding for housing initiatives significantly limits its capacity to respond flexibly to localized needs. Effective management of climate-driven housing pressures requires improved cross-sector integration, explicitly aligning housing, economic development, environmental resilience, and infrastructure planning. Without this integration, even well-funded efforts risk being too siloed, missing opportunities to expand affordability, stabilize communities, and strengthen the Indianapolis metro's long-term resilience.

Institutional and Community Perspectives

Much of the existing literature on housing and climate adaptation privileges top-down, technocratic solutions, emphasizing state or federal policies, zoning reform, or financial incentives as primary

drivers of progress. While these tools are undoubtedly important, they often fail to meaningfully integrate the lived realities, cultural contexts, and frontline wisdom of community members, nonprofit institutions, and local housing practitioners. Scholarship rarely elevates these local actors as central architects of resilient housing futures. National-level reports like those from big research institutions frequently acknowledge the importance of equity, but too often stop short of deeply examining the mechanisms through which institutional and grassroots voices co-produce policy or adapt strategies to neighborhood-specific realities.

Environmental justice and participatory planning scholars have long called attention to this gap. They emphasize that equitable adaptation requires more than spatial vulnerability mapping or investment in physical infrastructure — it requires procedural justice and recognition of marginalized communities' agency in shaping the systems they depend on. Yet in housing literature and discourse, institutional voices like community development financial institutions (CDFIs), land banks, and local housing nonprofits are often relegated to the periphery of policy analysis. Similarly, developers committed to equity-minded projects, or residents with generational ties to gentrifying neighborhoods, are rarely featured as knowledge producers in housing research and conversations. Even participating in conversations, such as community forums, can be inaccessible to many of these groups due to time, resource, or mobility

constraints. This exclusion skews perceptions of which solutions are truly feasible or desirable.

This project seeks to address that imbalance. Later sections draw directly from in-depth interviews with nonprofit leaders, climate adaptation experts, and socially conscious developers in the Indianapolis metro area — each offering insights that challenge, expand, or humanize dominant policy frameworks. In elevating these institutional and community perspectives, this work fills a critical gap in the literature: integrating place-based voices into the broader conversation on housing and climate resilience. This not only contributes to a more holistic understanding of the Indianapolis metro's challenges but also models a methodology for embedding community wisdom into adaptation planning elsewhere.

Contextualizing My Approach

My personal background deeply informs this project. As a mixed-race individual who experienced significant economic hardship, frequent evictions, and prolonged housing instability in childhood, I bring both profound empathy and nuanced understanding of housing insecurity's complexities. These experiences also instilled a strong work ethic and a belief in personal responsibility, which proved necessary to overcome the numerous barriers I faced. Recognizing potential biases, I intentionally incorporate diverse institutional insights, community engagement, and rigorous empirical analysis to ground my recommendations in both equity and evidence.

Gaps Identified

Several gaps in both literature and planning limit Indianapolis's preparedness for climate migration and housing pressures:

1. **Underrepresentation of Midwest Cities in Climate Migration Research:** Most research focuses on coastal or wildfire-prone regions, leaving Midwestern urban centers like Indianapolis underexamined. This lack of localized insight hampers effective planning and leaves cities unprepared for the scale and nature of climate-driven population shifts and related housing pressures.

2. **Insufficient Policy Integration:** Current housing frameworks inadequately integrate climate migration concerns, failing to fully address rising housing costs, dwindling affordability, and increasing housing instability. As such, existing policies often overlook the unique pressures climate-driven migration could place on local housing markets, disproportionately impacting economically vulnerable and moderate-income groups traditionally able to access homeownership.

3. **Lack of Comprehensive Housing Solutions:** Existing state and local policies lack detailed, actionable, scalable strategies that jointly

address affordability, stability, and displacement prevention amid investor-driven market pressures and anticipated population growth due to climate migration. Strategies fail to address the interconnected nature of housing availability, affordability, environmental resilience, and community equity comprehensively, limiting their effectiveness and long-term sustainability.

Without closing these gaps, Indianapolis risks intensified shortages, escalating costs, and widening socioeconomic disparities. Addressing them requires more localized research, integrated policy frameworks, and strategies informed by community engagement. Explicitly linking affordability, climate migration, and resilience could also open new avenues for federal or philanthropic funding.

Contributions of this Project

This project reframes the conversation about housing availability in the Indianapolis metro area — shifting from narrow policy silos toward a regional, design-conscious, and inclusive approach rooted in both literature and lived experience. Key contributions include:

● Advocating for a **Central Indiana Regional Housing Partnership** to coordinate planning, funding, and data-sharing across municipal boundaries, recognizing the increasingly fluid nature of housing markets and resident mobility.

● Elevating the role of **design quality and community-oriented development** as a strategy for improving public buy-in, attracting mission-aligned investment, and ensuring new housing actually meets the needs of diverse residents.

● Calling for zoning reforms that **legalize and promote a wider range of housing types**, including smaller lots, ADUs, and pre-approved infill housing — removing structural barriers that limit affordability and choice.

By leveraging insights and data from key stakeholders such as INHP, ERI, IMPO, and FHCCI, this project offers contextually-informed, practical solutions tailored specifically to Indianapolis's evolving housing landscape amid climate migration pressures.

Methodology
Core Research Question

Again, this project asked: *What opportunities exist to improve housing availability in the Indianapolis metro area as a climate resilience and adaptation measure in the face of domestic climate in-migration?* With rising national awareness around climate migration and intensifying housing pressures locally, answering this question felt both urgent and timely. The goal was not simply to identify gaps, but to surface actionable, equity-oriented solutions grounded in both data and lived experience. While climate migration may still seem distant to many, the impacts of under-supplied housing, widening affordability gaps, and structural inequities are already being felt in

Indianapolis neighborhoods today. By anticipating future migration now, the city has an opportunity to make preemptive decisions that protect its most vulnerable while being adequately prepared to welcome new residents who seek to call the Indianapolis metro area "home".

Research Design and Rationale

To answer this question, I used a qualitative research design that drew from multiple sources: policy documents, regional data, peer-reviewed case studies, and semi-structured interviews with local experts. I chose this approach because it allowed me to capture both the systemic and human elements of the problem; what the numbers say, and what the people living and working in & around Indianapolis see and experience.

This approach was shaped by a constructivist perspective, which assumes that knowledge is shaped by relationships, context, and reflection rather than being purely objective. In simpler terms, I believe we understand complex problems better when we combine different viewpoints and value both data and stories. I aimed to elevate insights from institutions and community perspectives alike, creating a fuller, more nuanced understanding of the local housing system as it relates to climate resilience.

Document and Data Review

My first step was to closely review planning and policy documents like *Thrive Indianapolis*, IDEM's *Priority Climate Action Plan*, the city of Indianapolis' *2025 Action Plan*, and Indy's *Housing Equity Plan*. These documents helped me see what city and state leaders prioritize as well as what they often overlook, especially when it comes to housing as a tool for climate adaptation.

I paired that review with analysis of economic and housing-related data, including the Self-Sufficiency Standard, housing market data, FHCCI's investor ownership statistics, and data on recent migration to Indianapolis. These sources confirmed that the city's most vulnerable residents are already experiencing serious housing strain. I also found cases like Martindale-Brightwood, where over 70% of homes are investor-owned, especially telling in terms of how quickly speculation can displace long-term residents.

To expand beyond the Indianapolis metro, I reviewed several case studies from other places tackling similar challenges: Montana's rapid housing legislation, Minneapolis's inclusionary zoning, Oregon's zoning reform, and South Bend's pre-approved infill housing efforts. These examples showed what can be done and how local context determines what will work.

Interview Process and Selection

The heart of my qualitative research was a series of four in-depth, semi-structured interviews with leaders in housing, sustainability, and planning in Indianapolis. I chose people with deep expertise and day-to-day involvement in these systems. Each brought a different

focus from housing policy and finance to environmental risk and resilience to housing development so I could gather diverse and grounded perspectives.

I used a flexible interview structure. I had questions prepared in advance, but I let the conversation flow naturally to surface insights I wouldn't have anticipated. This allowed participants to speak to the most urgent challenges and opportunities from their point of view without boxing them in.

I also had informal conversations with two peers who represent more market-oriented viewpoints. While not part of the core dataset, these talks helped challenge my assumptions, round out the ideological landscape I was working within, and also prepare me for various positions I might come across in seeking to engage stakeholders that may not agree completely with my own views in finding solutions to an issue that affects us all as members of the same community.

Coding and Analytical Framework

To analyze the interview transcripts, I used a process called thematic coding, which means I went through each interview line by line and labeled key themes that emerged. Then I grouped those themes to find patterns.

I used a realist–essentialist lens to guide this process. That's a mouthful, but the basic idea is that I assume people's views are shaped both by the systems they're part of (like institutions or economic structures) and by their own roles, experiences, and

identities. This helped me honor both the social forces at play and the individual insight each person brought.

Coding happened in multiple stages. First, I identified a wide range of topics and recurring ideas; things like displacement, red tape, or cross-sector collaboration. Then I separated themes into two buckets: common codes, which came up in most or all interviews, and unique codes, which were specific to one person but still insightful. This helped me tell the difference between broader consensus and important outliers.

This layered process helped me see where people agreed, where they disagreed, and what that meant. Rather than collapsing the interviews into one narrative, I treated the diversity of views as a strength. It made the overall picture more complex, but also more real.

Additionally, I compared these codes with the broader literature. For example, several interviewees talked about zoning reform, but some saw it as an equity issue, while others focused on market flexibility. That mirrors national debates, and it showed up locally in nuanced ways.

Justification for My Methodological Approach

I chose qualitative methods because I wanted depth, context, and local wisdom, not just numbers. There's little existing research connecting climate migration directly to housing in Indianapolis, and trying to study it with only spreadsheets would have missed the human story.

Interviews gave me a way to hear what people on the ground think should happen, and why.

This approach also aligns with justice-focused research values. It centers voice, relationships, and reflection, aspects that are especially important when exploring how policy impacts real lives. Letting people speak from their own experience and the experiences of those they represent, rather than fitting them into predefined categories, made space for more relevant and creative ideas.

Using the realist–essentialist coding lens let me appreciate both the bigger systems and the individuals within them. It helped me avoid flattening the findings into one-size-fits-all recommendations.

Limitations

As with any method, there were limitations. My interviewees were primarily professionals and institutional leaders, so direct perspectives from residents, tenant organizers, or frontline workers were not as well represented. This was due in part to time constraints of this project and access limitations. That said, several interviewees regularly interface with these populations in their daily operations and spoke on their behalf with considerable care and awareness.

I'm also aware of how my personal story shapes this work. Growing up with housing instability and financial stress gives me a deep understanding of what's at stake here. That experience helped me stay grounded and focused on practical,

equity-centered solutions, but I also stayed intentional about checking my assumptions and centering others' expertise where needed.

Methodological Takeaways

This approach of combining data, documents, real-world case studies, interviews, and thematic coding, gave me a multi-layered view of how Indianapolis might build a more resilient and just housing future. With climate change looming and housing challenges already urgent, we don't have the luxury of waiting and continuing to go about business as usual. This methodology gave me the tools to surface grounded, hopeful, and actionable ideas that reflect both evidence and lived reality.

Results and Discussion
Thematic Insights from Stakeholder Interviews

The interviews conducted for this research surfaced a number of compelling themes, many of which aligned closely with findings from the literature, while others added depth or nuance not previously captured. To organize the findings clearly, this section is structured around four major themes that emerged through coding: **(1) Rising Financial Barriers and Generational Wealth Loss**, **(2) Housing Diversity and Development Strategies**, **(3) Role of Institutions and Cross-Sector Collaboration**, and **(4) Policy Tensions and Equity Considerations**.

1. Rising Financial Barriers and Generational Wealth Loss

A dominant theme across the interviews was the intensifying impact of rising interest rates and high home values on family wealth-building and access to housing. Multiple interviewees emphasized how current economic conditions are preventing younger generations from purchasing homes, even those owned by their own families in some cases. Gabe Filippelli, Executive Director of the Indiana University Environmental Resilience Institute (ERI), noted that in previous decades, it was more likely that children could "buy their parents' homes" and sustain intergenerational ownership. But with mortgage rates doubling from historic lows and home prices continuing to climb, that is increasingly out of reach.

Gina Miller, President and CEO of the Indianapolis Neighborhood Housing Partnership (INHP), described how rising rates drastically reduce a family's buying power. Even a 2–3 percentage point increase in interest rates can erase tens of thousands in purchasing power, enough to push many families entirely out of the market. These conditions have contributed to the erosion of generational wealth accumulation, especially for households already operating on the margins. This mirrors the recent Marion County data presented earlier, showing that home prices have risen more than three times faster than incomes since 2016.

These findings are consistent with literature emphasizing the racial and economic dimensions of intergenerational wealth, including work by scholars who point to homeownership as the primary

wealth vehicle for American families. The insights also reflect and reinforce data from the Self-Sufficiency Standard and housing outlooks, both of which confirm that even modest changes in the market have outsized effects on affordability.

2. Housing Diversity and Development Strategies

Another common thread was the need for expanded housing diversity, not just in price points, but in types and configurations. Shane Phillips, Manager of the Randall Lewis Housing Initiative at the UCLA Lewis Center for Regional Policy Studies and author of *The Affordable City*, emphasized the importance of legalizing a broader range of housing types and allowing smaller lot sizes as a form of pressure release for constrained markets. This means zoning rules would be changed so that smaller homes, duplexes, or apartment buildings could be built in more neighborhoods. His focus is on creating a system where multiple housing options can be built to meet different community needs. That could include legalizing additional housing types, updating zoning laws, providing targeted subsidies, and more.

At the same time, Phillips expressed concern about poorly designed one-size-fits-all mandates. For example, he pointed out how certain types of zoning policies that impose affordability requirements have the potential to backfire, either by discouraging development or by shifting burdens to lower-resourced communities.

Miller echoed this need for more nuanced strategies, highlighting the growing importance of workforce housing. She explained that many middle-income earners now find themselves ineligible for assistance yet unable to compete in the current housing market. Teachers, firefighters, police officers, folks without whom our society could not function as it does today and to whom the American Dream has always previously been attainable, are now some of the primary clients INHP finds itself assisting in making buying a home more financially feasible. This mirrors a key gap identified in the Housing Equity Plan and reflects national concerns around the "missing middle."

Design quality also emerged as a significant theme. Brandon Powell, Vice President of Business Development at Chatham Park Development, underscored the necessity of making new developments visually compelling, arguing that beauty and excellence in design can help overcome local opposition — often referred to as "Not In My Backyard" (NIMBY) resistance — where residents push back against new development in their neighborhoods. He noted that strong design can also attract mission-aligned funding partners who are motivated by both profit and community impact.This expands on the literature's focus on supply by emphasizing that *how* we build matters just as much as *what* we build.

3. Role of Institutions and Cross-Sector Collaboration

There was strong alignment across

interviews about the need for continued and deepened collaboration among housing institutions, sustainability offices, developers, and lenders. While not all participants would agree completely, Miller described the current culture in Indianapolis as surprisingly collaborative, with multiple organizations actively seeking creative, interdisciplinary approaches to entrenched housing problems.

She provided examples of how INHP has had to "get creative" with financing tools to reach working-class buyers, including layering subsidies, using internal capital, and piloting low-barrier mortgage pathways. These examples echo the call in the Central Indiana Housing Study for integrated, innovative financing solutions.

Still, participants noted significant funding constraints, particularly the reliance on federal dollars, which come with restrictions and long lead times. Miller and Powell both discussed the importance of partnering with private actors who not only bring capital but are motivated to contribute to neighborhood stability and equity.

A unique insight from Filippelli was the need for non-partisan community champions with influence who can bridge divides and maintain focus on the shared goal of equitable growth. We need people who can make the business case for a "greener, cleaner city". These individuals can operate outside partisan divides and help build consensus among stakeholders who might otherwise be at odds. This expands on the literature's focus on systems and policy by emphasizing the human infrastructure

needed to drive and sustain complex change.

4. Policy Tensions and Equity Considerations

The interviews also revealed tensions between different policy approaches, particularly around how to balance growth with equity. For instance, while increased supply was seen as critical, there was ambivalence about how to implement inclusionary housing policies fairly and effectively.

Phillips voiced concern that inclusionary zoning — local laws requiring developers to include a set percentage of affordable units in new projects — can sometimes serve political optics more than real affordability, especially when not paired with tax exemptions that offset cost burdens on landlords and prevent indirect price hikes for residents. Filippelli worried that higher-priced developments could strain neighborhoods and residents already under pressure from rising home values and rents.

These tensions reflect ongoing debates in the literature about the tradeoffs between market-based solutions and direct intervention. They also underscore the value of a mixed approach like Phillips' framework; one that can adapt to local context and use multiple tools in concert.

Yet amidst these tensions, there was a clear consensus: policy alone cannot solve the problem without leadership, partnership, and sustained investment. In this, the interviews echoed the Central Indiana Housing Study's emphasis on aligning land

use, transportation, economic development, and community resilience strategies.

Distinctive Viewpoints

While shared themes provided important areas of overlap, the interviews also revealed clear distinctions in emphasis, assumptions, and framing. Filippelli, for instance, expressed concern about the potential for gentrification in areas of new development, particularly along corridors like the Monon, while others like Phillips and Miller were more skeptical that gentrification is currently occurring at scale in Indianapolis. Miller noted that the data often tells a different story than the dominant narrative, and Phillips warned against policy responses that assume displacement where evidence may not support it.

Miller emphasized cross-sector creativity and institutional problem-solving, offering optimism about the city's collaborative climate; in contrast, Filippelli was more focused on long-term systems pressures and the risk of exacerbating existing vulnerabilities without better coordination and vision. Brandon Powell introduced an entirely different entry point, underscoring the role of compelling design, narrative, and aesthetics in shaping public perception and funding pathways. His emphasis on what draws partners in and what makes communities proud of new housing offered a uniquely grounded, developer-driven insight.

