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The Impact of Water Infrastructure Inequality on Marginalized Communities

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Departmental Honors Thesis

University of Tennessee at Chattanooga

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## **Abstract**

America's current system of water infrastructure poses a threat not only to the environment but also to public health. The water crisis reveals the stark inequalities that exist from both an environmental justice and a social justice perspective. There is a growing concern that without adequate investment from federal resources, the problems related to this issue will only worsen the longer they are neglected. There is little information about how specific environmental and social factors combine with water infrastructure to create long-term infrastructure inequalities. However, this thesis explores the disparities in water infrastructure affordability, vulnerability patterns, and environmental hazards. It also examines the relationship between these variables and the adaptive capacity of disadvantaged communities. As these communities experience this infrastructural inequality on a much larger scale, we are driven to explore the root cause of these problems. Understanding the overlap between the social issues and environmental ones is key in developing strategies to strengthen the environmental and economic resilience of unempowered communities.

In the United States, an estimated 1.1 million individuals lack a piped water connection, 73% of which are located close to a networked supply.<sup>1</sup> Isolated statistics like these give only a glimpse into a problem that has much severer consequences. Drawing on statistical analysis and research, this paper explores sociodemographic patterns of racial, economic, and geographic disparities that characterize water inequity. In the Southeast region especially, these findings show connections between historically discriminative legislation and current infrastructure

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<sup>1</sup> Meehan, Katie, et al. "Geographies of Insecure Water Access and the Housing Water Nexus in US Cities." *PNAS*, 2 Nov. 2020, <https://www.pnas.org/content/117/46/28700>.

issues. While there has been research on water justice, there has not been significant evidence to suggest connections between race, income, and geographic location relative to the amount of exposure from environmental causes. This thesis argues that water infrastructure inequality in America should be framed as an issue of social and environmental justice that looks at the structural inequalities of race and class regarding the growing climate crisis. Implementing systems that provide adequate water infrastructure in the United States is a growing issue that continues to threaten the health and safety of public welfare every day.

## **Introduction**

Safe, dependable, and equitable water access is a fundamental right for all human beings. Despite this, there is a disturbingly large number of individuals in the US that face the ongoing water crisis. Although water insecurity has been studied in the United States, there are significant gaps in existing research. Current data typically focuses on a single dimension at a time, such as water quality or plumbing costs, instead of taking a more comprehensive approach to see the full scope of water infrastructure inequality. However, there are so many complexities surrounding water infrastructure revitalization that making substantial progress poses a challenge.

Millions of Americans drink tap water every day that comes from systems that are in violation of current health standards.<sup>2</sup> In many cases, administrations often lower these standards leading to less reports of water-related health issues and impacts. In 2013 alone, 9800 public

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<sup>2</sup> Meehan, Katie, et al. "Geographies of Insecure Water Access and the Housing Water Nexus in US Cities." *PNAS*, 2 Nov. 2020, <https://www.pnas.org/content/117/46/28700>.

water systems, serving 26.5 million Americans, had violations of health-based standards.<sup>3</sup>

Disparities in water management and policy have sparked conversations across the nation from environmental and civil rights activists urging policymakers and leaders to address the environmental justice issues at hand.

Environmental issues have disproportionately affected minority communities throughout history, specifically regarding water justice. Water infrastructure inequality acknowledges that certain communities lack access to resources and outdated infrastructure perpetuates inequality and environmental injustice.<sup>4</sup> The longer water systems remain compromised, the more difficult it will be to confront the ramifications. The US Environmental Protection Agency (EPA) projects water infrastructure replacement rates will peak in 2035 with approximately 20,000 miles of pipes replaced per year—four times the current annual replacement rate of 5,000 miles.<sup>5</sup> The EPA also estimates that it could take an investment of up to \$839 million per year to replace and monitor the millions of lead service lines that are currently in use in the United States. This is why strategic planning is required to tackle a nationwide project of this magnitude.

The effects of water infrastructure inequality on marginalized communities across the US have been increasingly observable in recent years. Data show that low-income areas and communities of color are disproportionately affected by the water crisis, subsequently exposing

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<sup>3</sup> Schaidler, Laurel A, et al. “Environmental Justice and Drinking Water Quality: Are There Socioeconomic Disparities in Nitrate Levels in U.S. Drinking Water?” *Environmental Health*, BioMed Central, 17 Jan. 2019, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6335696/>.

<sup>4</sup> Katner, Adrienne, et al. (2018). America’s Path to Drinking Water Infrastructure Inequality and Environmental Injustice: The Case of Flint, Michigan. 10.1007/978-3-319-71389-2\_5.