Phillips brought a nationally comparative lens; his insights about housing typologies, zoning reform, and the risks of misapplied affordability mandates were often more technical but informed by experience working with cities across the country. His framework suggested a policy structure that is flexible and tiered, while Powell's and Miller's remarks were more locally-grounded. The cumulative result is not discord, but productive tension — differences in angle that reflect the diverse institutions these leaders represent and the distinct priorities they hold. Those contrasts help ensure the findings speak not just to shared goals but to the range of tradeoffs and questions any comprehensive strategy must contend with.

Bridging Voices and Literature

Together, these interviews bring texture and clarity to the themes raised in the literature review. Incorporating these perspectives helps shift the conversation from abstract policy levers to grounded strategies that reflect both systemic challenges and community realities. In doing so, this project attempts to answer not just what needs to change, but how, and for whom.

Toward Actionable Synthesis

What emerges from this synthesis is a picture of possibility: Indianapolis has talented, motivated leaders working across sectors, a reasonably collaborative institutional culture, and a public increasingly aware of housing challenges. But aligning these strengths into a coherent strategy will require confronting hard

tradeoffs between growth and affordability, between aesthetics and density, between market logic and community need, between maintaining the status quo and pursuing changes that are genuinely beneficial to residents.

These findings suggest that successful adaptation will require creative financing, inclusive policy design, diverse housing types, and empowered local leadership. Just as importantly, they show that the city cannot afford to wait for a crisis to act: climate migration is not a distant scenario but a present trend, and its impacts will only intensify in a housing system already under strain.

This groundwork sets the stage for the paper's final section: a set of strategic recommendations that respond directly to these findings and offer a path forward for housing policy in the Indianapolis metro area.

Case Studies and Recommendations
Case Studies

Several jurisdictions offer valuable lessons for scaling affordable housing policies in a way that Indianapolis might emulate — not because their political, geographic, or climate contexts are identical, but because the underlying mechanisms they used can be adapted to fit Indy's realities. These examples also hark back to my earlier emphasis on the flexibility of frameworks like the Three S's (Supply, Stability, Subsidy) and the need for creative, status-quo-breaking solutions that respond to local context while pursuing shared

principles.

In Montana, the "Montana Miracle" showcases how bipartisan collaboration can dramatically accelerate housing construction. Through a combination of state-supported financing, streamlined permitting processes, and robust public-private partnerships, Montana enabled cities to alleviate housing pressures quickly. Indianapolis, and the State of Indiana more broadly, can draw from Montana's experience by exploring similar strategies and by convening cross-sector stakeholders early in the planning process to align on objectives and timelines.

Minneapolis provides another instructive model through its inclusionary zoning ordinance, which mandates that a share of new residential developments be set aside for households earning below certain percentages of Area Median Income (AMI). By embedding affordability requirements directly into zoning law, Minneapolis has produced a steady stream of below-market-rate units while preserving neighborhood diversity. While legal constraints in Indiana would require careful navigation, the underlying principle — tying

new development to practical affordability mandates — offers a clear pathway. Indianapolis could consider a modified version that incentivizes developers through density bonuses or expedited approvals rather than imposing fines or penalties, ensuring a politically feasible approach.

Across the country, Oregon's recent [overhaul of single-family zoning rules](#) demonstrates how state-level policy can reshape urban growth patterns. By eliminating single-family-only zoning and removing parking minimums, Oregon paved the way for up to fourplexes on lots previously reserved for detached homes. Early data suggest these reforms may help ease supply pressures and encourage more compact, sustainable neighborhoods. Indianapolis planners could study Oregon's legislative debates and early implementation reports to anticipate potential neighborhood resistance and craft messaging that emphasizes benefits such as increased housing choices and reduced sprawl. Local adaptations might include pilot districts where more of these "missing middle" housing types are allowed, paired with investment in transit and infrastructure.

Closer to home, South Bend, Indiana, has adopted a "gentle density" approach by [pre-authorizing a selection of home-building plans](#) for infill lots. Rather than requiring each homeowner or developer to navigate protracted permitting processes, South Bend's City Council and planning staff collaborated to vet a set of prototypical designs, ranging from bungalow-style duplexes to small courtyard homes, and

make them available by right. This strategy reduces both time and cost for builders, stimulating modest but steady infill development. Early results indicate that projects using these pre-approved plans can break ground within weeks instead of months. For Indianapolis, a similar program could rapidly increase infill housing in neighborhoods with underutilized lots and increase homeownership rates with denser new developments, particularly when paired with targeted financial incentives for low- and moderate-income purchasers.

These case studies collectively demonstrate that solutions need not be one-size-fits-all. From state-level bond funding and mandatory affordability ordinances to localized permitting innovations, each example offers concrete tactics that Indianapolis can adapt to match its regulatory context, community priorities, and market dynamics. What unites them is not identical policy language but the transferable mechanisms and principles they employ, which are exactly the kind of adaptable tools and creative approaches underscored in the earlier Results and Discussion section.

My Recommendations for the Indy Metro
A Central Indiana Regional Housing Partnership

Given the increasingly fluid nature of residential mobility across Central Indiana, a regional approach to housing availability is both timely and necessary. The borders between Indianapolis and its

surrounding municipalities — Carmel, Fishers, Avon, Greenwood, Lawrence, and others — have become more porous in terms of how residents live, work, and make housing decisions. A young couple may rent in Fountain Square, purchase a starter home in Lawrence, and later relocate to Fishers as they expand their family, all without perceiving a stark boundary between those communities. Yet housing policy, planning, and funding mechanisms often remain siloed along jurisdictional lines.

Establishing a Central Indiana Regional Housing Partnership would formalize collaboration across these communities to better align zoning standards, share regional data, and coordinate infrastructure and funding decisions. This would allow the region to treat housing access as a collective responsibility rather than a zero-sum competition. By doing so, municipalities can respond more effectively to the pressures of climate in-migration and economic change, reduce duplicated efforts, and increase their competitiveness for federal and philanthropic funding. The housing market already operates as a regional system; it is time for planning and policy to do the same.

Elevate Design Quality and Community-Oriented Development

Housing production cannot be guided by volume alone, but must also be shaped by quality, community fit, and long-term value. Both Brandon Powell and Shane Phillips highlighted the danger of defaulting to "whatever pencils out" rather than what actually enriches communities.

Too often, design is treated as an afterthought — yet it is critical to long-term acceptance, community value, and even financial viability. Developments that are beautiful, well-integrated, and reflective of community character attract not only future residents but also investors, philanthropic partners, and civic pride.

Powell emphasized that storytelling and aesthetics are essential; when people see new developments that are inviting and thoughtfully designed, they're more likely to support them. This insight is especially relevant in communities where NIMBYism can block even moderate new construction. Phillips likewise stressed that if we want new housing to serve the public good, it needs to be designed for the people who will live in it, not just for the margins of a pro forma. Public-private partnerships that prioritize quality and design can catalyze development that's not just tolerated but welcomed. And in an era where cities will be competing for new residents, climate migrants included, these qualities may determine which places are seen as destinations versus pass-throughs.

Legalize and Promote Diverse Housing Types

Expanding housing types is essential to addressing affordability, choice, and climate resilience. Indianapolis has taken early steps in this direction by [following South Bend's lead in creating pre-approved architectural design catalogs for small-scale infill housing,](#) including duplexes, triplexes, and other "missing middle" formats. As the

Indianapolis Business Journal reported, the city has requested $7 million in HUD funding to support the production and subsidization of these designs, an approach aimed at reducing barriers for smaller developers and speeding up the permitting process.

This is a promising start, but its impact will be limited without broader reforms. To truly unlock the region's housing potential, Indianapolis and neighboring municipalities should legalize smaller lot sizes, allow ADUs by right, and revise zoning codes that prevent modest density in neighborhoods that could easily support it. These changes would not eliminate the need for affordability policies or public investment, but they would make it far easier for the market to meet demand in a way that's context-sensitive and scalable.

Importantly, such reforms must be paired with public engagement, design standards, and clear permitting pathways to ensure that new housing integrates well with existing communities. Legalizing diverse housing types is not a silver bullet; it is a foundational move that, when combined with other strategies, allows for the kind of adaptive, resilient housing system the region needs.

Toward a Coordinated Response

These recommendations build directly from the thematic findings and stakeholder insights explored throughout this paper. They offer a practical, collaborative path forward; one that embraces the complexity of the challenge without being paralyzed by it. A regional partnership, an elevated standard for design, and a broader legal framework for housing diversity are not just policy choices; they are signals of a city and metro area ready to lead with vision and coherence in an era of mounting climate and affordability pressures. The final conclusion will explore what it means to move from recommendations to action, and why now is the time for Indianapolis to do so with urgency, creativity, and regional vision.

Conclusion

Housing availability is no longer a distant policy concern; it is a present and mounting pressure point, driven by converging forces explored throughout this paper, including climate migration, rising costs, and persistent inequities in housing access. It is in this context that this paper asked the question: *What opportunities exist to improve housing availability in the Indianapolis metro area as a climate resilience and adaptation measure in the face of domestic climate in-migration?* This research has argued that addressing these pressures is not only an economic or supply challenge, but a test of our region's long-term climate resilience and commitment to social justice. If we fail to respond thoughtfully and collectively, we risk deepening housing insecurity, accelerating displacement, and missing a historic opportunity to shape a more inclusive, prepared region.

The path forward does not lie in a single policy or institution. Instead, it

depends on our shared capacity to work across boundaries, drawing on the lessons highlighted in the case studies, the adaptable principles of the Three S's framework, and the lived and professional insights gathered through stakeholder interviews. These conversations revealed that the knowledge, creativity, and energy already exist in government, nonprofit, and private sectors to move beyond fragmented efforts. What is needed now is coordination, commitment, and a willingness to invest in both people and place. As shown in the Results and Discussion section, listening to diverse voices and grounding analysis in both lived experience and system-level perspective ensures that solutions are not only ambitious but also workable.

There is no guarantee that the Indianapolis metro will rise to meet the moment. But the foundations are there: a collaborative spirit, creative problem-solving, and a growing recognition that climate resilience is not a luxury, but a necessity. Housing is where people experience climate adaptation most directly. Whether we create neighborhoods that welcome new residents while protecting long-time ones, or allow rising demand to quietly displace those already living here, is a decision being made, implicitly or explicitly, every day.

We have a choice: to treat this period as a reactive scramble, or to lead with intention, designing a housing system that reflects the values of equity, sustainability, and shared prosperity. The recommendations outlined here are a starting point, not a finish line. The moment for Indianapolis to act with urgency, creativity, and a shared regional vision is now.

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The East Village Experience with the Urban Heat Island Effect

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Abstract

This study investigates how the urban heat island (UHI) effect impacts the lives of those in disadvantaged communities which have been shown to experience disproportionate impacts due to higher heat indexes than nearby affluent communities. Drawing from literature on urban heat islands in San Diego and elsewhere, I set out to determine real-world experiences with urban heat islands in the community of East Village in San Diego. My data collection involved taking ethnographic field notes and photographs from my observations and audit walks throughout the East Village area. To generate more qualitative data, I reached out to the mayor of San Diego, Todd Gloria, to see where his work in serving communities such as the East Village might contradict the underlying argument that minimal investment has been made in the community. The response from Mayor Gloria's office along with my observational findings suggest that the city falls short in hearing the voices of the East Village community when it comes to implementing strategies for UHI relief.

Introducing the Context of UHI Research

Throughout my research process, I have been seeking out answers to the question:

How is the urban heat island effect experienced by the community members of East Village and is there sufficient investment in the community by the City of San Diego?

This question was significant in guiding my research because urban heat islands cause a host of issues for any community, so when looking at a particular disadvantaged community – in this case, East Village – I wanted to know the problems that are impacting individuals and families the most. The main argument throughout the course of my research was that people within this community of concern felt disproportionate impacts from urban heat islands as a result of few resilience measures put in place and minimal investment into implementing cooling strategies by city leaders.

Many disadvantaged communities across the globe experience heat at a higher intensity because they are typically situated inland, surrounded by concrete and pavement, have compromised access to air conditioning, and limited availability of green spaces. Higher heat indexes are observed in communities such as these whilst little is done to mitigate the effects. While wealthier communities are equipped with air conditioning, pools, proximity to the ocean, and ample green spaces, low-income

communities struggle with access to these overall and thus [feel the effects of urban heat islands to a much greater degree](#).

This paper argues that UHIs negatively impact the community of East Village while city leaders fall short of providing support and investment. The system has failed many individuals and families in low-income communities by withholding access to the tools necessary to adapt to our changing climate. There is injustice at play when these families can not afford their city's cost of energy to help regulate their homes during extreme heat periods. Furthermore, families often seek refuge in places such as parks or public air conditioned spaces, but when they only have a single park in their vicinity and it has previously raised safety concerns, this is no longer something they can rely on. The purpose of my research was to find out just how much these concerns were relevant to the people of East Village and what else I was missing in terms of these struggles.

I sought out these answers with the hope of narrowing down the issues of which communities and leaders can focus on strategizing solutions for resilience. While [every community experiences UHIs in different ways](#) depending on their structure and location, I believed that the answers to these questions could point towards conclusions that could guide urban heat island mitigation efforts on a wider scale. As extreme heat becomes a more prevalent issue, I wanted to seize the opportunity to obtain real answers from a real community based on their lived experiences.

This article will feature a literature review which encapsulates some of the available literature on the urban heat island effect and its presence in San Diego. I will then detail the methodology of how I conducted research on the experiences of the UHI effect in East Village. I will then move on to the results and discussion of my findings and summarize the conclusions that I have come to.

Key Gaps in Existing Literature

Existing literature related to urban heat islands (UHIs) and the impacts to lower income communities can be categorized into three main categories. The sources I have found most informative thus far are focused greatly on urban heat islands as a scientific phenomenon, the equity side of UHIs, and case studies of the UHI effect on specific communities.

Urban Heat Islands as a Scientific Phenomenon

The [urban heat island effect](#) is a phenomenon that occurs during warm, summer months when the built infrastructure of city environments creates and retains excess heat. A city in which minimal or no green spaces exist and where the urban areas are lined with concrete and outdated buildings is a prime hotspot for the urban heat island effect. This description fits many low-income areas within San Diego such as the community of East Village. The lack of green space further contributes to polluted air, inaccessibility to cool zones, limited recreational space, and more. The

individuals and families of these communities have been neglected by their governments and city leaders when it comes to building resilient urban spaces and managing the effects of climate change. For my project I wanted to examine how community members respond to the effects of urban heat islands.

Some literature provides an in-depth scientific background of energy consumption and heat conductivity as related to UHIs. This information is instrumental for understanding how heat islands develop in the type of society we live in. This peer-reviewed paper from the MIT Sustainability Hub provides an analysis of data on how a material's thermal mass affects its energy consumption. It contrasts how the climates of different regions in the U.S. manage thermal mass within their buildings and infrastructure. This source contributes to readers' understanding of the effect that building materials, concrete, and pavement have on ambient air temperature and heat levels.

Equity as Related to UHIs

Some literature discuss the environmental justice side of urban heat islands which involves varying levels of impact based on geography and demographics. This article on the EPA website discusses how intra-urban heat islands particularly affect certain communities. It traces the inequity of UHIs back to historic redlining and explains how heat islands put the most vulnerable communities at even higher risk. Similarly,

this article discussed many different urban heat island related topics including the mapping of UHIs and their distributional consequences which are measured by comparing temperatures in city centers vs. rural areas. This informative article also covers the correlation of UHIs to redlining, income to mean temperature correlations, impacts of heat on health, and more.

Much of this literature reiterates the assertion that low-income, marginalized communities suffer disproportionately from urban heat islands whilst lack of support from city leaders enables these injustices to persist. Research by UC San Diego was conducted to examine surface heat among different urban environments in cities all across the U.S. They found consistencies in surface heat spikes in low-income communities with large minority populations despite differences in geographies. The research concludes that the concrete make-up, lack of green space, high population density, and minimal access to cool zones are to blame for the disproportionate heat surface exposure in these inner city, urban areas.

Literature also consists of news stories in which extreme heat is discussed in relation to specific marginalized communities in San Diego. This ABC10 news article recaps a study done on the effects of the UHI effect on another lower-income community called City Heights. A non-profit titled Circulate San Diego teamed up with the City Heights Community Development Corporation to walk 42nd St. to audit the severity of heat in

the area. They recognized the environmental inequities at play and the reality that heat stays trapped in areas like this and that residents feel the effects disproportionately to other communities.

Sources like these offer excellent first hand, up-to-date feedback from community members. Journalists and non-profit representatives work within the community and can obtain authentic responses from people facing the issues at hand. The auditors interviewed Maria Cortez of City Heights who has lived there for over 50 years. She relayed, "It feels horrible, it feels miserable. I walk here every day," said Cortez. "Families with children, with babies, they struggle. And it's heartbreaking to see. You think my face is red? Their faces are even worse." Other conclusions from the audit include how heat risk and sidewalk conditions pose issues for pedestrians. The groups want to use the findings to plan landscape improvements, bike paths, etc. with a $3.3 million grant given to City Heights by the state back in March 2024.

News stories like these provide evidence of what community members want out of projects such as these related to UHIs. The story concludes by disclosing that "Longtime residents like Cortez say change can't come soon enough. "We are one of those under-served communities. But guess what? We're not gonna be under-served, we're gonna be served, and that would be my greatest joy and accomplishment."

Many other literature sources detail the urban heat island effect and the pertinent solutions that can be applied to nearly any city. Both The Environmental Protection Agency and National Geographic provide a breakdown of the heat island effect in urban centers and how increasing green infrastructure can be widely implemented as a solution. These sources reference specific metropolises around the globe, laying out the social and economic costs of the UHI effect.