<sup>5</sup> Brody, Sarah. *US Water Infrastructure: Making Funding Count*. McKinsey & Company, 7 Jan. 2022, <https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/us-water-infrastructure-making-funding-count>.

residents to higher levels of pollutants in both the water and the air.<sup>6</sup> This puts them at a higher risk, making them more susceptible to unsafe climatic events and health problems. Several pieces of legislation have been established to address the water crisis in America. Despite these passing and higher standards being established, 4.1 million Americans still do not have access to the most basic level of sewage treatment, and the USACE estimates that aging pipes and inadequate capacity has resulted in the discharge of 900 billion gallons of untreated sewage and wastewater into U.S. waterways each year.<sup>7</sup>

Conversations about environmental justice have focused on how unequal access to infrastructure drives unequal access to safe drinking water and wastewater disposal systems. Since a large portion of these communities impacted by the infrastructure crisis live in poverty, they are under too much financial strain to access the necessary resources without outside assistance. These financial burdens placed upon communities to address issues relating to water infrastructure have restricted any progress from being made. Identifying the source for these problems will help us discover innovative strategies to implement moving forward.

In order to fully understand the different facets involved in water infrastructure, we can break it down into its basic segments. Water infrastructure is conceptualized as four components: (1) available water sources, (2) the physical infrastructure (e.g., treatment facilities, transmission, and storage), (3) operational/managerial capacity, and (4) government policies and agencies that

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<sup>6</sup> Schaider, Laurel A, et al. "Environmental Justice and Drinking Water Quality: Are There Socioeconomic Disparities in Nitrate Levels in U.S. Drinking Water?" *Environmental Health*, BioMed Central, 17 Jan. 2019, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6335696/>.

<sup>7</sup> "Failure to Act: The Economic Impact of Current Investment Trends in Water and Wastewater Treatment Infrastructure," American Society of Civil Engineers. 2011. Page 4.

regulate, assist, and financially support system operators.<sup>8</sup> Investment and attention to each of these areas is necessary for resolving many of the water problems society faces in the U.S.

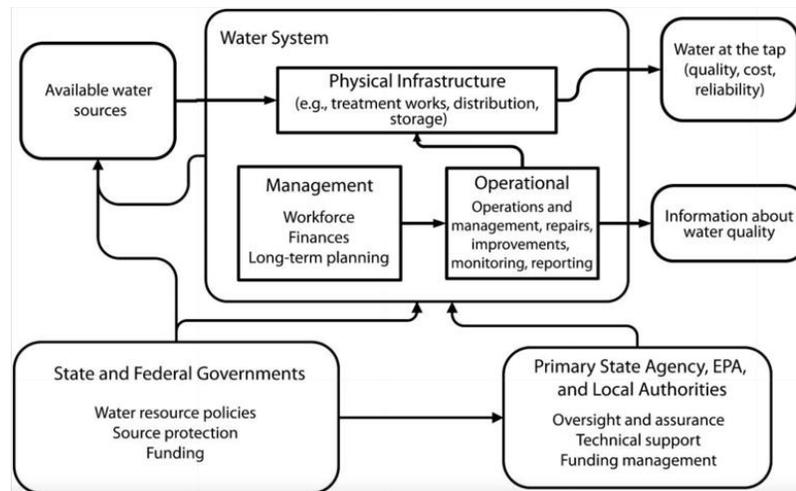


Figure 1: Four components of water infrastructure

It's important to understand each aspect of water infrastructure and their ability to affect water quality, reliability, and cost. The ability of functional infrastructure to reliably bring drinking water that meets public health standards at reasonable cost requires adequately trained operators and sufficient administrative capacity to ensure sustainable financial and operational performance.<sup>9</sup> Each aspect of water infrastructure is connected to one another, so neglecting any one of them has the potential to harm the rest. Allocating funding to underserved communities with failing water infrastructure is important for alleviating poverty, improving human health, and protecting the surrounding environment.

<sup>8</sup> VanDerslice, James. "Drinking Water Infrastructure and Environmental Disparities: Evidence and Methodological Considerations." *American Journal of Public Health*, American Public Health Association, Dec. 2011, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC322486/>.

<sup>9</sup> VanDerslice, James. "Drinking Water Infrastructure and Environmental Disparities: Evidence and Methodological Considerations." *American Journal of Public Health*, American Public Health Association, Dec. 2011, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC322486/>.

## History of the Environmental Justice Movement

The United States Environmental Protection Agency defines environmental justice as the “fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.”<sup>10</sup> Despite the growing evidence of environmental injustice in the US, vulnerable populations continue to bear a disproportionate burden of environmental harms. Research indicates that marginalized communities are most likely to be targeted for hazardous waste sites and polluting industrial facilities.<sup>11</sup> These facilities are historically the leading factors that most heavily impact water quality and access to high quality infrastructure. A large part of this can be attributed to the lower property costs of land that was previously home to potentially hazardous materials.