UHI Case Studies in Specific Communities

This storyboard details urban heat islands throughout San Diego and the plethora of impacts on its communities. This source discusses how UHIs retain heat even into the night, making it difficult for residents to find temporary relief during long periods of extreme heat. It talks about UHIs as a health hazard in all parts of the city. Energy use and costs are driven up to mitigate impacts to health, which can sometimes only exacerbate the issue. It includes a map of heat risk in different municipalities, illustrating high heat exposure in areas like Mira Mesa, San Ysidro, and Barrio Logan which is situated directly next to East Village. The East Village community is shown as red, indicating high heat exposure, on the heat exposure map. Next, it shows a map of vulnerability across different areas of San Diego which again provides evidence of greater vulnerability to heat amongst inland areas. This source provides a useful snapshot of UHIs in San Diego which is helpful before looking closely at individual

communities. However, it does not necessarily suggest a correlation between low-income communities, higher heat index, and low government investment levels. This source provides an objective layout of UHIs in San Diego, displaying the geographical distribution of UHIs without suggesting any ethical significance. In contrast, the following source points directly towards systemic injustices as related to UHIs.

The San Diego Union Tribune writes about a field study conducted by NOAA and the San Diego Foundation to gather temperature data on low-income neighborhoods across the city. The study highlighted City Heights and Southeast San Diego where temperatures can be up to 20 degrees hotter than in affluent, coastal communities. The data collection was part of a campaign to protect vulnerable residents from dangerously hot temperatures as threats of climate change heighten. Similarly, the following paper looks at the state of California to dissect the social vulnerabilities associated with UHIs and other climate hazards.

This peer-reviewed paper by the Pacific Institute examines the lack of vegetation and open space in particular neighborhoods as contributing factors to heat stress. The authors provide further evidence of the positive correlation between poverty and high amounts of impervious surfaces in communities and the negative correlation between poverty and tree cover in multiple areas of California. They discuss other factors that make the heat island effect so impactful to low-income populations

such as the lack of accessibility to electricity for some minorities and the tendency for families to not want to open their windows if living in high-crime neighborhoods. The literature includes data about racial groups' vulnerability to heat-related illness. Statistics show that African Americans' mortality during a heat wave in Chicago were 50% more than among whites. They concluded that this is likely a result of living in inner city neighborhoods, housing conditions, poverty, and medical conditions. The paper includes insight about how the impoverished are more vulnerable because they can not find relief with fans or AC if they are unable to afford high utility bills.

Another detailed case study recounts how low-income communities are impacted disproportionately during heat waves in Athens, Greece. This peer-reviewed article discusses the poor conductivity in low-income housing and the resulting health impacts to individuals. Although geographically removed from San Diego, this source is invaluable in demonstrating how systemic injustices and low investment levels are at play as the effects of climate change ramp up. Moving on to my next source, the tone switches to a more solution-based discussion of urban heat islands with a focus on San Diego. Readers are introduced to a tree cover as a widely-applicable solution that could be implemented in any community regardless of socioeconomic distinction.

In this article, the local organization Tree San Diego advocates for increased green space as a mitigation tactic. The

arborists at Tree San Diego advise the implementation of more tree cover as a solution for UHIs. One of TSD's fellows conducted a study of trees as a mitigation strategy for UHIs as well as how permeable/porous pavements compare to asphalt when measuring surface heat. Findings showed the significant difference between shaded and unshaded asphalt at the same time in the middle of the day. There is clearly a bias in this research as Tree San Diego would undoubtedly be a proponent of tree planting for urban development. Nonetheless, the research findings present a good argument for trees as an effective solution.

Much of the literature that focuses on UHIs provide solutions for the environmental side of the issue whilst somewhat neglecting the justice side. Furthermore, when we look at the green infrastructure that has been developed as a mitigation strategy, they are largely situated in affluent cities and areas that are typically prioritized and favored by governments and planners. While the Tree San Diego article argues for greater tree cover in San Diego and the EPA's article on Heat Islands and Equity argues for greater dispersion of cooling strategies, a key gap between the two is a discussion on precautions of implementing cooling strategies like urban green spaces. Important considerations include the possibility of gentrification as a result of increasing urban greenery. I believe another component missing from much of the literature is the real voices of community members. The opinions of those individuals

in communities of concern would bring the data and statistics of this research to life. The numbers and correlations do not just exist on paper but are actually lived out by the people in these spaces. Another gap that I notice is the ethnographic reality of those living in neglected communities. From the literature alone, it is hard to decipher how people live amongst UHIs with the limited support from city leaders.

The contribution that I would like to make with my project is to focus on one specific community and amplify the voices of their people. I will aim to give attention to finding community specific solutions that could be developed in the future. It is crucial that green infrastructure solutions are practical and entirely beneficial to marginalized communities. My goal is to take extra consideration for how projects might impact livelihoods and resource accessibility for low-income individuals. Some of the answers that I am seeking out from communities are how they have seen the UHI effect impact their own lives and overall health. Focusing on a specific community that has historically not seen enough investment in its community was an important guiding factor for my research. This project will be a tool for getting to a point where low-income communities gain the attention from local governments when it comes to policy, funding, and overall investment.

I hope that my research will eventually lead to contributions in improvements such as workforce development. In this way, low-income

community members can engage in policy related to extreme heat at a systemic level by working in city or environmental planning. Bringing awareness to more community members may encourage them to want to be involved in policy and infrastructure change.

I hope to seek out some sources of literature featuring communities around the world who have overcome UHIs in unique ways, despite where they might have begun. In other words, I would like to discover stories of impoverished or low-income communities who, with or without help, found innovative solutions to UHIs that were by and for their community members. Solution building is that much more impactful when the ideas and motivations come from within. Much of the literature I have read has been composed by research groups, organizations, or scholars who intend to address the issue of UHIs. And while this literature is powerful in leading the movement, it does not typically feature the voices from within. I want to ensure that the peoples' voices are heard on this issue and that solutions are made to improve their lives without taking anything away.

Upon contacting Mayor Todd Gloria about financial and time investment into East Village's cooling access, a representative from his office responded highlighting the research on citywide climate change vulnerability. Representative Randy Reyes included links to the City of San Diego's vulnerability assessment, heat index, community heat mapping tool, cool zone locator, and the Extreme Heat Action Plan. These tools challenged my assumption

that East Village was severely neglected by government leaders and lacking in mitigation measures. However it is clear that more time and funding is still needed to address the issues at play. The Extreme Heat Action Plan provides minimal direction of what measures will be taken to reduce heat in vulnerable neighborhoods.

Methodology of Conducting Community Based Research

I had initially planned to take a community-based participatory research (CBPR) approach for data collection. I wanted to explore the possibility of conducting interviews, distributing surveys, and overall engaging with the community of East Village to gain insight on my research question. I began by seeking out a volunteering event in which I could get responses to a survey that I wrote. I was unable to locate any events in East Village within my time frame but I signed up for a food distribution bank at Barrio Logan located right next to East Village. I had contacted the event organizer twice about distributing my survey to food bank recipients but received no response prior to the food distribution event.

Upon arriving to help at the food bank, it was evident that it was not an appropriate time to ask recipients to fill out the survey. Instead, I printed out copies of my survey and posted them on the community boards with extra copies at each level of the library. It was difficult to find other places to post the survey because posting fliers on street lamps or poles is

prohibited. I unfortunately did not receive any responses in the 2+ weeks after posting them. I struggled a lot with reaching the community and having the conversations I had intended. Before conducting any research I had made a point to avoid prodding for information in a manner that would invade people's boundaries or privacy. I decided to find new methods and transition away from CBPR to instead aim more for qualitative, observational data collection.

Ethnographic Observations and Field Notes + Photo Journal:

I spent time observing public spaces in East Village including the park, library, and various businesses. I compiled a photo journal and jotted notes from what I noticed regarding how people utilized cool zones. I framed my ethonographic observation around the following questions:

Do people appear to be seeking relief from the heat in air conditioned spaces?

What demographics enter (and thus feel welcomed) into certain spaces? Are there patterns in who takes up space in comfy areas like cafes or restaurants as opposed to who occupies spaces like public transit or parking lots?

Are there observable ways people combat the heat? For example, do unhoused individuals put up tents or use clothing for shade? How can these methods be expanded upon and utilized to equip the community at large and present the solutions that they find helpful and want to see?

Are people open to discussion of this topic? If I spark a conversation around the topic of UHIs, how responsive are people? Who is willing to discuss and who is not? How do I get those people's opinions and support them as well? What do people already know about the topic/issue? Have people previously thought about what solutions could be implemented? Is there hope within some people and not within others? What can be done to instill more hope?

Testimonial from Randy Reyes at Mayor Todd Gloria's office:

I wanted to further expand the polyvocality of my research and invite the opinions of someone that may disagree with my overarching argument. I sent an email to Mayor Todd Gloria which read,

"Hi Todd,

I am reaching out in hopes of gaining some insight from you regarding the community of East Village here in San Diego. I am conducting research on urban heat islands and how they are experienced differently across communities.

I would greatly appreciate your thoughts on how the City's investment (financial or otherwise) into East Village has or will impact them during warm summer months.

Moreover, do you believe that the community's infrastructure is fit to accommodate for excessive heat and its effect on people?

If you think there is room for improvement in access to cool zones or relief methods, what kinds of improvement do you envision?

I greatly appreciate your time and consideration here. I am excited to hear your thoughts and integrate them into the range of voices and perspectives I have observed thus far in my research!

Thank you,

Lani Warren"

I figured that given Gloria's time as San Diego's mayor he would largely disagree that East Village is neglected by its government. I was curious to know if he would display accountability for low investment levels or if he is content with the community's access to cooling spaces. I was hoping that his response would serve as a testimony for what the city has done right in serving the community of East Village and if perhaps I was wrong about the lack of city involvement and support. My goal was for Mayor Gloria's role in city leadership to fuel a response that would provide some insight that would stand in opposition to my argument.

Results of Field Data Collection

While volunteering at the Barrio Logan food bank did not

serve as a form of data collection, it revealed much truth about the stories of the people who I intended to draw insight from. For just a couple of hours I was immersed into the struggles of the individuals living in Barrio Logan. I came face-to-face with their reality in which they lack the sustenance, cleanliness, and basic resources that many of us are accustomed to. Although photos would have conveyed a lot about the experience, I took no pictures out of privacy and respect to the people.

I recorded field notes, photos, and observations of different public areas within the community. I stopped at a park to observe the categories of people there which included working professionals, dog-walkers, children and parents, people of color, and unhoused individuals. I noticed also that policemen patrolled the area making it difficult for the unhoused to set up camp even in the heat. Unhoused individuals migrate throughout the community to avoid increased surveillance. The results of my ethnographic observations in East Village contributed to my assertion that the community is underserved in UHI mitigation tools and strategies. I have included my photo journal and notes which contain more results from my observational audit.
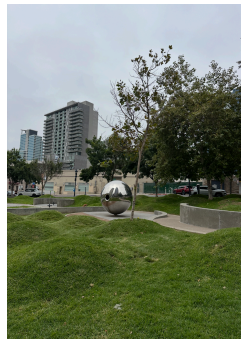
I then headed to the nearby Central Library to post my survey flyers. I posted my flyer on the. Community board on five floors of the library and left a few copies next to the postings. The questions are typed out and a QR code is found at the top for individuals to submit responses.

There were a substantial number of visitors in the library including unhoused individuals with their belongings taking refuge in the comfortable, air conditioned atmosphere. Aside from the park, the library is one of the few places that unhoused individuals can enjoy a cool space for free. Many of the buildings in the immediate area were locked up and vacant, making it difficult for East Village residents and unhoused populations to take refuge elsewhere. I then drove to an area with more stores, restaurants, cafes, etc. to see what I could observe. This area had more tree canopy and shading to help cool the community on warmer days.

In arguing that urban heat islands present disproportionate impacts to East Village and other underserved communities, I had felt that the strongest

argument in opposition of my own would be Mayor Todd Gloria. Having been the [San Diego Mayor since December of 2020](#) and tasked with improving the wellbeing of communities, I believed he would stand in opposition of my assertions.

I emailed the Mayor's office and quickly got a response from representative Randy Reyes reading:

"Thank you for contacting the Office of Mayor Todd Gloria. I reached out to the City's Chief Resilience Officer to gather some answers for your questions. Please [refer to] the following responses:

Moreover, do you believe that the community's infrastructure is fit to accommodate for excessive heat and its effect on people?

- The City completed a Citywide Climate Change Hazard Vulnerability Assessment in 2020. It found our conservation and open space areas to be highly vulnerable to extreme heat and various asset classes to have medium vulnerability to extreme heat (airports, bridges, distribution reservoirs, etc. A snapshot of the findings can be found here on page 3 and the full assessment here:

*https://www.sandiego.gov/sites/default/files/
climate-change-vulnerability-assessment-br
ochure.pdf*

*https://www.sandiego.gov/sites/default/files/
climate-change-vulnerability-assessment.pdf*
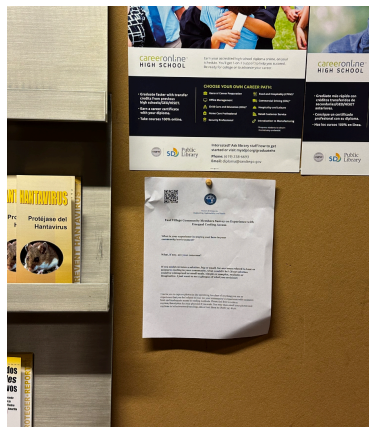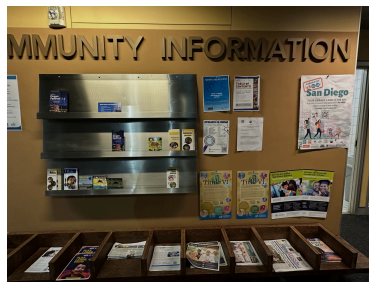
*- Additionally, the City developed an Urban
Heat Vulnerability Index that considers the
vulnerability of communities to extreme heat
events based on land use as well as social
and health factors and completed a
community heat mapping campaign to
understand how urban heat varies across
neighborhoods. These show the East Village
area as high heat risk / exposure.
https://www.sandiego.gov/climate-resilient-s
d/projects/urban-heat-vulnerability-index*

*https://www.sandiego.gov/climate-resilient-s
d/projects/community-heat-mapping*

*If you think there is room for improvement in
access to cool zones or relief methods, what
kinds of improvement do you envision?*

*- During heat events, the City activates
libraries, recreation centers, and other
public buildings as cool zones. For East
Village, the closest cool zone would be the
Downtown Library. Through a recently
awarded grant from the Governor's Office of
Land Use and Climate Innovation, the City
will be developing an Extreme Heat Action
Plan that will identify specific projects and
programs to mitigate heat risk. This work
will be kicking off later this year.*

https://www.sandiego.gov/cool-zones

*https://www.sandiego.gov/planning/work/ext
reme-heat-action-plan*

Again, thank you for reaching out.

Best regards,

**Randy Reyes (he/him) Community
Representative Districts 2 & 3 Office of
Mayor Todd Gloria City of San Diego***"*

Reyes' response is highly valuable as
it further affirms my assertions that East
Village is of a high heat risk location. His
email included hyperlinks to heat index
tools, mitigation tactics, and plans. I will
include these below and use them to expand
upon my literature review. These sources
somewhat refute the notion that East Village
is neglected by San Diego city leaders. It is
clear that there is some effort being made in
the context of urban heat islands.

However, the resources provided in
Reyes' email still reflect some truth about
my argument. It is clear that the city *plans* to
implement strategies to address extreme heat
in certain communities, but upon reviewing
the Extreme Heat Action Plan and observing
the area of East Village, there is much room
for resiliency strategies to develop and
actually take shape in the community. The
library was identified as a cool zone, which I
did in fact observe to be true. However, it
seems to be the only place available to
certain demographics such as the unhoused
populations. When the library is closed on
weekends and holidays such as the Fourth of
July in the heat of summer, what other cool
zones do unhoused populations have to go
to?

One of the few cooling zones is Fault
Line Park in East Village. I observed the

park to be well-kept, welcoming, and effective for cooling. But with heavy policing in the area, unhoused populations in particular can be discouraged from taking up space in areas like this. Where can they go to keep cool? Furthermore, if parents deem the park to be unsafe as they did in this [news story](#), what other cool spaces are available to families in East Village? Fault Line is essentially the only park in the community yet it is falling short in the safety component.

After observing various areas within East Village and considering Reyes' response to my questions, I identified multiple gaps in the City's efforts to build resilience to heat in communities of concern such as East Village. A major one being that the Extreme Heat Action Plan does not state specific strategies that will be implemented or point to a plan for what will be done. I believe another missing element is devising ideas on how the community can equally access heat mitigation and voice their ideas for cooling solutions, as this was a key aspect of the Extreme Heat Action Plan.

In analyzing my observations I would also like to address the gap that I previously identified in my literature review regarding the [possibility of gentrification](#) in mitigating UHIs. I noticed that there are already certain businesses such as cafes within East Village that, despite serving as cool zones, welcome in consumers while discouraging the low-income and unhoused community members. It is very likely that more cool zones being introduced may have the same effect, leaving lower-income

residents to fend for themselves in the heat. These are important considerations to make when urging city leaders to develop their plan for heat mitigation. They should by all means find ways to cool the community for residents but they must do so in a way that does not drive away the most vulnerable individuals. This again is where the voices of the community are important. City planners must determine where community members will feel welcomed and invited into cool spaces.

Summarizing Findings on the Lived Experience with UHIs

My project investigated the lived experience of urban heat islands by East Village community members and explored how the City's level of involvement related to heat mitigation impacts their lives. [City leaders and policymakers](#) think that East Village is equipped with sufficient cool zones, but by using ethnographic data collection methods, I observed that there are areas and categories of residents in East Village that are still neglected. City leaders must find ways to introduce cooling zones and other strategies to protect those most vulnerable while minimizing the possibility of gentrification.

The results of my data collection methods had underlying themes pointing to the experience of UHIs by the East Village community. While the city has developed two main cool zones, the Central library and Fault Line Park, there are still issues of safety, cleanliness, policing, 24/7 accessibility, and more. The city has [a plan](#)

in the works to address extreme heat mitigation in vulnerable communities such as East Village. However, the funding sources and specifics of the plans are yet to be determined. Although it is currently an early stage of the plan that will be completed in 2027, the issue is still a pressing one that deserves more attention. The issue of urban heat islands that can cause great distress for some individuals is evidently on the back burner of city leaders' priorities. East Village still lacks in areas of cooling access where other communities thrive.