In the 1960s, the environmental justice movement received national attention when the North Carolina state government designated a small, predominately black community in Warren County to host a hazardous waste landfill that would accept soil contaminated by polychlorinated biphenyls (PCBs). These came from the illegal dumping of toxic waste along roadways.<sup>12</sup> The EPA classify PCBs as a probable human carcinogen, causing developmental effects, cancer, neurological deficits, effects on the hormone system, and negative effects to the immune

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<sup>10</sup> “Learn About Environmental Justice.” *EPA*, Environmental Protection Agency, <https://www.epa.gov/environmentaljustice/learn-about-environmental-justice>.

<sup>11</sup> Norwood, Candice. “How Infrastructure Has Historically Promoted Inequality.” *PBS*, Public Broadcasting Service, 23 Apr. 2021, <https://www.pbs.org/newshour/politics/how-infrastructure-has-historically-promoted-inequality>.

<sup>12</sup> “Environmental Justice History.” *Energy.gov*, Office of Legacy Management, <https://www.energy.gov/lm/services/environmental-justice/environmental-justice-history>.

system.<sup>13</sup> Due to these risks, residents of Warren County protested for six weeks, eventually losing the battle to the state.<sup>14</sup> Despite their loss, the events during this time attracted mass media attention to the environmental justice movement as well as inspiring conversations that made connections between historical discrimination and current environmental problems.

Studies have shown how historical economic and racial disparities shape the lack of access to clean water for cities across the United States. From black communities in the South to indigenous communities in the West, people are facing very similar challenges that can be traced back to water infrastructure. Government institutions like the EPA and the Occupational Safety and Health Administration (OSHA) facilitated the implementation of enforceable standards for protecting and regulating water resources. “Though class is a crucial element impacting the quality of life among urban dwellers remaining in de-urbanizing areas where there are very few jobs and the public transportation system is derelict, race is correlated with environmental injustices beyond the effect of class. Environmental racism is the product of a long history of discriminatory practices cumulatively disenfranchising minority civic societies.”<sup>15</sup>

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<sup>13</sup> Richards, Sean. 2022. “Air & Water Pollution Control Lecture Slides”

<sup>14</sup> “Environmental Justice History.” *Energy.gov*, Office of Legacy Management, <https://www.energy.gov/lm/services/environmental-justice/environmental-justice-history>.

<sup>15</sup> Wright, Beverly. In *Just Sustainabilities: Development in an Unequal World*, Edited by Julian Agyeman, 125-45; Cambridge, MA: The MIT Press, 2003.

## Urbanization

Accelerated urbanization is an important trend to analyze when considering the roots of water infrastructure inequality. Intensive development of urban areas with high population densities has implications for exacerbating vulnerability and increasing environmental hazards. The spatial and sociodemographic patterns of infrastructure inequality reveal that urban water insecurity is a relational condition reflecting disparities of race and class.<sup>16</sup> There is not one specific agency responsible for collecting comprehensive data on the scope of water infrastructure inequality in urban areas which leads to significant gaps in urban housing and water policy management. While rural areas are not immune to infrastructure issues, they are compounded when introduced in urban areas. Infrastructure inequalities are not a direct result of urbanization because they are so deeply ingrained in the process, which is why as urban areas increase in the United States, so does the importance of shaping infrastructure expansion projects. Achieving equitable urbanization requires addressing these infrastructural inequalities first.

### *Redlining*

Many inequalities are rooted in historical and geographical discrimination like redlining. In the 1930s, the Home Owners Loan Corporation drew maps that divided neighborhoods based on the quality of their housing stock and the risk they posed to lending institutions. Black neighborhoods were typically designated as “high risk,” resulting in black families being denied

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<sup>16</sup> Meehan, Katie, et al. “Geographies of Insecure Water Access and the Housing Water Nexus in US Cities.” *PNAS*, 2 Nov. 2020, <https://www.pnas.org/content/117/46/28700>.

federally subsidized mortgage loans.<sup>17</sup> This redlining only exacerbated segregation during this time and made communities of color susceptible to predatory lending, leading to foreclosures and the loss of wealth among these areas. This loss of wealth contributed to their inability to relocate to areas more resistant to climate change, industrial facility placements, and potentially discriminatory environmental legislation. In fact, a study conducted by Redfin in 2021 shows that formerly redlined areas have \$107 billion worth of homes facing high flood risk, 25% more than non-redlined areas.<sup>18</sup>

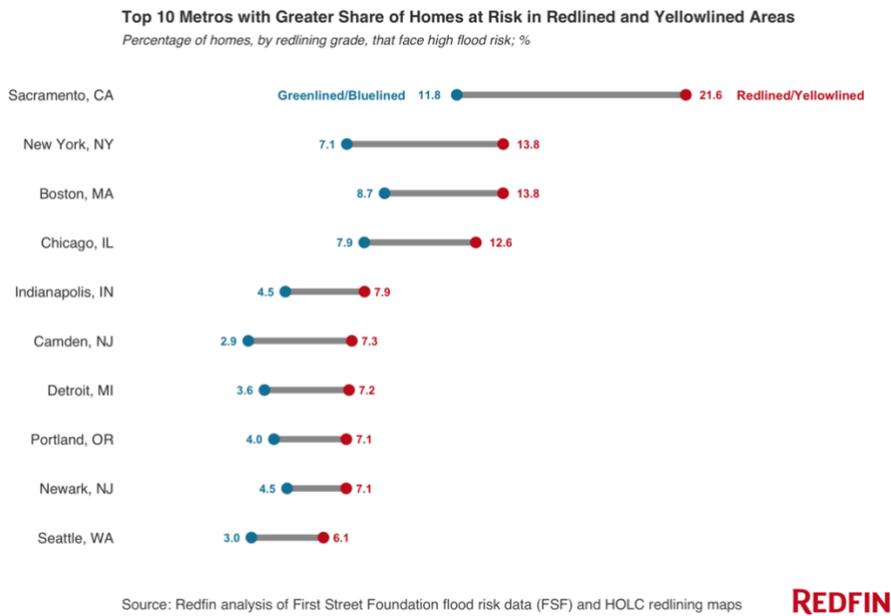


Figure 2: Flood Risk Data from Redfin Study

<sup>17</sup> Yakini, Malik, et al. “Undoing Structural Racism: The Need for Systemic Change in Housing Policy.” *Non Profit News | Nonprofit Quarterly*, 4 Aug. 2021, <https://nonprofitquarterly.org/undoing-structural-racism-the-need-for-systemic-change-in-housing-policy/>.

<sup>18</sup> Katz, Lily. “A Racist Past, a Flooded Future: Formerly Redlined Areas Have \$107 Billion Worth of Homes Facing High Flood Risk-25% More than Non-Redlined Areas.” *Redfin Real Estate News*, 23 June 2021, <https://www.redfin.com/news/redlining-flood-risk/>.

After decades of racial discrimination in the housing market and economic inequality, many minority communities were cornered into living in neighborhoods that are more vulnerable to climate change. We see how the lasting effect of redlining affects current communities and their ability to handle the intensifying climate issues. “A number of regional studies have suggested that housing dynamics are instead at fault: even if a facility is located in a middle class or wealthy community, those who can relocate to other neighborhoods soon move out of the area and housing prices fall, making the community more attractive to minorities and poorer individuals who previously could not afford to live there.”<sup>19</sup>

Researchers have analyzed the impact that poor water infrastructure has on marginalized communities, and have raised similar questions about the causes and potential solutions for these issues. Several research models have been constructed around cities like Flint, Michigan that show correlations between minority areas and low environmental health. A few researchers have investigated how the historical marginalization of poor communities determines the condition of their water infrastructure and results in a higher exposure to contaminants. This causes negative health effects which leads to generational health issues that are compounded over the years. Most solutions to these questions have focused on reactive measures, such as health care access, rather than on the root of the problem: water infrastructure. Several years of research in the field of environmental justice has established clear patterns of racial and socioeconomic disparities in the

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<sup>19</sup> Alvarez Camila H, and Clare Evans. “Intersectional Environmental Justice and Population Health Inequalities: A Novel Approach.” *Social Science & Medicine* (1982) vol. 269 (2021), U.S. National Library of Medicine, 2 Dec. 2020, [pubmed.ncbi.nlm.nih.gov/33309156/](https://pubmed.ncbi.nlm.nih.gov/33309156/).

distribution of environmental hazards.<sup>20</sup> These hazards include unsafe waste sites and unwanted land uses. Historical discrimination in zoning and the housing market, like redlining, explains a lot of the current inequities in infrastructure.

### **Vulnerability Factors & Health Impacts from Pollutant Exposure**

Racial, ethnic, and economic segregation in the U.S. throughout history has resulted in pollutant exposure disparities and water infrastructure inequality. Assessing infrastructure quality and water access along with community vulnerability is important for reducing the risks associated with it. Climatic events and poor water infrastructure have contributed to environmental degradation and public health issues in many communities across the United States. In vulnerable situations where communities lack the ability to anticipate or recover from environmental disasters or infrastructure related problems, there can be significant impacts on the population as well as the ecosystems that they depend on. “Communities affected by such factors may benefit from support in assessment of their degree of vulnerability and water situation, both in terms of climate change adaptation and with regards to health and sanitation, particularly given that improving access to safe water can be an effective part of poverty alleviation strategies.”<sup>21</sup>

Community water systems (CWSs) that serve communities with lower median incomes, lower rates of home ownership, and higher proportions of Hispanic or non-white residents have

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<sup>20</sup> Erickson, Jim. “Targeting Minority, Low-Income Neighborhoods for Hazardous Waste Sites.” *University of Michigan News*, 19 Jan. 2016, <https://news.umich.edu/targeting-minority-low-income-neighborhoods-for-hazardous-waste-sites/>.