Progress can be driven by involving community voices to achieve the solutions that residents desire most. As the city continues to develop its Extreme Heat Action Plan, spotlighting the concerns of the community will be instrumental. The limited funding allotted to assisting East Village should go directly towards what the people express the need for. Engaging the East Village community residents in UHI mitigation strategy development is crucial for moving forward and strengthening resilience in the face of climate impacts.

Ethics and Reflections

I am proud that I was able to look deeper into a community of concern within San Diego beyond conducting research online. I was able to contact the Mayor's office and get more insight into the aspects of my topic that I perhaps was not seeing through my own research and observations. This gave me a different perspective than my own and even provided me with some reassurance that there are real efforts for

heat mitigation going into the community of East Village.

I am also very content with the fact that my ethnographic research pushed me out of my comfort zone a little bit without jeopardizing my deeper values regarding human-centered research. I had the opportunity to help at a food bank in a severely neglected community and made the conscious decision to render my intention to collect data in that space. I learned that in seeking out insight into a demographic of people, it is sometimes enough to spend time in the community or to serve them in some manner rather than to follow a strict agenda to collect data.

On another note, I am feeling a bit discouraged about my inability to fully implement CBPR methods throughout my research. I had a feeling that this was going to be a bit difficult given my reach as a young individual without a larger organization or team to represent. It was difficult to present myself as a professional seeking answers without feeling that I would not be taken seriously enough. Moreover, it felt as though the community members who I was seeking answers from were unapproachable for various reasons. My goal was to reach mostly resident families who are affected by UHIs in their homes and at work. However, when walking the streets of East Village, I did not come across many of these individuals as they were likely occupied with work and other responsibilities. My plan for collecting surveys fell through as well because there weren't enough places where I was

permitted to post my survey. These roadblocks made it difficult to fulfill my intentions for this project.

As I wrap up my research I am feeling that my work here is unfinished. I did not get all of the answers I was looking for and I certainly did not solve the issue at hand. I am left wondering what I could have done differently to collect the information that I intended to without intruding on people's privacy. I feel that there were lines I did not want to cross and in being cautious of this, I did not come quite close enough to my research goals. I am conflicted with my approach to data collection as I begin to realize that in order to make an impact with your research you need to be willing to ask tough questions and sacrifice yours and others' levels of comfort. In the future, I think getting into close contact with volunteer or community organizations would help tremendously with opening doors for more conversation.

One of the biggest takeaways from my research is the importance of amplifying the voices of those most silenced. Sometimes these individuals can be the trickiest to reach, as I learned in my own project work. Nevertheless, one can not strive for sustainability in any space without using their voice to empower the powerless. The moment we stop uplifting those communities is the moment we turn from the true meaning of sustainability.

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Empowerment After the Flames

Sierra Gibson

Abstract

The largest of the Los Angeles 2025 Fires was the Eaton Fire, which devastated the city of Altadena. Thousands of structures were destroyed, and 18 innocent lives were lost. Data shows that Black residents were disproportionately affected (Ruff, 2025). This article explores how historic patterns of discrimination have continued into the present day, contributing to the ongoing societal and environmental injustices experienced by Altadena's Black community pre and post Eaton Fire. Through attendance at two community and nonprofit-led events, as well as an interview with the CEO of a local foundation, this research investigates the extent to which members of Altadena's Black community feel empowered in the city's rebuilding process. This paper adds further support to the work of advocates and scholars who emphasize the importance of inclusive empowerment in post-disaster recovery efforts. Such inclusion is essential to dismantling systemic injustices and ensuring an equitable rebuilding process.

From Shady Grove Oliver/AfroLA (2025)

Research Question: To what extent do members of Altadena's Black community feel empowered during the rebuilding process of their city after the Eaton Fire?

THE INTERSECTION THAT SPARKED THIS STUDY: BACKGROUND

Damaged buildings from Copernicus Sentinel-1 satellite data by Corey Scher of CUNY Graduate Center Jamon Van Den Hoek of Oregon State University. By the New York Times (2025).

On January 7th, 2025, the Eaton Fire was ignited at 6:18 p.m. PST in Altadena, California. Although wildfires are a common natural disaster in this region, no one was prepared for the insurmountable damages that would arise from this conflagration. With the combination of extreme wind speeds and drought levels, this fire was one of The United States' most

difficult to control. It took 24 days for 100% containment and within those days, 18 innocent souls were lost along with thousands of structures (Romero, 2025). Of those fire victims, 48% of Black households were affected compared to the 37% of households from other racial groups.

"And I mean, what natural disasters typically do is just illuminate inequities. That's all. It just illuminates the inequities that are already there, right? Like, because we know that natural disasters themselves - they don't discriminate, right?" - Jasmin Shupper, CEO of Greenline Housing Foundation.

These illuminated inequities sparked my desire to research this topic further. Throughout the master's program in Engineering, Sustainability, and Health program at the University of San Diego, I have come to understand how deeply interconnected these themes are in shaping the state of our society and planet.

Living in Los Angeles, this issue felt especially close to home. The ongoing discriminations faced by Altadena's Black community are a powerful example of a broken system, one that has failed to recognize the links between health, sustainability, and engineering. This neglect has allowed systemic injustices to persist.

Methodology

This article employs a qualitative approach exploring the extent to which Altadena's Black community members feel empowered during the rebuilding process of their city after the Eaton Fire. The methodology aims to emphasize the significance of polyvocality by speaking with different stakeholders supporting the recovery processes of Altadena's residents. The information included in this article has been collected through a literature review and from three primary sources: a public virtual meeting, the Design For Dignity conference, and an interview with the CEO of Greenline Housing Foundation.

The virtual meeting was hosted by the organization Altadena Collective on June 12th, 2025 at 7:00 pm. This call lasted over one hour and there were up to 72 participants. While it cannot be confirmed, it is estimated that most individuals present were directly impacted by the Eaton Fire. Although the session was open for public input, it was primarily led by Tim Vordtriede, one of the leaders for Altadena Collective.

The Design For Dignity conference, organized annually by the American Institute of Architects, took place on June the 13th and the 20th, 2025, from 7:30 am - 12:30 pm. Each day held roughly 120 people. This year's theme focused on housing inclusivity for all California's residents, with emphasis on housing challenges stemming from the LA Fires.

I was introduced to Jasmin Shupper, CEO of the Greenline Housing Foundation, during the Design For Dignity conference, where she participated as a panelist. Following the conference, I reached out to her via email asking to schedule a

semi-informal interview related to my research question. This interview took place on July 9th, 2025, and lasted close to 35 minutes. It was semi-structured, leaving space for open conversations and deeper discussions on topics that were brought up.

After attending these events and the interview, I began searching for themes across the different conversations. For the Altadena Collective meeting, I analyzed the questions and comments in the virtual chatroom, as well as how Tim Vordtriede responded. Two recurring themes presented: many attendees did not understand redevelopment terms he used, and there was concern about the lack of local business involvement. Additionally, I noticed one gap in the discussion: there was no specific mention of Altadena's Black community.

At the Design For Dignity conference, I focused on the themes presented by the speakers. These included strong support for plans that focused on the resiliency of Altadena's Black community and continual emphasis on the importance of community participation in decision making. Additionally, many of the speakers conveyed a large emotional presence, as several were directly or indirectly impacted from the LA fires. However, the conference demonstrated some access related gaps: high admission cost and lack of a publicly available recording.

During my interview with Jasmin Shupper, I examined her responses and emotional tone to the discussion topics. Much of our conversation focused on

housing and resource inequities towards residents of color, as well as the long term impacts from redlining and other discriminatory practices highlighted from the LA fires. In addition, Shupper repeatedly mentioned how the Altadena's Black community has had to advocate fiercely for recognition and support from many agencies, otherwise they will continue to be overlooked. After identifying key themes and gaps across my data sources, I compared them to the findings from the literature review. This analysis demonstrated areas of improvement in empowering Altadena's Black community during the recovery steps after the Eaton Fire.
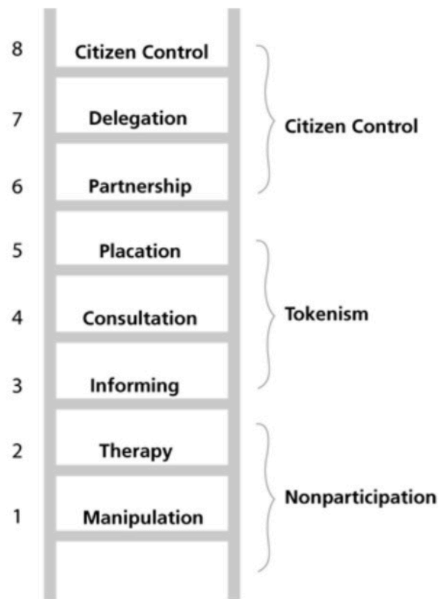
In the 'Voices from the Community' section, I further explore these themes and gaps within each data source.

UNDERSTANDING THE EXISTING CONVERSATION

In the late 1960's, Altadena became a haven for many Black individuals looking to purchase their own homes due to nearby redlining practices. Because of those racial discriminations, the Black population quickly grew, eventually expanding to 43% by 1980 (Altadena Heritage, n.d.). While this percentage has dramatically decreased with proceeding years, their historic culture has been profoundly embedded into this city.

Following the destructive fire, concerns have been raised about whether new development plans will consider ways on preserving the important Black expressions and heritage that were once the

heart of this city. One route to help preserve

Arnstein's Ladder (1969)
Degrees of Citizen Participation

Figure 1, Ladder of Participation (Arnstein, 1969)

Figure 2, Who Are Most Impacted by Natural Hazards? (Davis et al., 2021)

that culture is through community

empowerment and engagement. As history has shown, minority populations have rarely been included in conversations that regard their livelihoods. Instead, these discussions typically involve privileged members of society who are not familiar with what is best for those individuals.

Community engagement is not typically a central focus in urban development and policy discussions. In many cases, a top-down approach is utilized, leaving those choices to be made from government officials and planners, excluding civic consultation (Sadiqi et al., 2016). Often, this form of planning neglects resident participation which can lead towards unsatisfied end-users, provoking local conflict and continued social inequities.

In 1969, Sherry Arnstein created the Ladder of Participation to dictate the various levels of citizen participation in selection processes (Arnstein, 1969). **Figure 1** showcases Arnstein's ladder**,** demonstrating the higher levels corresponding to more citizen power. At the time of formulation, Arnstein mentioned that most community involvement occurred at lower levels. Although she created this model in 1969, very little has changed in the status of citizen participation. This statement of hers can be easily transferable to today.

"... rarely does a community develop citizen control to govern a program or conditions of change." - Arnstein, 1969
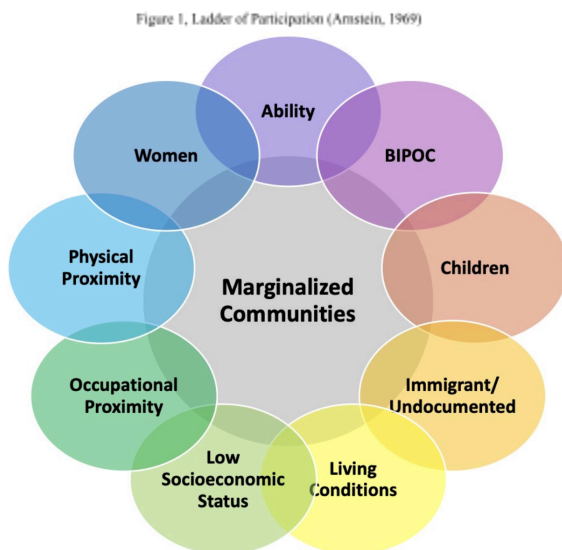
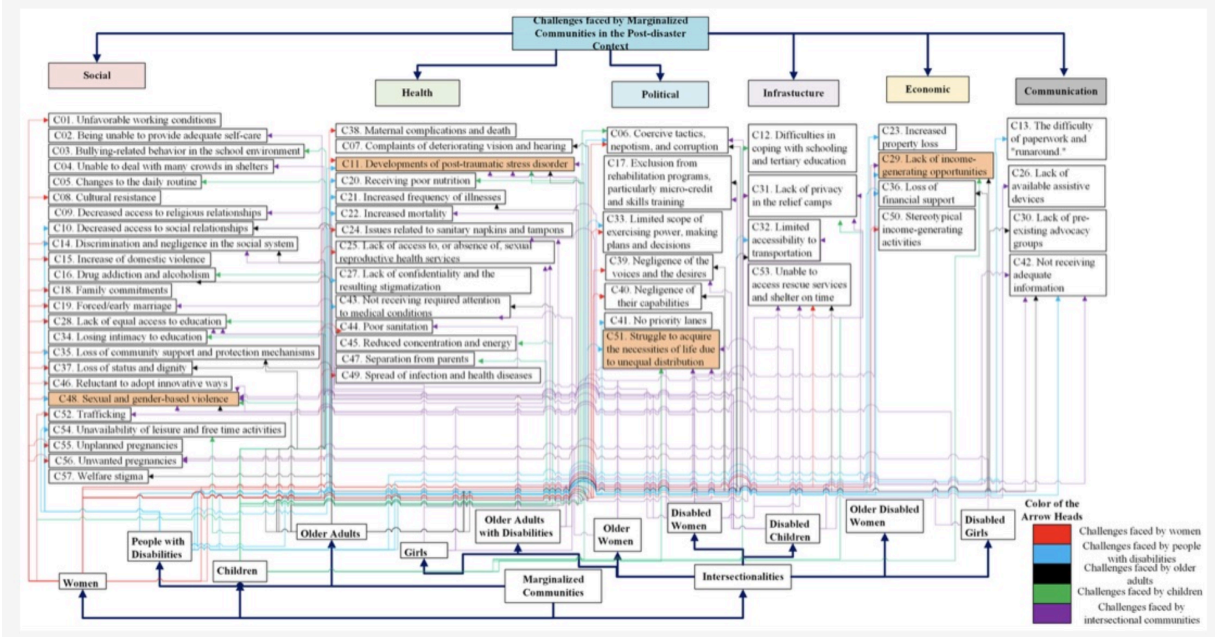**Figure 5.** Key challenges faced by marginalized communities in the post-disaster context.

Figure 3. Key challenges faced by marginalized communities in the post disaster context
(Mendis et al., 2023)

Disproportionate Impacts of Natural Disasters

The lack of local participation not only fails at respecting an individual's thoughts and concerns, but it specifically excludes historically marginalized communities. This social issue is even more evident following the impacts of natural disasters. Sharma (2014) supports this notion, further explaining that low- income regions and their residents suffer significantly more from disasters. Amongst these are typically BIPOC, women, children, immigrants, and persons with disabilities. **Figure 2** visualizes these groups which face increased exposure due to societies continuous oppressions against them.

These injustices can be viewed internationally and within the United States.

For example, the 2004 Indian Ocean Tsunami, which claimed over 225,000 lives among the developing countries of South and Southeast Asia, exposing the disproportionate impact from a natural disaster. At the time, and still to this day, this area holds some of the most vulnerable people in the world (Britannica, 2025).

Throughout U.S. history, we have seen this play out in endless scenarios. For example, in 1865 when newly freed slaves in the United States wanted to purchase land, their only option was to buy in a high-risk flood and tropical storm region. This area was known as Freedom Hill. However, very quickly did Black residents learn that there was no true freedom here due to the endless natural catastrophes prohibiting them from living without

hindrance.

Another case of a national example of natural disasters unequally affecting a marginalized group was the occurrence of the 1906 San Francisco Earthquake. It is estimated that around 4,000 Chinese immigrants lost their lives in this event due to being forced to reside in confined and withdrawn spaces (Davis et. al., 2021).

Inequities in Disaster Resources

In addition to natural disasters disproportionately affecting marginalized communities, during recovery processes, those inequities continue. Due to pre-existing discrimination, many of these individuals experience post-disaster issues related to monetary instability, scarcity of resources, communication challenges, lack of political power, and insurance difficulties during the recovery processes. Additionally, these various inequities have the tendency to influence and exacerbate one another, making the situations even more grueling to overcome (Mendis, 2023). A study from Howell & Elliot (2019) found that on average, these disasters create extreme economic loss for Black individuals while White counterparts gain significant financial sums.

Figure 3 from Mendis et al. (2023) reveals the extensive and complicated challenges faced by marginalized communities' post-disaster.

One of the most well-known natural disasters in U.S. history was Hurricane Katrina in 2005, which exposed the unequal resource and aid distribution to communities of color.

Figure 2: Impacted Areas vs. National Rates

Source: "Hurricane Katrina Social and Demographic Characteristics of Impacted Areas," Congressional Research Service, 2005.
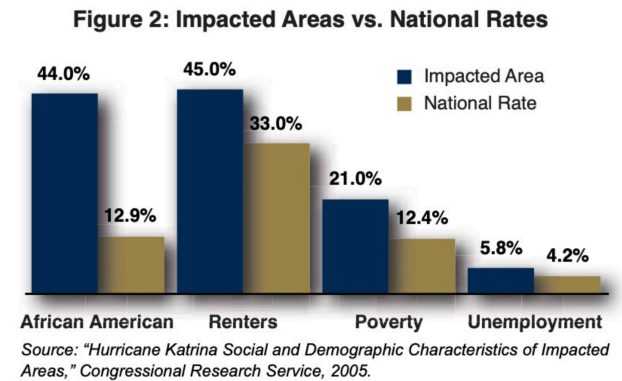
Figure 4. Impacted Areas vs. National Rates (Morse, 2008)

This catastrophe underscored the deeply rooted inequities in disaster response and recovery, revealing disempowered populations were less likely to receive equitable aid from federal officials (Morse, 2008).

Although there was a national surge of solidarity and grassroot support to the affected Black communities, government recovery decisions still reflected prejudices. Even with this nationwide support, Black survivors were forced to advocate for just recovery policies, challenging the systemic neglect they faced. They had to fight for recognition and inclusion in the recovery phases.

Hurricane Katrina became a horrific turning point which illuminated many silenced societal inequalities. Local Black communities recognized the lack of communication and engagement, which left little room for empowerment. Another

shortcoming that occurred was the unequal disaster assistance from FEMA and the Red Cross to Black residents (Anderson, 2008).