<sup>21</sup> French, M., Alem, N., Edwards, S.J. *et al.* Community exposure and vulnerability to water quality and availability: a case study in the mining-affected Pazña Municipality, Lake Poopó Basin, Bolivian Altiplano. *Environmental Management* **60**, 555–573 (2017). <https://doi.org/10.1007/s00267-017-0893-5>

been associated with higher levels of nitrate and arsenic.<sup>22</sup> Types of contaminants like these that are present in water systems are likely being leached in the soils and released into waterways through runoff. Exposure to water pollutants is linked to heart disease, high infant mortality rates, respiratory issues, and dementia. In one of the earliest environmental justice studies more than three decades ago, the United States government reported a disproportionately high representation of disadvantaged communities located near landfills. Similar trends have been described that connect geographic distribution of hazardous waste sites to be in poorer, more rural areas. Observations like these have sparked concerns about broader socioeconomic disparities in exposures to drinking water contaminants and water infrastructure access. CWSs are also not required to compile sociodemographic information about their customers, which make it difficult to assess the disparities in water infrastructure by income or racial characteristics of residents. Despite these concerns, there is a lack of academic literature and scientific data to substantiate evidence of the connections within this problem.

Many of the water systems in the South are much smaller, and subsequently, often have fewer financial resources to address potential infrastructure issues. Researchers have examined the relationship between the level of TRI (Toxics Release Inventory), air pollution and community characteristics, weighted by the relative toxicity of each pollutant. Through these studies find that race is significant and positively related to pollutant emissions. There is robust evidence to support that high vulnerability and exposure are mainly an outcome of skewed development processes, including those that are associated with environmental mismanagement,

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<sup>22</sup> Balazs, Carolina L, and Isha Ray. "The Drinking Water Disparities Framework: on the Origins and Persistence of Inequities in Exposure." *American Journal of Public Health*, American Public Health Association, Apr. 2014, [www.ncbi.nlm.nih.gov/pmc/articles/PMC4025716/](http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4025716/).

demographic changes, sudden rapid urbanization, and the scarcity of livelihood options for low-income individuals.<sup>23</sup>

“Risk is determined not only by the climate and weather events but also by the exposure and vulnerability to these hazards. Therefore, effective adaptation and disaster risk management strategies and practices also depend on a rigorous understanding of the dimensions of exposure and vulnerability, as well as a proper assessment of changes in those dimensions.”<sup>24</sup> In this case, vulnerability is directly related to the lack of resiliencies to cope with extreme weather events and inability to adapt to harmful environmental processes. Vulnerability can be an umbrella term involving traditionally at-risk groups like children and the elderly. However, this study defines vulnerability from a climate change perspective, looking at how it is embedded in the communities that have been financially and socially neglected in past years.

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<sup>23</sup> Cardona, O.D., et al, 2012: Determinants of risk: exposure and vulnerability. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, pp. 65-108.

<sup>24</sup> Cardona, O.D., et al, 2012: Determinants of risk: exposure and vulnerability. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, pp. 65-108.

## Climate Change

Over the past few decades, conversations regarding anthropogenic climate change have evolved and inspired action across communities worldwide. Climate change has triggered an increase in environmental problems while exacerbating those that currently exist. It is projected to increase the likelihood of flooding, extreme heat, wildfires, and ozone events affecting communities around the world — reshaping the sustainability, health, and well-being of these communities and the surrounding areas.<sup>25</sup> The impacts of climate change are disproportionately felt by different social groups, putting them at risk for higher exposures to climate hazards. Marginalized communities are more vulnerable now than ever to feeling the effects of climate change, and are rarely equipped with the resources to handle it. While adaptation to climate change has been a focal point of policy and research agendas, it is extremely important to ask why these communities are disproportionately affected by climate threats. By analyzing how poor water infrastructure amplifies the negative impacts of the climate crisis in vulnerable communities, we can better navigate potential solutions moving forward.

Water providers are also feeling the growing pressures of climate change as water systems continue to endure increased wear from age and effects of climatic events. Climate change has been threatening water utility operations to the point where the EPA has drafted several adaptation strategies intended to assist communities in combatting potential threats. Investments in water infrastructure systems not only provide assurances of access to safe drinking water, they are also key to local economies across the United States. The effects of

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<sup>25</sup> Yu, J., Castellani, K., Forsynski, K., Gustafson, P., Lu, J., Peterson, E., . . . Brauer, M. (2021). Geospatial indicators of exposure, sensitivity, and adaptive capacity to assess neighbourhood variation in vulnerability to climate change-related health hazards. *Environmental Health*, 20, 1-20. doi:<http://dx.doi.org/10.1186/s12940-021-00708-z>

climate change and water infrastructure inequality are only exacerbated by the existing societal inequalities that put marginalized communities at risk.

Resource access has a large impact on people's ability to prepare for, protect from, and recover from the dangers that climate change presents. The unequal distribution of economic, institutional, and political resources enables highly-resourced individuals and groups to more readily adapt to changing climatic conditions than those who are less highly-resourced.<sup>26</sup> The ability to adapt to the constantly changing climatic conditions is crucial and becomes more urgent as climate hazards increase. Climate-adaptive infrastructure that provides safe drinking water and processes sewage properly is fundamental for public health and environmental health.

### **Politics & Government Responsibility**

The imbalance of power within politics often obstructs effective policymaking from taking place. Due to the federal water policy prioritizing water sanitation over affordability and equity, non-white communities are left more vulnerable to water shut-offs than white households.<sup>27</sup> From climate control to air and water quality reporting, standards have evolved dramatically from one administration to the next. Despite robust empirical evidence of the risks associated with climate change, there are several political barriers that impede environmental action from taking place.

“In the late 20th century, legislation granted groups underrepresented in positions of power the equal right to be protected from environmental degradation [Executive Order 12898 (White House, 1994)]. This policy prioritized racial minority and low-income groups, promising procedural, geographic, and social equity. The mandate also shifted the burden of proof from

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<sup>26</sup> Thomas, Hardy, R. D., Lazrus, H., Mendez, M., Orlove, B., Rivera-Collazo, I., Roberts, J. T., Rockman, M., Warner, B. P., & Winthrop, R. (2019). Explaining differential vulnerability to climate change: A social science review. *Wiley Interdisciplinary Reviews. Climate Change*, 10(2). <https://doi.org/10.1002/wcc.565>.

<sup>27</sup> Holdsclaw, Abigail. *Water Affordability Disparities In North Carolina*. 2021. <https://doi.org/10.17615/b9gz-zj89>

community members to business enterprises, requiring proof from industry representatives that vulnerable populations are not disproportionately affected by environmentally degrading practices. But if environmental degradation is the result of cumulative de-urbanization, divestment, and deterioration--if businesses are closing or relocating--accountability is impossible and justice fails. Environmental justice policies regulate what businesses do, not what they *do not* do.”<sup>28</sup>

These policies acknowledge the fact that race can still be related to the distribution of economic burdens; however, there is little discussion about the environmental ones. The EPA suggested implementing metrics that would monitor affordability for low-income households; however, it does not capture the extent of variables involved in water infrastructure challenges. Many water policies currently in place under the Clean Water Act are aimed at regulating water pollution, not establishing protection against infrastructure failures. Localizing the control of water delivery systems increases fragmentation of affordability policies, decreases regulation, and leaves the responsibility to stakeholders whose interests may not necessarily align with consumers.<sup>29</sup> Studies of disparities in enforcement related to the Clean Water Act used the number of enforcement actions taken by state environmental agencies as a measure of the regulatory agency’s effectiveness.<sup>30</sup>

In addition to a lack of federal affordability standards, there is debate over which governing bodies are responsible for addressing water justice issues. This lack of consensus only compounds consumers’ vulnerability to infrastructure failures due to inaction and competing

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<sup>28</sup> Butts, R., & Gasteyer, S. (2011). ENVIRONMENTAL REVIEWS & CASE STUDIES: More cost per drop: Water rates, structural inequality, and race in the united states--the case of michigan. *Environmental Practice*, 13(4), 386-395. doi:<http://dx.doi.org/10.1017/S1466046611000391>

<sup>29</sup> Holdsclaw, Abigail. *Water Affordability Disparities In North Carolina*. 2021. <https://doi.org/10.17615/b9gz-zj89>

<sup>30</sup> Konisky DM. Inequities in enforcement? Environmental justice and government performance. *J Policy Anal Manage*. 2009;28(1):102–121

interests.<sup>31</sup> There are also inequities that exist within these debates, and its importance to addressing these injustices as a part of it: “an economic mobilization that ignores justice and equity is a danger to both marginalized people and decarbonization...for example, the racist distribution of home loans, fueled redlining, residential segregation, and suburban sprawl, all of which exacerbate emissions.”<sup>32</sup> The lack of a comprehensive conceptual framework that facilitates a common multidisciplinary risk evaluation impeded the effectiveness of disaster risk management and adaptation to climate change.<sup>33</sup> Framing climate change induced disasters as a social process allows for a shift in focus from responding to disasters towards understanding how to mitigate risk. Understanding the different aspects that are tied to the effects of climate change is crucial in the updating of current water infrastructure policies.