Ultimately, Hurricane Katrina revealed that marginalized empowerment has not been a priority in the United States, either in everyday governance or in disaster assistance programs.

Subsequent disasters displaying similar patterns of injustices were the Hurricanes Irma and Maria, which destroyed Puerto Rico in 2017. Many residents felt that due to racial prejudices and the complicated history with the United States government, challenges were had with sufficient federal aid (Rodriguez- Diaz, 2020). Similarly, when Hurricanes Florence and Michaels hit the southern sections of the U.S., many Black individuals stated that they had large difficulties obtaining FEMA assistance (Sturgis, 2018).

Disasters batter the same vulnerable communities over and over, making it harder to recover and thrive

Natural disasters since 1953
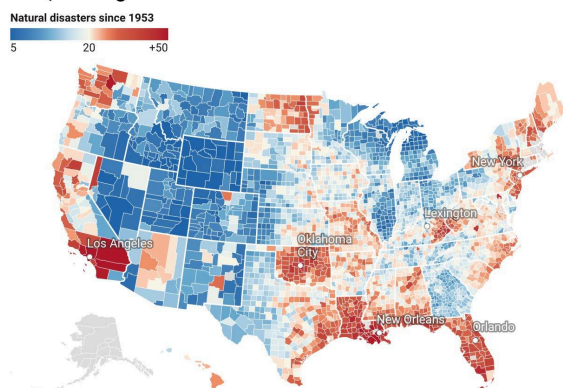
1953 - 2023
Map: Jeremy Ney @AMERICANINEQUALITY • Source: FEMA • Created with Datawrapper

Map created by Jeremy Ney, American Inequity (2023)

A more current instance of these systemic inequities in disaster recovery

occurred during the Maui wildfires of August 2023. Prior to these fires, Maui had a severe housing crisis, especially towards vulnerable groups including many Native Hawaiians. The island's steady incline of living costs and housing has made it increasingly unaffordable to many residents, unless they are a part of the wealthy elite, often outsiders or white individuals. Now that the wildfires have destroyed large areas that were once home to Native Hawaiian communities, the risk for permanent displacement is at an all-time high. As rebuilding plans continue to be made, the acts of gentrification become more as housing costs rise even higher, making it even less affordable for most residents to return to their ancestral lands.

"In Maui, unfortunately, most of the native Hawaiians will likely not be able to return to the land that burned where their homes once stood. It's just not going to be affordable when new urban development will cater toward making the most money." - Dixon, 2023

In her article, Dougherty & Witkowski (2025) investigates how the Maui wildfires are perpetuating the unhoused issues further with Native Hawaiians. Through her research, she highlights how the impact of settler colonialism is unique to Native Hawaiians compared to the experiences of Indigenous people on the U.S. mainland. She argues that Native Hawaiians are consistently excluded from discussions about racial equity and how they are disproportionately exposed to housing insecurities. Now with the added

pressure from capitalistic redevelopment plans, the number of unhoused Native Hawaiians is expected to grow significantly.

Another study which focused on the recovery process on the Maui wildfires found that there were four main concerns from local residents on community inclusion in redevelopment plans. Those were: respecting our grief, focusing on families first, distrust of government aid, and inflated housing prices (Dougherty & Witkowski, 2025). Their research also found that, due to lack of federal support, community members heavily relied upon one another for support and empowerment during recovery.

"[Our community is] very strong… The community is what has been the most helpful out of anything." - One participant from Dougherty & Witkowski's paper, 2025

Local Empowerment in Recovery Efforts

Because of the predisposed structural racist acts oppressed communities are faced with, community engagement and empowerment may seem impossible to many. After a natural calamity unfolds, many of these individuals do not have the privilege to stand up and ensure that their voices are being acknowledged throughout the rebuilding decisions. Instead, their focus must be on ways to simply survive with the limited resources and aid they are given.

A study from Davis et al. (2021) researched the importance of focused disaster resiliency plans within disadvantaged communities. They found

that, of 95 programs that focused on supporting marginalized communities' post-disaster in the U.S., only 19 focused on resiliency routes to help prevent future environmental racism (Davis et al., 2021). The remaining programs focused solely on immediate relief. Results indicated that those 19 resiliencies directed programs had the highest success rates due to long-term recovery groups bridging together local leaders and FEMA. They even saw more achievement compared to national organizations due to their more personal interactions with community members. A reason for national organizations falling behind was because these support agencies had the tendency to not follow up after the immediate disaster relief was completed (Davis et al., 2021).

Furthermore, this study discovered that a lack of trust between locals and government organizations created a large barrier for recovery activities. Many federal programs have shown that they do not trust the community members to properly relate accurate disaster data. While on the other hand, locals have not believed in those federal programs' genuine interest in mitigating further systemic injustices.

Davis et al. (2021) suggest that trust and relationship building with affected communities should be a priority for federal aid agencies. For instance, creating ways to hear community feedback on the post-disaster interventions and creating spaces to welcome local knowledge on their culture and values. When trust from all stakeholders is had, that is when triumphant

resiliency efforts can be born.

This accomplishment was witnessed in 2020 when an earthquake hit Puerto Rico. A non-locally sourced organization was assigned to aid Puerto Ricans and instead of using their own procedures on obtaining disaster data, they asked the community to help in reports of housing damages. Through this relationship, it was discovered that more underrepresented groups were accounted for compared to when only relying on government authority data (Davis et al., 2021). This action of engagement with residents allowed for usually forgotten victims to be acknowledged, assisted, and empowered.

"When disaster strikes or is imminent, closing this political and social distance can reduce detrimental outcomes for socially marginalized groups." - Davis et al., 2021

Former President Bill Clinton emphasized the importance of collaborations between communities and federal policy and planning decisions, stating that natural disaster survivors hold the most accurate knowledge on what recovery strategies best meet their communities' needs (Clinton, 2006). This mutual engagement was demonstrated after the 2004 tsunami, when the Sri Lankan government supported processes which employed survivors to share their experiences, thoughts, and concerns. As a result, a community driven reconstruction effort formed, which gained strong backing from prominent organizations such as the World Bank.

Clinton also advocated that one of the most effective routes to ensuring community empowerment following disasters is to put the financial resources directly into their own hands. Often, aid organizations have little understanding of the communities' context, however they hold the bulk of recovery funding. Without resident inclusion in financial decisions, existing inequalities and vulnerabilities have the potential to get overlooked and perpetuated.

Another example of community-involved redevelopment plans after a natural disaster occurred in the Philippines following typhoon Yolanda. As the prioritization of civic participation was central in the recovery process, the local government created a Local Inter-Agency Committee (LIAC) (Ngulube, 2024). LIAC was composed of various stakeholders, from federal employees to local residents. The purpose of LIAC was to create a platform to voice the communities' needs, particularly regarding relocation plans.

In addition to LIAC, the government launched the National Housing Authority (NHA) to provide sufficient housing for survivors (Ngulube, 2024). Within NHA, there were opportunities for community members to directly participate in the construction of their homes and receive compensation for their labor. Through the LIAC and NHA, individuals gained greater influence over redevelopment decisions of their community. This empowerment not only led to a more inclusive recovery but also addressed preexisting social injustices.

Despite the extraordinary outcomes and satisfaction resulting from community engagement in the reconstruction plans, in the third year, the Philippines' government shifted their focus from resident participation to accelerating the pace of construction. Even with the multitude of studies and examples supporting community-centric approaches, achieving sustained civic participation post disaster remains a challenge. As seen in the Yolanda Typhoon recovery efforts, consistent local engagement is necessary for lasting and successful community involvement. However, the pressure for faster recovery often poses a significant threat to genuine local empowerment.

Power, Policy, and Discrimination

Even with supporting data showing how beneficial it is to all members of society for community participation in post-disaster recovery efforts, there are many opposing views that do not support this notion. President Trump being a large face for this. Prior to Trump's second presidency, President Biden largely supported a program that's attention was on actions related to community empowerment, specifically within marginalized individuals. This program was the Building Resilient Infrastructure and Communities (BRIC) which was a section under the Federal Emergency Management Agency (FEMA) (EPA, 2024). From the EPA website, the description of BRIC is stated.

"… provides grants to identify mitigation actions and implement projects that reduce

risks posed by natural hazards, promote partnership to enable high impact investments, support adoption and enforcement of codes and standards to facilitate community-wide risk reduction impacts, and to reduce disaster losses and protect life and property from future disasters." - EPA, 2025

Biden's approach for BRIC was to promote equity and justice for disadvantaged communities after natural disaster occurrences through financial support (TEMA, n.d.). More specifically, Biden ordered for 40% of the BRIC grant money to be used towards projects that focus on underserved populations (Frank, 2025). BRIC was outlined for 75% of an eligible disaster victim's application to be funded from the federal government and 25% came from the state. For impoverished communities, 90% was federal and 10% came from the state (EPA, 2024).

Despite this program's accomplishments and its overwhelming support from Congress and states, when Trump was admitted into office in 2025, he abruptly eliminated this program on April 4th, canceling all applications from the years of 2020-2023 (FEMA, 2025). A spokesperson for his administration stated,

"… it was a wasteful program that was wrongfully used for political agendas and unnecessary climate change policies- it was not helping Americans affected by natural disasters." - Courthouse News Service, 2025

The timing of this decision to cancel BRIC was devastating. This termination

came only two months after the disastrous Los Angeles Fires. Pairing this with California's complicated relationship with President Trump, it is unlikely that there will be adequate federal financial and social support. Without federal programs like BRIC after natural disaster occurrences, the chances for equity driven recovery efforts in marginalized communities lowers significantly. Monetary aid has demonstrated to be a top factor in ways to help empower citizens in leading recovery initiatives. Without this assistance, concerns have been raised on the risks of gentrification occurring in areas such as Altadena.

In response to these concerns, there have been several locally led organizations stepping up to support Altadena's community and help restore its legacy through recovery efforts. Below are three examples of such organizations.

VOICES FROM THE COMMUNITY

Greenline Housing Foundation

After speaking with Jasmin Shupper, the CEO of the Greenline Housing Foundation, it was apparent that disaster capitalism is quickly advancing in Altadena post Eaton Fire. Prior to the fire, there had been a notable drop in Black households here. In 2000 30% of Altadena residents were Black, compared to in early 2025 that number being 18% (Oladipo, 2025). Combining this declining trend with the effect from the Eaton Fire, there is much concern that residents of color will be pushed out of their city. This is where Shupper's foundation, Greenline Housing, comes into play.

Before the LA fires erupted, Greenline Housing Foundation was designed to help increase minority homeownership through financial support and monetary education systems (Greenline Housing Foundation, 2022). With these resources, Shupper and her team hoped to help restore justice to people of color. Once the LA fires broke out, this foundation then created a specific focus on routes to help the colored people of Altadena and nearby areas. This being named the Rebuild, Restore, Remain Eaton Fire Relief Fund. This funding process includes three phases. Below is the information shared from Shupper.

Phase 1 - Long term temporary housing and rental assistance

People of color have historically had more difficulties attaining housing, even prior to the fire here in California. After the fire, this housing crisis was exacerbated. There were many housing units available, however people of color are not being approved compared to white residents. Greenline Housing has been able to

eliminate this hurdle for colored households by entering into direct leasing agreements for interim housing. They have signed a corporate lease with an apartment complex in Glendale that allows Greenline's financial assets to qualify for families to approve. So far, this foundation has been able to help 26 families secure long term temporary housing and have awarded over $500,000 in rental assistance.

Phase 2 - Land banking

Greenline has been the first local community organization to implement an emergency land-banking initiative post-fire to keep lands out of the hands of those looking to capitalize from the Eaton Fire. Greenline has been able to buy back land from colored households who have decided to sell their property instead of rebuilding after the fires. So far, this foundation has been able to purchase 2 properties, investing over $1 million back into this area, ensuring that it stays community-driven.

Phase 3 - Rebuilding

Greenline is aiming to aid 50 households up to $250,000 in rebuilding costs. They hope that this support will help community members be able to afford to stay in Altadena, instead of selling their land off to corporate capitalists.

This 3-phase process has engendered hope back into the community in an unexpected way than Greenline was expecting. One success story that this foundation has had is being able to help a woman find stable interim housing after she

had moved 15 times in 90 days post the fire. Now that she has been able to feel secure in her temporary home, she feels more empowered to focus on rebuilding her family's home. Steady housing gives community members confidence that they can be resilient after a disaster occurs.

"But what it demonstrated to the community was that somebody gives a damn, and that we have power. The community does have power, because so many people feel powerless against all the speculative development activity and against all the

Photo from Mario Tama/ Getty Images (2025)

things that it'll take to rebuild. And there's an overall sense of powerlessness, but if we can give power and hope back to the community, that is the real win." - Jasmin Shupper

Organizations like Greenline Housing that continue to demonstrate genuine interest in resiliency efforts for impacted communities are instrumental today.

"Losing everything in the Eaton Fire has been a devastating blow, but the outpouring of support, especially from people like Greenline, has been a beacon of hope. Greenline's kindness has lifted a huge weight from our shoulders and gives us the strength to face the challenges ahead. Your generosity will be instrumental in helping us rebuild our lives." - Joe and Lerna, Greenline Housing Beneficiaries

Unfortunately, there are many deceiving companies that take advantage of vulnerable individuals after a natural disaster occurs. One of these untrustful companies regarding the Eaton Fire is FEMA. Shupper had mentioned that while accepting applicants for her foundation, they ask individuals what sort, if any, aid have they received from FEMA? Overwhelmingly the applicant's answers are that their FEMA application is still pending or has been denied multiple times. When they get denied, they are then told to resubmit their application which is an exhausting and endless cycle for an uncertain result.

Additionally, Shupper shared that if people are approved FEMA offers, it is such a low amount that provides little stability. The maximum amount of financial housing assistance FEMA will offer is $42,500 (FEMA, 2024). This aid will barely cover a year's worth of rent for many families. During a time of struggle, FEMA has created an additional exhausting process instead of helping to restore people's livelihoods. These challenges have developed a mistrust from disaster victims towards FEMA, leading towards less confidence and individual empowerment.

Adding onto these challenges with FEMA, Shupper mentioned that disaster support typically does not reach the populations that need them the most. This was the case for many black residents in Altadena post fire. Following the LA Fires, the media portrayed an immense amount of volunteering and fundraising for the affected individuals. However, Shupper mentioned that the Black community in Altadena did not automatically receive that support. After the fire, lots of community members were asking, "Where is all of this money that's being shown fundraised in the media?" She stated that the Black community has had to fight to be able to receive some of the fundraised resources.

She also mentioned that Senator Sasha Perez and Congressman Judy Chu have been huge advocates for the colored community of Altadena in receiving the support and resources needed. Senator Perez has introduced two new bills to help protect communities from predatory property land grabs and provide funding to rebuild neighborhoods affected from the fires.

"With so much lost, the road to recovery demands exploring every possible avenue to ensure communities have the resources needed to recover and thrive once again." - Senator Sasha Renée Pérez, 2025

Congresswoman Judy Chu (2025) has put her efforts more into FEMA and how it should be exploring all available housing assistance options for every

survivor and further federal disaster aid needed to support long-term recovery efforts.

"FEMA has provided $40 million in Housing Assistance, which has been critical in helping survivors find long-term housing. But there are still survivors who are slipping through the cracks, with many still struggling to secure stable housing in their own communities." - Congresswoman Judy Chu, 2025

With support from community driven organizations like Greenline Housing and policymakers such as Senator Perez and Congresswoman Chu, Black residents are just now finally being able to receive post disaster resources.

"We had to fight for that. There was some scratching and clawing that had to happen for the organization serving the Black and Brown populations to get those resources for sure." - Jasmin Shupper, 2025

Altadena Collective Public Virtual Call

Prior to speaking with Shupper, I had

attended an online public meeting for Altadena residents put on by the non-profit organization, Altadena Collective. This event was intended to help break down the home rebuilding process for community members. Tim Vordtried, one of the team members of this NPO, mainly led this meeting. From my perspective, the focus of this event was to speak about the contractors Altadena Collective has vetted for residents.

Throughout the explanation of this, three aspects stood out to me. First, although the primary reason for this online event was to help local Altadena individuals better understand the rebuilding steps of their homes, many seemed to still be quite confused on terminology. Second, there were lots of mentions by the attendees for Altadena Collective to try to better involve local companies in the construction plans to help put money back into local hands. Third, there was no mention of explicitly helping Black Altadena residents.

These three details stood out to me because I would have assumed that they all would have been better addressed or addressed at all–especially from a non-profit community-driven organization. In my opinion, the lack of terminology clarification, local business involvement, and mentioning of Black households does not encourage inclusive empowerment of all Altadena residents during the rebuilding phases. Specifically looking at the omission of Black community members, I believe this is a form of continued racial oppression. The leaders of Altadena Collective may disagree, stating that there was no need to clearly

speak about the Black community because they are automatically included in this conversation. However, I do think it is important to specifically acknowledge this community. As stated above, colored individuals are not instinctively included into all decisions, they are often forgotten or ignored.

Design For Dignity Conference

Another event that I had attended to seek out information on empowerment efforts for Altadena's Black community was the Design For Dignity conference. This conference was themed around architectural routes to support housing inclusive communities, with a particular focus on the LA Fires. Due to this event being highly advertised that it was an architectural event, I was pleasantly surprised to listen to the various topics on the Black community of Altadena throughout different presentations. The first group of speakers all were affected by the Eaton Fire. Steven Lewis, a Black Altadena resident and one of the speakers, shared heartbreaking photos of his neighborhood which was almost completely

burnt down.

Photo from Hilary Beaumont/Al Jazeera (2025)

Throughout Lewis's presentation, you could feel how connected he is to his community and how this has deeply affected him. He mentioned that before the fire, if someone were to guess what the Black population in Altadena was, their guess would probably be somewhere close to 50%, when it was only 18%. That is how deep the Black culture was rooted into Altadena. Although Black individuals were forced to live here due to the discriminatory practice of redlining, they transformed this area into a strong, loving, and culturally rich location to which they could call home.

Lewis also noted how important it is to get people back into their neighborhoods as quickly as possible. He stated how impactful it is to see your neighbors back in their homes and how this motivates others to rebuild on their land instead of selling. Throughout the recovery phase of his neighborhood, he has found one silver lining, the strong bonds that have been formed on his street. He has grown closer to his neighbors more than ever before, largely because outside support agencies have proven untrustful, making community strength one thing they can truly rely on. His neighborhood has already created plans to have dinner together once everyone is resettled into their homes.

From listening to Lewis's discussions about his personal experience with the Eaton Fire, it was evident that members of the Black community have started taking steps on their own to empower themselves throughout the rebuilding phases through locally started initiatives, even as simple as motivating one another to stay rooted in Altadena instead of selling their land.

Later, at the Design For Dignity conference, another group of panelists spoke about the importance of preserving Black culture throughout southern Los Angeles. They discussed ways to do this through urban art scattered around the city. Examples were bridges, infrastructures, sculptures, and paintings all related to Black culture. Yvonee Farrow, one of the panelists, emphasized her support for this and how crucial it is to continue to imprint the Black culture amongst LA.

While this presentation was not focused on the region of Altadena, I found it very relevant to reconstruction decisions of Altadena. Their idea of creating various monuments relating to Black culture could be used in the rebuilding of Altadena, which could have a profound effect on the communities' feeling of empowerment and acknowledgement from government officials and policymakers.

Although I was encouraged to witness the immense amount of support and awareness of Altadena's Black people, it is meaningful to note that even with this conference being open to the public, there was still a high admission price to attend which makes this event not accessible to many. Additionally, this event was not recorded in any manner and the information spoken about was not shared with the public after the event had concluded. Even though the Design For Dignity conference was meant for architectural and related professionals, I believe the insights could have benefited all fire survivors. The event highlighted strong support for Altadena's Black residents throughout the recovery processes, and simply sharing this support with the broader community could help foster a continued sense of hope towards outside agencies.

REIMAGINING RECOVERY IN ALTADENA

Community-led organizations and nonprofits such as Altadena Collective,

Design For Dignity, and Greenline Housing Foundation have taken inspiring steps to involve and empower survivors in rebuilding plans. Even with that support, there is still a significant need for federal agencies to proactively adopt and apply similar community engagement strategies.

"By embracing citizen power and facilitating community involvement in decision making processes, policymakers can enhance the efficacy and sustainability of recovery initiatives, ultimately fostering resilience in disaster-affected communities." - Ngulube, 2024

From the recent disaster in Maui to the other previously mentioned examples, each offers valuable lessons on the ramifications of neglecting community empowerment and systemic injustices during recovery. I believe these errors can better inform the recovery processes in Altadena following the Eaton Fire. To ensure a just rehabilitation, Altadena's plans should prioritize community empowerment and engagement, as demonstrated in the above examples.

Personal Reflection and Analysis

Empowerment of residents of color has not been a priority for many private and government entities. Altadena's Black community has had to fight their way to simply begin receiving even modest support, mostly from community led organizations. This type of systemic neglect creates inequality and deepens mistrust between marginalized groups and institutions meant to serve them. Black households should not

have the added burden of having to fight for equal amounts of aid and attention compared to more privileged fire affected households receive without question.

"Altadena's Black community has long served as a symbol of resilience and opportunity in the Los Angeles region, but the Eaton Fire exposes how decades of segregation and the legacy of redlining practices have left Black households more vulnerable…The recovery process must acknowledge this historic legacy and the disparities stemming from it…Policymakers and relief organizations must act swiftly to protect the legacy and future of this historic community." - Lorrie Frasure, Director, UCLA Bunche Center, 2025

I am extremely grateful that there are many community-led and genuinely inclusive organizations that have emerged or shifted focus to support minorities impacted from the LA fires. But the reality is, their existence should not be necessary. Equity should be automatically applied into the policies and practices of disaster response agencies at all levels of government.

After attending Altadena Collective's online public event, the Design For Dignity conference, and speaking with Greenline Housing Foundation's CEO, Jasmin Shupper, it was more known that there are many inequities of resources given to the Black community in Altadena prior and post Eaton Fire. Even with the Civil Rights Act signed 1964, discriminatory acts have continued to the present day. Many people remain unaware of the deeply rooted

systemic issues that persist, which is part of the reason they have been able to exist in our society. Even those who do not stand for prejudicial behaviors can unknowingly contribute to its continuation through their lack of awareness. Embarrassingly, I was one of them.

Before enrolling in a master's program focused on societal and environmental injustices, I believed I was doing everything in my power to act against the oppression of marginalized communities. However, throughout the program, my eyes have been opened to the many systemic inequalities that still shape our world and to the ways I have been unknowingly complicit. This includes failing to recognize my own privilege as a white, educated, middle-class person living in the United States, supporting companies with discriminatory practices, overlooking signs of prejudices in my own neighborhood, and naively thinking that the racism of the past was no longer present in today's world.

What I hope to convey from this article is the reality that systemic injustices continue to occur today, specifically in Altadena following the Eaton Fire. Many people assume that because they have donated supplies, money, or time, everyone affected by the fire has received the support they need. However, as we have learned from the text above, that is far from the truth. Black residents have often been ignored, silenced, and discriminated against in both distribution of resources and the decision-making processes that shape

resiliency efforts.

In a time when we face the open racism and discriminatory policies of a president who has repeatedly shown his disregard towards minority communities, fighting for equity is especially urgent than ever. From dismantling federal aid programs, to spreading hateful rhetoric, President Trump has made it clear that equity is not a goal of his administration. This is why it is more critical for society to amplify the voices of marginalized groups, support their empowerment, and help restore their confidence.

As a society, we cannot allow discriminatory practices to continue whether in housing, insurance, resource distribution, financial equity, or any other aspect of life. With this article, I hope to contribute to the fight for justice and equity for Altadena's Black community, as well as for all communities impacted by systemic oppressions.

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Community Engagement and Natural Disaster Preparedness

Lena Fossett

Abstract

Natural disasters, such as droughts, hurricanes, and wildfires, pose fundamental challenges to ecosystems and the communities that inhabit them, particularly those residing in low-income areas. Numerous communities, particularly those in poverty, face challenging financial, social, environmental, and cultural decisions regarding ensuring fundamental security and quality of life during natural disasters. Natural disasters unequally impact poor individuals. This article explains how constructing community resilience can benefit low-income communities in the Eastern and Western Shores of Maryland. Because services are often restricted during an emergency, it is increasingly recognized that resilience is vital to a

Core Research Question: How do members of underserved communities in the Eastern and Western Shores of Maryland perceive their disaster-preparedness experiences, and how can these insights inform a just program of community resilience? community's capacity to

minimize long recovery periods following a natural disaster. Improved resilience enables greater anticipation of natural disasters and more effective planning to reduce disaster losses.

This project examines how strengthening community resilience can mitigate the long-term impact of disasters in vulnerable communities. Resilient communities are better prepared, can respond successfully, and recover more quickly when resources are disrupted. The project involved a two-step process. First, a baseline survey was conducted with local community organizations, social service institutions, and public health departments to assess present disaster preparedness attempts. The survey collected perceptions on equitable access to resources, community engagement methods, and prevailing obstacles associated with communication. Additionally, a qualitative method was employed, and interviews were conducted with residents to gain insights into their perceptions of disaster preparedness, barriers to accessing resources, and responses to actual disasters.

Introduction

Background

Natural Disasters: earthquakes, flooding, thunderstorms, droughts, and tornadoes. These diverse types of natural disasters, alongside others, have occurred in the United States and globally (Johnson et al., 2022). Globally, communities are experiencing an increase in the prevalence, severity, and frequency of severe adverse

events, including pandemics, heat waves, floods, and wildfires (Johnson et al., 2022). While regional variations prevail, the international increase in ecological extremes has increased vulnerabilities throughout numerous populations. As the increasing probability and severity of severe environmental circumstances become more pronounced, the associations between human communities and their surrounding environments become increasingly vital for their resilience (Johnson et al., 2022).

The American people have become aware of the significant risk of disasters and the frequency with which they may occur in their population. The Department of Homeland Security (DHS) has played a crucial role in efforts to safeguard lives and homes against the destructive effects of these circumstances (Johnson et al., 2022). Over the past decades, natural disasters have become a significant element in safeguarding the homeland and have increased in significance with the establishment of the Department of Homeland Security (DHS) and the creation of the Federal Emergency Management Agency in the late 1970s (Johnson et al., 2022).

Particularly, after the destructive Hurricane Katrina impacted numerous communities in New Orleans, Louisiana, DHS, and other organizations have enhanced their disaster management capacities to prevent excessive casualties and become better prepared to handle natural disasters such as Hurricane Katrina (Choong et al., 2025). This natural disaster

was the tipping point for numerous people within Homeland Security to center on terrorism and natural disasters at the district, federal, and state levels, while including cultural governmental administrations, non-governmental agencies, and the private sector to provide greater reactions and protections from substantial disasters to all communities (Choong et al., 2025).

Why do I care about this topic?

Despite the increase in awareness of disaster management, there have been populations that have not seen a rise in awareness and care towards socially vulnerable communities. Disasters are naturally catastrophic to communities, particularly impoverished sectors, typically resulting in substantial and enduring impacts on individual and community-level psychological, physical, and social health in communities where welfare is already substandard in numerous circumstances (Johnson et al., 2022). Poor people internationally experience the most tremendous impact of natural disaster losses and have the most limited access to recovery resources (Johnson et al., 2022). Public and private recovery resources are available in both poor and wealthy nations, such as the United States. The socioeconomic aspect can encompass all sectors of social life, including disasters. Low-income communities may be marginalized in disaster resiliency efforts by federal and non federal governments, thereby encountering severe impacts when a disaster occurs.

Severe Weather in Maryland

Numerous residents in Maryland find themselves facing an increasingly expensive threat to their homes, primarily the expenses associated with extreme weather conditions. For instance, in Elliott City, community members and businesses have experienced multiple severe flooding events. The first extreme flood event involved nearly six inches of rain that fell within a three-hour period, prompting severe flooding and damage to properties (E. C. Merem, 2024). Another flood occurred, involving eight inches of rain falling within a three-hour period, which led to a flash flood with a peak height of over 10 feet, resulting in extensive property damage and loss of life (E. C. Merem, 2024). In each example, the amount of rainfall was documented to have a 1-in-1000-year possibility of occurring. Thus, it happened twice in a two-year period.

The Elliot City floods are one of the numerous possible natural disasters that community members experience (E. C. Merem, 2024). Annually, Maryland residents experience hurricanes, droughts, tornadoes, and hailstorms. Numerous elements of the 11,684 miles of the Chesapeake Bay's shoreline are continuously at risk of coastal flooding, erosion, and increased flood occurrences (E. C. Merem, 2024). Over the past decade, cities in Maryland, including Baltimore and Annapolis, have experienced significant increases in the frequency of flooding.

One of the poverty-stricken counties in Maryland, located on the eastern shore, Dorchester County has a proverb, "Water Moves Us," that doesn't receive the same level of digital attention as Baltimore and Annapolis during severe weather events (E. C. Merem, 2024). However, Dorchester County's experience presents a grim representation of what lies ahead for residents in the future unless substantial changes are made by lawmakers.

For example, researchers have discovered that nearly 60% of Dorchester County residents reside in the 100-year floodplain. Approximately 50% of the residents are subjected to partial destruction from slight storm flows not associated with hurricane-like occurrences (Scott, 2020). Residents may encounter various potential damages to essential elements of their homes due to natural disasters, including mold, windows, roofs, and ductwork (Scott, 2020). Dorchester County faces numerous significant barriers in establishing a private and public framework due to the ongoing risks of severe weather conditions (Scott, 2020). The county ranks 19th out of 24 in terms of income, with an average income between 2017 and 2020 of $55,652. It has a poverty ratio of 15%, and a majority of its residents are minorities (Scott, 2020). According to E. C. Merem (2024),

approximately 69% of residents are homeowners with a property value of $190,000. Wealthier counties, such as Anne Arundel County, attain a property value of over $1.7 billion. In comparison, Dorchester County's budget of $75.7 million critically restricts the county's capacity to fund issues related to climate change.

The victims of natural disasters experience a multitude of human rights violations, including unequal access to aid, inequality in assistance facilities, gender-based brutality, the disappearance of documents, enlistment of children in wars, dangerous deportation, and problems of housing restoration (Choong et al., 2025). Furthermore, natural disasters additionally aggravate the unmanageable vulnerability of those who experience numerous sectors of past unfairness, such as women, gender, ethnicity, religion, race, and housing. For instance, native people, with anciently close connections to their land and home, typically have limited residence rights and often encounter injustice. Women are disproportionately susceptible to human rights contraventions that are gender-specific (Choong et al., 2025). No individual or community is immune to disasters or their related losses. Therefore, governments and their communities face challenging social, ethical, cultural, financial, and ecological decisions about the best ways to ensure fundamental security and quality of life in the event of disasters. Increasing community resilience can mitigate the impact of natural disasters in low-income communities (Choong et al., 2025).

The Importance of Increasing Resilience

Adoptions by communities regarding whether to support resilience construction are challenging. If constructing the culture and application of disaster resilience were basic and low-cost, communities and countries would likely have taken measures to be more resilient already (Parker, 2019). Formulating the decision either to continue with the existing condition, where collective expenditures and planning do not occur all around the United States to augment resilience when a disaster occurs, or to make aware choices and expenditures to construct more resilient systems is encumbered by a few primary points:

• Disasters will always happen in various communities.

• Populations will continue to develop and expand, as will the size and scope of communities; in some districts, the community may decrease, and the size and scope of communities will generate similar

challenges as tax bases decline.

• More individuals are residing in coastal and southern regions, where a large number of prevailing dangers are present.

• Public infrastructure is presently maturing, exceeding bearable design restrictions.

• Infrastructure such as public health, academic institutions, and public safety is vital to populations experiencing financially challenging periods as the community develops and matures.

• Social and financial structures are becoming progressively mutualist and, therefore, gradually susceptible to damage.

• Risk cannot be removed entirely, so the partial remaining risk will necessitate administrative action.

• The effects of climate change and the degradation of natural protections can make countries vulnerable.

What is Resilience?

Resiliency is one of the primary concepts that significantly influences how natural disasters impact communities (Parker, 2019). Numerous individuals have been informed about and used the word "resilience," possibly to explain how a person or community demonstrates exceptional strength in the face of adversity (Parker, 2019). In the face of adverse circumstances, a person or community can become more resilient, its methods and organizations more adaptable, and its community members more competent in resisting future adverse natural disasters or

events (Parker, 2019). Resiliency is one of the most essential elements of disaster management, helping a community and its people safeguard themselves and their homes from severe consequences. Resiliency in communities is typically taught to community members through disaster administration and education, which has a powerful focus on improving resiliency through the provision of facilities.

There are numerous approaches that communities can take to improve their disaster resiliency, which include, but are not limited to, developing new infrastructure and enhancing existing ones, improving engagement strategies and educational resources (Parker, 2019). Community administrators, public health professionals, engineers, and emergency management professionals can aid in executing different approaches that function to increase the entry to healthcare and social resources, educate and assist in preparedness measures such as education concerning natural disasters, emergency kits, and reinforcing infrastructure, enlarging communication between people, and engaging the entire community in approaches, training, and exercises (Parker, 2019). Improving resiliency can enable low-income communities to enhance their ability to manage and mitigate the impacts of natural disasters (Parker, 2019).

Community Resilience

Community resilience is defined as the adaptive capacity of a community to resist and recover from distress, such as

natural disasters and financial hardships.

The definition highlights the following notions:

• Prime community health

• Partnerships among diverse organizations

• Successful and culturally pertinent education regarding hazards

• Economic strength of families and companies

Communities can be viewed as interconnected structures that provide a standard perspective, and the comprehensive resilience of communities may be considered similarly to the comprehensive welfare of the human body (Ma et al., 2023). The human body relies on the coordinated operation of its specialized systems, including the immune, nervous, and skeletal systems, to maintain health and withstand diseases and injuries (Ma et al., 2023). Similarly, communities rely on a range of reticular structures for financial stability and growth, business, communication, education, population health, transportation, and sustainable energy. The comparative health

Box 6.1: Aspects of Healthy Communities

• Inexpensive and sustainable energy utilization
• Clean environments including indoors and outdoors
• Green spaces
• Recreational sectors that are safe containing inexpensive physical activity and regulations that encourage equal access to those sectors
• Resilient and safe infrastructure
• Quality educational events easily available to all community members.

of a population system will determine how effectively a community can resist challenging circumstances. Suppose a community has debilitated infrastructure, such as a human body with a weakened immune system. In that case, it won't combat traumatic experiences as effectively as when community members have healthy bodies (Ma et al., 2023).
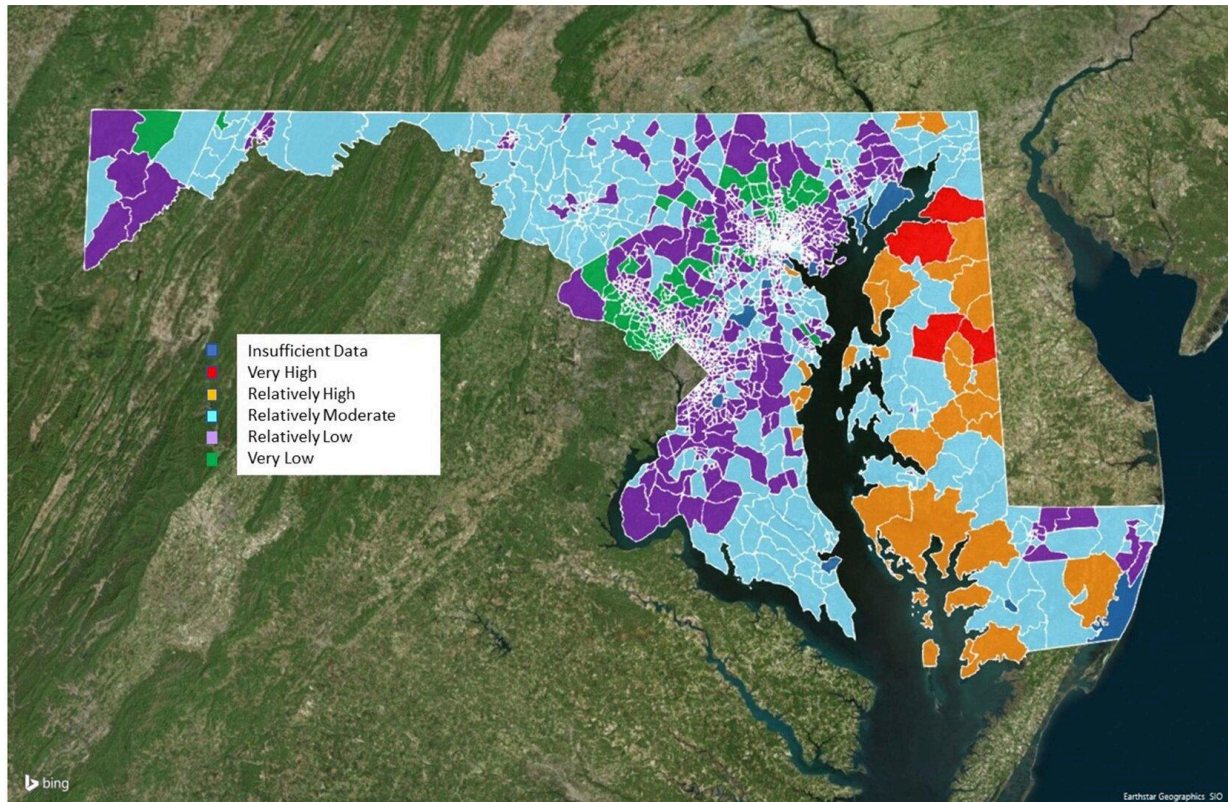
From the list in Box 6.1, several transecting subjects for healthy communities arise:

Statement of Problem

In the Eastern and Western Shores of Maryland, the most endangering dangers are coastal flooding, tornadoes, and drought. Four sectors of tracts in Maryland exhibit a high level of combined danger and economic vulnerability. However, 30 additional tracts are classified as upper-level high-risk (E. C. Merem, 2024). Sectors with the most risk are concentrated on Maryland's Eastern Shore, with others located on the western shore of the Chesapeake Bay. Approximately 81,000 residents in Maryland are currently at risk of coastal flooding. By 2050, an additional 38,000 residents are expected to be at risk, particularly in low-income communities (E.