Many of the problems associated with current solutions is that they are reactive to disasters as opposed to being proactive at preventing them. Having the capacity to adapt and recover is driven by numerous factors, including financial, political, and environmental viability. The reconstruction phase after climate change disasters should provide an opportunity to address the root causes of risk associated with poor water infrastructure. These opportunities should include a diverse set of options for expanding and revitalizing current infrastructure. Several strategies can be implemented in disadvantaged communities that would increase climate resilience. Building infrastructure for aquifer storage and recovery, financing and facilitating systems to

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<sup>31</sup> Holdsclaw, Abigail. *Water Affordability Disparities In North Carolina*. 2021. <https://doi.org/10.17615/b9gz-zj89>

<sup>32</sup> Prakash, Varshini & Gunn-Wright, Rhiana. (2020). *Winning the Green New Deal*. Simon & Schuster, p. 69.

<sup>33</sup> Cardona, O.D., et al, 2012: Determinants of risk: exposure and vulnerability. *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, pp. 65-108.

recycle water, developing emergency response plans, implementing watershed management, developing models to understand potential water quality changes, and integrating climate-related risks into capital improvement plans.<sup>34</sup>

### *Community Water Systems*

A community water system is a public water system that supplies water to the same population over the course of a year. Of the approximately 155,693 public water systems in the United States, 52,110 (33.5%) are community systems, with over 286 million Americans getting their tap water from these systems.<sup>35</sup> These systems are important for ensuring the health of the community; however, many communities lack the capacity to effectively adapt their current systems to environmental issues and changes in population. Since the federal government is responsible for less than one quarter of all public spending on water infrastructure, states and localities must coordinate and cover most of infrastructure costs.<sup>36</sup> The lack of available federal funds for water infrastructure has resulted in critical upgrades to be postponed, motivating the need for infrastructure investment even further.

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<sup>34</sup> Gray, Wayne, et al. "Environmental Justice: Do Poor and Minority Populations Face More Hazards?" *EPA*, National Center for Environmental Economics, Sept. 2010, <https://www.epa.gov/sites/default/files/2014->

<sup>35</sup> "Public Water Systems." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 30 Mar. 2021, <https://www.cdc.gov/healthywater/drinking/public/index.html>.

<sup>36</sup> Kane, Joseph, and Robert Puentes. "Flint's Water Crisis Highlights Need for Infrastructure Investment and Innovation." *Brookings*, Brookings, 14 Mar. 2017, <https://www.brookings.edu/blog/the-avenue/2016/01/13/flints-water-crisis-highlights-need-for-infrastructure-investment-and-innovation/>.

## Examples of Cities Experiencing Issues

Studying water insecure communities in the United States can build a better understanding of how climatic factors influence them. There is substantial evidence that water infrastructure inequalities exist and are connected to factors like race and economic status. Part of this research looks at several cities that have suffered the consequences of poor water infrastructure. Many of which have received intense media attention in recent years for the severity of the issues. These are a few examples that show the scope of severe water infrastructure problems. From environmental hazards to human health risks, these areas demonstrate how the magnitude of infrastructure inequality.

### *Lowndes County, AL*

Lowndes County, Alabama has been experiencing the consequences of neglected infrastructure for decades. Catherine Coleman Flowers, an environmental and civil rights activist who grew up in Lowndes County, discusses the inadequate management of waste water in rural communities: “We put more emphasis on addressing wastewater in urban communities and less on rural communities. Wastewater policies have been directed at densely populated areas. Other areas, especially unincorporated communities, have been excluded from those policies, so they can never get at the public funds to address these issues.”<sup>37</sup> She calls for the need of public investment in programs focused on marginalized communities in rural areas especially.

The city has dealt with raw sewage running through the streets for years as a result of failing sewage systems. Current laws require residents to be responsible for upkeep of their own

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<sup>37</sup> “Catherine Coleman Flowers Reveals Americas Dirty Secret.” *Rotary Magazine*, Mar. 2021, <https://www.rotary.org/en/catherine-coleman-flowers-reveals-americas-dirty-secret>.

systems, despite the cost of a new septic system nearly doubling the median income for residents. The majority-black county has a poverty rate that is double that of the national average, making it one of the most vulnerable areas in the South.<sup>38</sup> Residents of Lowndes County also face the threat of criminal charges for failing to install their own updated septic systems, resulting in the arrests of several residents. Compared to their wealthier counterparts living in urban areas that rely on their connection to a municipal system.