C. Merem, 2024).

Objective

This project aims to enhance community resilience in impoverished communities along the Eastern and Western shores of Maryland through surveys of organizations and interviews with local community members to inform approaches that reinforce community resilience and accelerate recovery after natural disasters occur.

To comprehend the significance of incorporating resilience in low income communities, it is crucial to understand social vulnerability, community resilience, and the reasons why low socioeconomic families struggle to develop strong resilience towards natural disasters. Disasters are associated with human health in various elements, including disturbances to living conditions, financial outcomes, welfare, human rights, and loss of life. A large body of literature demonstrates the connection between disasters and the disproportionate impact on low income populations (Lee et al., 2022). People living in poverty are typically more impacted by natural disasters since they usually have to reside in dangerous sectors that can be perceived as risky. Risk environments can be viewed as beneficial for those in poverty due to financial opportunities, public resources, and increased income (Lee et al., 2022). For instance, families living in poor, high-risk areas in Mumbai reported being aware of the

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flood dangers but accepting them due to better access to educational institutions, healthcare resources, and employment opportunities (Lee et al., 2022).

In urban sectors, housing and land businesses often force poorer individuals to reside in riskier areas, particularly where land is in short supply. Research has shown that environments at risk can be less costly. Furthermore, in impoverished countries with informal markets, a lack of land can be drastic.

One of the primary causes of impoverished communities experiencing hardship more than their wealthier counterparts prior to, during, and after a natural disaster is described by the concept of social vulnerability. People residing in hazard-prone terrains, such as mountainous areas prone to landslides or drought-prone regions, will always be at risk. In a study conducted by Lee et al. (2022), it was discovered that environments with a larger vulnerability to natural disasters weren't socially vulnerable. This signifies that the establishment of social vulnerability doesn't entirely rely on geographical settings but instead primarily on its socioeconomic system. Lee et al. (2022) defined vulnerability as the intersection of hazardous locations and the social context of populations. The concept of social vulnerability has emerged from the fields of sociology and geography, which identify the inherent socioeconomic system as the primary cause of vulnerability.

The concept of social vulnerability encompasses various factors that may influence how people respond to, recover from, and manage the impacts of a disaster at each level. The factors include minorities, gender, and culture. Research has shown that victims who were minorities during Hurricane Katrina didn't receive a substantial amount of support (Lee et al., 2022). During Hurricane Andrew, rental homes in minority communities that were impacted by the disaster recovered at a slower rate compared to those in majority communities, despite economic scarcity (Lee et al., 2022). Social vulnerability can also play a role in human prompted disasters. During COVID-19, marginalized groups were more likely to be subjected to those sorts of disasters. Past research has demonstrated that women can be more vulnerable in comparison to men through the perspectives of family and gender beliefs (Lee et al., 2022). Research has shown that parents prioritize evacuating their children and implementing essential measures when they are in danger, with mothers often taking the lead in this process as an extension of their caregiving roles (Lee et al., 2022). In addition, enlarged post-disaster pressures have increased domestic violence against women.

Cultural and linguistic circumstances provide another explanation for why race is associated with vulnerability (Adams et al., 2022). For instance, foreigners often encounter communication issues due to language barriers. The problem of language communication encountered by foreigners poses challenges in comprehending

emergency communications during natural disasters (Adams et al., 2022). Therefore, vulnerable individuals who don't attain language abilities can't correctly understand and execute public health safety regulations (Adams et al., 2022). In terms of cultural factors, when minority groups perceive that post-disaster reassurance programs aren't suitable for their culture and deliberately choose not to participate in the required actions, they may be more vulnerable compared to others throughout the recovery process from natural disasters (Adams et al., 2022). Immigrants who are undocumented are typically inclined to not partake in disaster recovery plan activities due to the fear of deportation.

Educational Inequalities

One of the most compelling rationales for low-income families that struggle to develop strong resilience against natural disasters is the lack of access to education and technology. Traditional education is crucial for comprehending disasters, their impacts, and the measures that must be taken to prepare community members for disasters (Torani et al., 2019). A fundamental comprehension of disasters and their impacts can empower people with the knowledge that enables them to develop the skills to handle, expect, and recover from disasters (Torani et al., 2019). A basic understanding of disaster administration can evolve into a more advanced knowledge, which begins in educational centers and can incorporate community members who hold academic degrees or certificates (Torani et

al., 2019). Nevertheless, low socioeconomic families encounter extensive educational inequalities that affect their adaptability.

The preparedness of impoverished children in educational establishments requires various aspects that these adolescents typically lack due to the lack of financial resources that enable them to meet these needs. These elements encompass physical health, suitable motor skills, social comprehension and capabilities, age appropriate skills, and intellectual abilities (Torani et al., 2019). These aspects typically relate to the comprehension of disaster management. When people lack cognitive and social skills, they will not have the opportunity to acquire an education that enables them to take measures to reduce their vulnerability to dangers. Education focused on natural disasters, and data allocation is vital in decreasing community members' vulnerability to disasters and their impacts (Torani et al., 2019). Particularly for low-socioeconomic communities, disaster education is essential in enhancing their resilience and providing them with a comprehensive understanding of how to safeguard themselves, their households, and their land (Torani et al., 2019). Students from low-income families have been reported to drop out of high school at a higher rate than those from higher-income households (Torani et al., 2019). There is a larger ratio of not attaining a fundamental degree of essential cognitive and educational abilities that allow them to comprehend natural disasters and their impacts, understanding the language of what

emergency preparedness professionals are communicating, or being able to engage in training, can occur due to not being able to comprehend (Torani et al., 2019).

Socioeconomic Resilience

Poor households lose more when encountered by a natural disaster.

Concerning absolute terms, wealthy communities lose additional resources or earnings due to natural disasters, which is anticipated since they already possess more resources and higher salaries. In relative terms, impoverished communities generally suffer greater losses compared to wealthy communities in the aftermath of natural disasters.

Why do low socioeconomic communities lose more when natural disasters happen? Individuals in poverty tend not to invest as much in risk alleviation and preserve their resources in a more vulnerable configuration. Concerning the loss of income, poor communities are more likely to rely on lower-quality resources, infrastructure, and natural capital to earn a living (Torani et al., 2019). Also, they are receptive to food prices. The following sections evaluate these susceptibilities.

Impoverished households tend to invest less in natural disaster preparedness and risk mitigation.

Impoverished communities are less inclined to fund initiatives in areas such as mitigating and reducing the negative impacts of natural disasters and ecological changes. Wealthier communities are more

likely to invest in proactive modification actions (Torani et al., 2019). Additionally, members of impoverished communities often lack assets for long-term investments and risk management, typically relying on short-term outlooks.

Income losses

Natural disasters are associated with income losses. Low-income households aren't able to cope with income losses. Approximately 50% reduction in income has dissimilar outcomes for multiple households residing between $1,000 and $30,000 annually (Torani et al., 2019). Specifically, impoverished households cannot reduce opulence expenditure or delay expenditure the way rich households can. In numerous countries, they are near the maintenance level, which means that decreasing expenditure can have immediate adverse effects on welfare, financial aspects, and education (Torani et al., 2019).

In rural sectors, a lack of access to markets can exacerbate food security problems: if community manufactured goods are destroyed by a flood or hurricane, isolated populations cannot depend on goods from other sectors. For instance, researchers found a 4% reduction in food consumption in impoverished areas of the Philippines following moderate flooding. Yet, this outcome is less pronounced in areas near highways (Hallegatte et al., 2020). This research proposes that well-connected sectors are less vulnerable to adverse food security outcomes of extreme disasters. However, natural disasters can impact

well-connected sectors, leading to increased food prices due to disruptions in the supply chain. Natural disasters can impair crops, thereby depleting vital resources in agricultural populations and causing food price fluctuations, as seen with the unprecedented floods in Pakistan (Hallegatte et al., 2020). In 2010, the floods affected 2.1 million acres of agricultural land, resulting in a decline in manufacturing and a 50% increase in wheat prices, surpassing the pre flood levels (Hallegatte et al., 2020).

Low-income communities are more vulnerable to increases in food costs than wealthy communities. The World Bank Global Consumption Database reported that low-socioeconomic households in poor nations expend, on average, 50% of their family budget on groceries, which is over 25% more than the amount spent by households from wealthier communities (Hallegatte et al., 2020).

Quality of Housing

Low-income families' primary problem is substandard housing quality, which can adversely impact their resilience to natural disasters. Most low-income families reside in homes that aren't new and often have poor construction and various structural problems, which affect the standard and security of the home (Hallegatte et al., 2020). Due to the inexpensiveness of older homes with weak infrastructure, these types of houses appeal to low-income earners who can't afford a newly built home with strong structures (Hallegatte et al., 2020). This type of

housing puts low-income families at risk of experiencing harm from disasters. Impoverished communities with numerous older homes of weak construction, combined with increasing repair costs due to inflation, are less likely to access essential services that can protect their homes and families in the event of a natural disaster.

The Center for the Study of Traumatic Stress reported that low socioeconomic families are more likely to reside in ecologically vulnerable communities (Hallegatte et al., 2020). While housing is a substantial problem for low-income families, who often encounter a deficiency in disaster resiliency, addressing this issue is challenging for government representatives (Hallegatte et al., 2020). The federal government doesn't offer a substantial amount of affordable housing subdivisions. There is a limited number of low-income individuals who qualify for affordable housing. Only one in four families can acquire federal housing aid. Housing problems continue to increase, and scarcities persist due to the federal government's inadequate response. As a result, additional low-income households will be forced to reside in the same older homes with weak structures or in homes that cannot withstand natural disasters (Hallegatte et al., 2020).

Importance of Community Resilience

Community resilience is associated with community identity salience, disaster systems, and memory functioning as three vital socio-cultural elements in disaster production. Community resilience involves

establishing demands that consider the diverse viewpoints, needs, and approaches of various actors to foster a shared commitment to disaster response (Boston et al., 2024). Fundamentally, community resilience must be developed through an extensive understanding of the personalized perspectives of the players themselves, their community's knowledge and traditions, and the historical circumstances of the environment or social development (Boston et al., 2024). Vitally, the community resilience building structure explains why some communities recover or transform more successfully after disasters than others (Boston et al., 2024).

The community resilience structure proposes that resilience building partially comprises an adaptive cycle that associates individuals' discernments, their traditional understanding of actions to take, prior disaster experiences, and the measures to recount and acquire knowledge from the past (Boston et al., 2024). Therefore, the first main social-cultural element of the substructure is disaster foundations, which involve a psychological plan of action integrated with prediction and diagnostic characteristics, as they aid members of communities in understanding the disaster. Community members typically formulate viewpoints based on socio-cultural elements rather than sponsors of analytical questions and comprehension. Furthermore, community resilience suggests that consistent disaster systems can enhance the success of devised and trained actions throughout a response to natural disasters and the recovery process (Boston et al., 2024). The success of planned and trained measures is further improved when community members are operationally diverse, providing multiple abilities to ensure the necessary variation in disaster response. Researchers have reported that this converse operation can be preemptively altered through operative vital measures of memory work, which involves the production of memory through accounting for molding what is to be recollected regarding prior disaster encounters (Boston et al., 2024).

Additionally, the community resilience system highlights the district's community recognition, which likely

changes the allocated capacity to successfully handle natural disasters. Therefore, the second significant social cultural element within the community resilience structure is community identity salience, which encompasses a site-specific specification allocated to other individuals and institutions occupying a setting that's superior to institutional and social group specifications, particularly in certain circumstances (Boston et al., 2024). Community identity is essential if it is exceedingly primary to their merits, objectives, and vital characteristics. The community resilience framework emphasizes the importance of community identity in determining how actively individuals in a community participate in developing measures to mitigate a disaster circumstance and how successful these measures are in conjunction with planned disaster response projects (Boston et al., 2024). Community salience also influences how individuals comprehend and connect with disaster frameworks comparatively.

A transformative approach is necessary to change communities. Community resilience entails that the transformation process can be guided both affirmatively and adversely through memory work. Therefore, the third vital social-cultural aspect of the community resilience system is district memory work. The approach emphasizes the importance of community identity as the primary authorizing aspect in a community's capacity to address, develop from, and adapt to changing scenarios and pressing ecological

concerns (Boston et al., 2024).
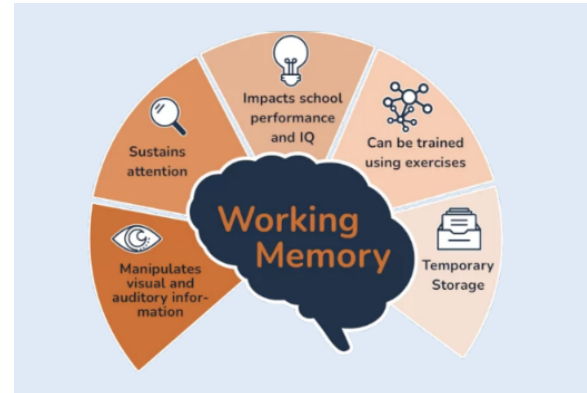
Resilience & Community Identity Salience

The experience of extensive reciprocal support during disasters can bond situation-based group identities, thereby reinforcing community identity salience. Communities that encounter disaster response measures naturally observe an outbreak of denotations that might enfeeble their identity continuity (Hall et al., 2023). Following the disaster response, communities assess the available recovery approaches and begin reconstructing their social frameworks accordingly (Hall et al., 2023). This renewable phase provides opportunities for communities to undergo significant change. Numerous examples illustrate the impact of changing social and cultural systems on reliable and unreliable procedures. For example, in Ladakh, India, severe floods affected multiple communities and nearly 10,000 villagers (Hall et al., 2023). Despite the severity of the flood and

the inability to exercise emergency operations, the Ladakhi village made astonishing attempts to assist one another. In 2009, a typhoon occurred in the Philippines, which aided in the improvement of the native Igorot population's anima through reciprocal aid. This led villagers to happily contemplate an allocated identity, differentiating them from the Philippines' lowland populations (Hall et al., 2023).

Methodology

A baseline survey and ethnographic observations were conducted among local community organizations and community members to evaluate vulnerabilities, interests, and challenges. To explore the resilience approaches in parts of Maryland,
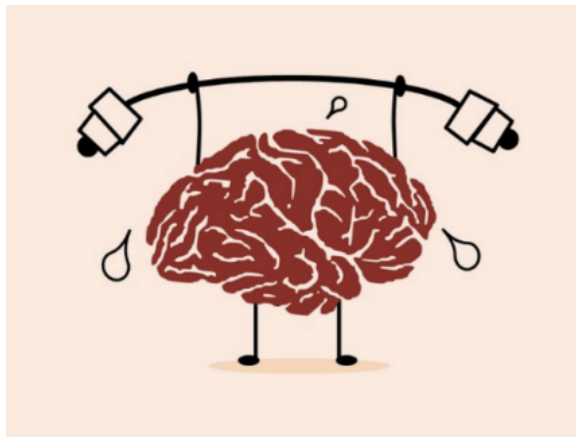
surveys were conducted with local residents.

Data Collection

The author collaborated with professionals from diverse backgrounds, as mentioned above, by first identifying vital activities for constructing and strengthening community resilience. They drew on literature reviews and meetings to identify concepts that communities can utilize to enhance their resilience.

The concepts are emphasized below:

• Education can be utilized to enhance communication related to risk.

• Health associates provide pre- and post-incident community welfare, which incorporates behavioral welfare. Enhancing health in communities is significant because the resilience of a community can lie in the degree to which community members are proactively engaging in healthy lifestyles. Encouraging health includes measures to decrease vulnerabilities by devising for or decreasing a population's vulnerabilities.

• Engagement can occur through encouraging decision-making and activities related to recovery. Engagement is required to construct social connectedness specifically for building resilience amid neighbors.

The baseline survey was conducted through the online platform LimeSurvey, preceded by an email invitation explaining the study. Our survey was open for only four weeks in January 2025, and participants received four email reminders during that time to complete the survey. The objective was to complete the baseline survey before the first project meeting, so we could be informed of activities and perspectives before project submission.

Sample Characteristics

We surveyed a sample of employees demonstrating all areas in the community members of the Maryland Public Health Association (MPHA), Maryland Department of Emergency Management (MDEA), American Academy of Environmental Engineers and Scientists (AAEES) (n= 12), and Health Care Access Maryland (HCAM) during January 2025, before the first community meeting that would be the start date of our project. We invited all members of the Maryland Public Health Association (n = 100), the Maryland Department of Emergency Management (n = 500), and Health Care Access Maryland (n = 70) to participate in the survey. We decided to use a stratified method due to the number of employees. Stratification ensured that we collected survey representation from throughout the various sectors within the organizations. This was vital because one of our project's goals is to connect emergency preparedness work in public health with other community health measures. We ensured that we chose staff members who were administrators or administrative employees.

Content of Surveys

Table 1: Baseline Survey Questions Centered on Education, Engagement and Health

Section 1: Institutional Profile

1. What type of institution are you?

• Health department

• Community agency

• Non-profit organization

2. Which neighborhoods do you assist?

3. Which groups do you serve?

• Elderly

• Low socioeconomic families

• Individuals with disabilities

• Homeless Population

• All the above

4. What approaches are utilized to engage communities for disaster preparedness?

Section 2: Disaster Preparedness

5. Does your institution conduct annual training for employees concerning preparing for disasters?

a. Yes

b. No

6. Can your staff effectively communicate with community members when a local disaster occurs? If so, what methods are taken to execute the communication?

Section 3: Education

7. What activities are currently taken to construct community resilience?

8. What approaches are currently being used to allocate information on local emergencies?

• Social Media Platforms

• Email

• Phone Calls

The survey incorporated three

classifications of inquiries, organizational profile on the type of organization, zip code, and groups they serve; strength of their disaster preparedness between staff members and possible barriers in aiding communities during natural disasters; and current actions being taken to educate community members concerning constructing resilience in Maryland and communication approaches that are being used to allocate information on emergencies. We chose to incorporate only a limited number of inquiries, as we wanted to focus on community resilience. Nonetheless, we inspected prior community resilience studies to pinpoint response lists. Examples of this include essential community resilience activities and accomplishments, such as the capacity of community agencies to educate community members about disaster preparedness, successful partnerships between two separate organizations, and methods used to share information about emergencies. Our team also assessed other surveys related to disaster emergency preparedness to conceptualize pertinent inquiries that could be utilized or adapted for the organizations to which we emailed surveys.

The author pilot-tested the study with 12 participants (Maryland Public Health Association, Maryland Department of Emergency Management) to evaluate the flow and readability and to determine if participants understood the inquiries as planned.

Examinations were intentionally detailed at this phase, as the objective of the baseline survey was to assess the barriers and interests of community members. Additionally, the sample size and variations in the organizations and institutional representatives sampled prevented a strong contrast with weights during this period. Nevertheless, we did make note of discoveries in agencies where pertinent.

Interviews with Community Members

Interviewees were recruited through quantitative community surveys and outreach conducted via Facebook groups in Frederick, Dorchester, and Allegany counties. Quantitative community surveys were promoted through flyers placed at libraries, farmers' markets, and community centers. Participants who completed the survey could voluntarily provide an email address to receive a $20 gift card; email addresses were collected individually and not linked to responses or surveys to ensure discretion.

Outreach community specialists from the organization I work for played a crucial role in designing flyers that were available in both Spanish and English.

To gather perceptions successfully from Maryland, six interviews were conducted via Zoom. Participants were recruited through community Facebook groups and community flyers. Each participant received a $20 gift card for their participation, and consent was obtained before the interview began. The interviews lasted 30 minutes each.

Questions that were asked to Interviewees:

• How have recent natural disasters impacted your community?

• How have you and your family prepared for natural disasters, and what obstacles did you encounter?

• Were resources provided to you before or after disasters occurred in your community?

• Do you believe your community is prepared for disasters that may arise in the future?

• What would you want emergency planners to be aware of the necessities concerning your community during disasters?

Highlights from Interviews:

Local Resident of Dorchester County (Age 64, retired farmer):

"I don't receive warnings about extreme weather events. During the last flood that occurred, I only heard about it through my neighbor."

Local Resident of Dorchester County (Age 44, stay-at-home parent):

"I don't think my community is prepared for natural disasters. We don't engage with emergency professionals or organizations enough to know what to do or what resources are required."

Local Resident of Dorchester County (Age 36, regional manager):

"My neighbors and I have a group chat to be able to contact each other if we believe that a flood will happen in our community again."

Local Resident of Dorchester County (Age 25, graduate student):

"I do wish we had community engagement workshops to be able to learn more about how to handle disasters as a community."

Ethnographic Observations

Location Selection

The locations chosen included Dorchester and Alleghany Counties. I selected these counties due to their substantial poverty ratios and severe vulnerability to natural disasters. Alleghany and Dorchester counties do not have a large representation in terms of researchers and natural disaster planning.

Observations

I conducted observations at local community potlucks, churches, and community centers. My observations centered on community engagement. Observations were conducted over three weeks. I visited each county twice, primarily on weekends.

Limitations

The study was conducted in a sizable county and is primarily relevant to other sizable communities. Nonetheless, numerous propositions addressed in the capstone project, such as improving support in communities and fostering partnerships between different organizations, are vital to any population's efforts to enhance public health and build community resilience before and after a natural disaster occurs.

Furthermore, the low response rate

from the organizations is a concern. Although we included a variety of institutions within the compact sample, encompassing education, health, and public safety, which make up most of the agencies surveyed, this is still a concern. The response rate may be indicative of a lack of engagement or coherence regarding the project's purpose. The survey participants are busy professionals and may not have had the time or motive to complete the survey. To encourage participation, the survey was brief, with only a few open-ended questions. The responses to the open-ended questions from the survey participants were brief.

Results

We acquired 150 complete surveys that were sent to the Maryland Public Health Association, the Maryland Emergency Department, and Healthcare Access Maryland. We inquired of the agency participants regarding their institution type independently. Participants from the MPHA represented the largest group in terms of response rate. Roughly 32% of the survey respondents were from MPHA. The next sizable group was from the Maryland Department of Emergency Management. Most respondents from Healthcare Access Maryland represented service agencies, and a majority were employed in the education and healthcare sectors.

Survey respondents explained their present activities and primary concerns associated with developing community resilience in Maryland. Essential themes for strengthening resilience include maintaining continuous, successful communication, providing suitable education to community members, and establishing an integrated structure that overcomes barriers for community members residing in impoverished areas. One of the essential themes concerning effective communication is being administered to community members. One respondent elaborated on the open-ended question:

"I don't think we have realized the significance of effectively communicating with community members, and if they can understand what is being communicated to them if a local disaster occurs."

Additional approaches identified by some of the participants incorporated:

• Allocating data through numerous channels

• Communicating with and collaborating with local governments and agencies with different backgrounds

• Assisting community members with making action plans that can be used for different types of disasters

• Constructing messages to every individual's needs, such as using social media platforms, newsletters, and phone calls

• Having trained professionals available to actively listen to community members' necessities

One respondent employed in the Maryland Department of Emergency Management discussed the effectiveness of suitably

trained professionals by stating:

"Having access to teams of public health workers has got to be the key to managing disasters in our local communities. I think they could help with the communication aspect."

Numerous challenges were identified in offering education and constructing a culture of community resilience, incorporating:

• Replacement due to climate change mitigation attempts

• A lack of capacity to train community administrators and members

• A lack of understanding of resources attainable in disaster circumstances (e.g., psychological health, collaborative partnerships, social resources, facilities for those with disabilities)

• The impacts of disasters on their organization

• The effects of civil maintenance structures on communities and people who are prone to natural disasters

A majority of the survey respondents identified significant challenges to community preparedness, including restricted access to public transportation, language barriers, and educational barriers. Additionally, only 20% of the surveyed institutions had managed disaster preparedness outreach activities, particularly in low-income communities. Participants demonstrated interest in enhancing accommodation, with 73% concurring that localized, community-prompted methods

would notably enhance community preparedness for emergencies. Regarding challenges to executing community resilience actions, each organization reported a lack of materials to support community members with disaster resilience knowledge, and 36% of survey respondents indicated that there was inadequate training for staff on disaster preparedness. Staff of the Maryland Department of Emergency Management documented the following challenges to resilience as a lack of interest from community members in disaster preparedness (35%) contrasted with Maryland Public Health Association respondents (15%) and a lack of institutional interest in disaster preparedness (35%) contrasted with the Healthcare Access Maryland agencies (20%).

Ethnographic Observation

Both counties demonstrated a lack of disaster preparedness in their local community areas. For example, in one of the community centers located in Dorchester County, there was only one map that demonstrated emergency evacuation plans. In Alleghany County, multiple residents mentioned that there weren't any modern plans for emergency data and that it needed to be updated.

The communities within Dorchester and Alleghany County demonstrated a strong support system. For instance, I attended a community potluck event held at the community center. I seated myself near the entrance to observe the residents. The setting was welcoming. Community

members shared recipes and food with one another. I overheard residents offering car rides to anyone who needed them. Additionally, community members offered to provide extra meals and shelter if the weather became severe within the next couple of days.

Discussion

The results of the survey, ethnographic observations, and literature review demonstrate the need for educational approaches that are culturally pertinent and community-based to increase resilience. Based on the identified gaps, the suggested next steps are to implement community resilience-building activities within low income communities.

The baseline survey of diverse institutions offers significant insight into how employees and institutions perceive community resilience, their fundamental participation in resilience-building measures, and their preparedness, as well as their current partnerships with other organizations. The information provides the necessary data for evaluating gaps in community education and engagement. It demonstrates various types of community activities that may be required to enhance resilience outcomes in underserved communities.

The survey demonstrated that the organizations didn't allocate substantial time to activities related to disaster preparedness within the communities they serve. However, they engaged with numerous vulnerable communities concerning health encouragement workshops that also demand this type of data. A majority of the institutions don't allow much time to prepare. Although the institutions are dedicating significant time to institutional preparedness, they reported fewer activities in partnership advancement and community engagement with vulnerable populations. A primary challenge for these organizations is to construct organizational and community proficiencies in these sectors before the response stage.

In the partnership sector, the survey responses were enlightening. The institutions didn't attain official associations for disaster response and readiness. The American Academy of Environmental Engineers and Scientists hasn't yet conducted comprehensive community associations that could be vital for community resilience during natural disasters, particularly those involving non-traditional institutions that can achieve community reach, such as community organizations, religious institutions, and ventures.

The primary essential discoveries were in the realm of education, incorporating measures to distribute readiness data and standard viewpoints on community resilience. While community resilience relies on the readiness of individuals and communities, the evaluation of household readiness and neighborhood dependence on each other during a natural disaster was found to be low. Most survey respondents didn't believe that vulnerable populations in Maryland possessed the

necessary comprehension to prepare for and respond to natural disasters effectively. However, a majority of respondents at the Maryland Department of Emergency Management reported that if staff received additional training, they would gladly provide time to educate vulnerable populations about preparing for natural disasters, thereby building community resilience. While the American Academy of Environmental Engineers and Scientists is currently working towards creating social systems for building community resilience using engineering systems, these institutions may require additional influence to promote more impartial and widespread education centered on community preparedness.

Despite the various challenges that hinder resilience and response in underserved communities, some sectors can be improved in the future to support impoverished communities in overcoming institutional and societal barriers that limit their capacity to be resilient in the face of natural disasters.

What Actions are Required for Communities to Completely Execute Community-Resistance Measures?

Similarly, in public health sectors, executing community-resilience-building actions requires the ability to construct and maintain strong and dependable partnerships, engage with members of vulnerable populations, and utilize data for assessment, monitoring, and decision-making. Robust and reliable partnerships encompass a diverse range of nongovernmental, private, and public organizations. In constructing partnerships, communities will need to consider questions regarding who should lead the initial collaborations and how activities related to building community resilience may require adjustments for specific communities.

What Approaches Can Be Implemented to Increase Community Engagement?

Grassroots Community Engagement

The Grassroots Community Engagement approach can be utilized to improve resilience in impoverished areas. A primary focus that can be attributed to the susceptibility of low-income populations to natural disasters is the deficiency in risk communication (Palombi et al., 2019). Successful risk communication is vital for ensuring that continuous data is provided to the general public. Risk communication is defined as the reciprocal process that involves the exchange of information between groups regarding a troubling problem (Palombi et al., 2019). Essential features of risk communication include the message being communicated, the individual conveying the message, and how the message is conveyed (Palombi et al., 2019). Effective risk communication can help establish trust within a community, leading to significant benefits for psychological well-being.

These types of communication are

essential for notifying individuals of the hazards associated with natural disasters, public safety concerns, and environmental issues, as well as data regarding measures that must be taken during emergency events. Nonetheless, numerous low-income households face challenges in acquiring this data; the deficiency of risk communication for low-income households reduces the resilience of families and makes them susceptible to encountering harmful outcomes.

A grassroots structure is defined as a collaboration between diverse community-serving establishments and low-income communities, working with emergency management experts to enhance risk mitigation activities in the event of natural disasters and engage families at risk in disaster recovery and preparedness. (Palombi et al., 2019). A majority of these organizations typically form associations with at-risk communities due to the resources and treatment that these types of establishments offer to underserved families. Grassroots organizations are often trusted more than governmental institutions, religious institutions, and community-based organizations to effectively communicate risks to low-income families (Palombi et al., 2019). As a consequence of this, low-income families are more likely to follow the orders and data being conveyed to them regarding the necessary measures that must be taken during the disaster preparedness phase.

Community Education

Community education is a continuous process wherein the community gains an understanding of its responsibilities, roles, and expectations for community and individual preparedness. Additionally, community education involves individuals who can work together with their neighbors in the event of disaster circumstances. Public health education is a crucial aspect of ensuring that communities are informed about health risks and how to respond to and recover from them when they occur (Torani et al., 2019). Additionally, community education enables people to know where to go for assistance, whether for their neighbors, families, or themselves, allowing the community to naturally implement the theory of community resilience (Torani et al., 2019).

Community organizations, industry partners, and other institutions trained in disaster preparedness and effective communication with local community members can establish a secure social framework for resilience. Secure community systems enable a coherent, integrated, and resilient community. Chosen approaches help reach communities at risk. Community systems that combine the knowledge of healthcare providers, health executives, spokespersons from various public groups, and trusted community members result in a more secure and integrated community education.

Partnerships

Enhancing a community's ability to avert, resist, and mitigate the impact of a

health event is a fundamental aspect of community resilience. Since much of this ability may currently reside within a connected network of groups and institutions, creating strong partnerships in communities is a primary focus for building community resilience.

Collaboration between Engineers and Health Professionals

Collaboration among engineers, emergency management professionals, and health professionals is crucial for low-income communities to effectively implement community resilience. The National Health Security Strategy reports that achieving national health security requires an interdisciplinary approach that incorporates professionals from various fields, populations, government institutions, and nongovernmental organizations.

Implementation of Community Resilience through Collaboration

Establishing and maintaining community resilience requires the formation of partnerships. Allocating data, resources, and best practices can be simplified through cooperative associations between professionals from different fields. Environmental engineers, emergency management professionals, and public health officials would collaborate to outline and provide activities centered on community resilience, such as community education and engagement actions that are easily accessible, relevant, and practical (Hermawan & Guntoro, 2024). Environmental engineers would create

simple models and graphics to illustrate how infrastructure enhancements could mitigate the impact of natural disasters. Engineering blueprints and frameworks are closely tied to public health through their ability to influence human responses to health risks. Emergency management professionals would lead community members through district alert structures and evacuation plans of action. Public health officials would guide outreach by arranging community workshops and providing education on managing the health impacts of natural disasters and maintaining safety.

The process of implementing a community resilience framework involves engaging and organizing community members in resilience-building activities, developing a detailed resilience approach, establishing collaborative partnerships and systems, and enhancing natural disaster preparedness capabilities (Hermawan & Guntoro, 2024). Each phase plays a vital role in ensuring the effective execution of the framework, allowing communities to grow and support resilience in the face of natural disasters. The first step of the collaboration entails identifying the community's vulnerabilities to inform proactive actions for creating and preserving community resilience. Emergency management officials will be responsible for identifying feasible natural disasters, public health issues, and associated hazards by conducting hazard and vulnerability assessments. To ensure that the identified dangers and vulnerabilities are pertinent and tailored to the community's specific needs,

these evaluations will consider the community's unique ecological and socioeconomic conditions. This will be achieved by promoting community collaboration and ensuring that diverse perspectives are considered throughout the planning process.

How Much Time May It Take for Low-Socioeconomic Communities to Acquire Community-Resilience Activities?

Executing community resilience activities can be a time-consuming process. It takes time for communities to adapt to new approaches. However, with the consistent implementation of community engagement methods, it's then possible that community members will want to engage more in the types of activities mentioned above.

Summary

Natural disaster problems are occurring with greater frequency and intensity than ever. Climate change, urbanization, and environmental degradation have exacerbated these problems. Millions of individuals worldwide are increasingly affected by natural disasters. In recent years, over 3 million individuals have been dislocated by natural disasters (Adams et al., 2022). Many of these individuals incorporated gender minorities, people of color, people with disabilities, and those of lower income. The adverse impacts of disasters were reported to happen more consistently to minorities and individuals residing in low-income communities. Some of the adverse effects include a reduction in food and water, loss of electricity within their homes, and unhygienic conditions.

The surveys and observations provided significant insight into how impoverished communities respond to disasters. Although formal disaster response efforts are limited in these areas, community members rely on one another and consistently build strong networks. These findings highlight the importance of developing disaster preparedness programs that prioritize community resilience. There should be programs scattered throughout these counties that incorporate building relationships with residents to establish trust. Successful approaches have to integrate sustainability, grassroots strategies, and community engagement.

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