Out of thousands of homes surveyed, the majority had failing septic systems or no systems at all. Septic systems are also known to fail because of the type of soil they are placed in. The soil in Lowndes County, once rich for growing cotton, has been reduced to a dense clay texture from overuse. Clay-like soils reduce the porosity and permeability of soil material due to the small pores, thus having slower water transmission and high water retention. Because of this density, the soil is unable to absorb liquid that drains from septic tanks, causing wastewater to pool in the yards of residents. This problem has proved to be a huge health risk for Lowndes County residents, leading to several hospitalizations in the community.

A study conducted by the National School of Tropical Medicine at Baylor College of Medicine in conjunction with the Alabama Center for Rural Enterprise, found that 34% of the population tested positive for genetic traces of hookworm.<sup>39</sup> “Some 73% of residents included in the Baylor survey reported that they had been exposed to raw sewage washing back into their

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<sup>38</sup> Whitaker, Bill. “Americans Fighting for Access to Sewage Disposal .” *CBS News*, CBS Interactive, 19 Dec. 2021, <https://www.cbsnews.com/news/alabama-sewage-disposal-60-minutes-2021-12-19/>.

<sup>39</sup> Pilkington, Ed. “Hookworm, a Disease of Extreme Poverty, Is Thriving in the US South. Why?” *The Guardian*, Guardian News and Media, 5 Sept. 2017, <https://www.theguardian.com/us-news/2017/sep/05/hookworm-lowndes-county-alabama-water-waste-treatment-poverty>.

homes as a result of faulty septic tanks or waste pipes becoming overwhelmed in torrential rains”<sup>40</sup>In this regard, Lowndes County, located in Alabama's Black Belt, reflects broader struggles of poor rural communities of color in the United States”<sup>41</sup>

### *Chattanooga, TN*

Portions of Chattanooga’s wastewater infrastructure systems are reaching the end of their effective lifecycle. This contributes to failures in the wastewater disposal process and the level of contaminants released into waterways and soils. Many of these failures are the result of climatic events like sustained heavy rains or sudden changes in temperature. This can lead to sanitary sewer overflows (SSOs) when there is not enough capacity in the wastewater system.<sup>42</sup> Clear Chattanooga is a community-wide improvement plan that aims to decrease the number of SSOs and meet the terms of its Consent Decree agreement with the EPA. They entered this degree in 2013, with the goal of reducing and potentially eliminating sanitary sewer overflows. In the agreement, the city began a \$250 million project that would include major upgrades to improve the overall operations of Chattanooga’s sewer system. These types of projects are increasingly necessary for cities requiring updated water infrastructure systems.

There are two phases involved in Clear Chattanooga’s approach: phase 1 focused on high-priority wastewater pipelines deemed as “time critical.” This also includes equalization

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<sup>40</sup> Pilkington, Ed. “Hookworm, a Disease of Extreme Poverty, Is Thriving in the US South. Why?” *The Guardian*, Guardian News and Media, 5 Sept. 2017, <https://www.theguardian.com/us-news/2017/sep/05/hookworm-lowndes-county-alabama-water-waste-treatment-poverty>.

<sup>41</sup> “Catherine Coleman Flowers Reveals Americas Dirty Secret.” *Rotary Magazine*, Mar. 2021, <https://www.rotary.org/en/catherine-coleman-flowers-reveals-americas-dirty-secret>.

<sup>42</sup> “Water for Life.” *Clear Chattanooga*, 25 Jan. 2022, <https://clearchattanooga.com/>.

stations responsible for temporarily storing excess wastewater and stormwater until the systems are properly equipped to handle it. Phase two includes similar strategies and continued installation of these stations. The EPA and the Tennessee Department of Environment and Conservation (TDEC) have conducted several environmental studies in both soil and water quality in Chattanooga. South Chattanooga has a history of high levels of lead in the soil, which has a big impact on neighboring water systems. The Agency for Toxic Substance and Disease Registry (ATSDR) found that children with high lead exposure are more likely to be poor and from minority groups living in substandard housing.<sup>43</sup> Water that travels through soils contaminated with lead can infiltrate outdated water pipelines and be a threat to public health.

#### *Tuba City, AZ*

The Navajo Nation in Tuba City, Arizona has some of the most severe water infrastructure deficiencies in the nation, despite being in such a rural area. The lack of economic development combined with the community's sustained poverty poses a challenge for infrastructure development. A recent assessment in the Navajo Nation found that 30% were without piped water; more than 70% of water sources used for domestic purposes were positive for total coliforms, 21% were positive for *Escherichia coli*, 12% had arsenic concentrations above the maximum contaminant level (MCL), and 5% had uranium concentration above the MCL.<sup>44</sup> Scarce funding and resource allocation make it difficult for this community to develop

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<sup>43</sup> "Lead Toxicity: Who Is at Risk of Lead Exposure?" *Environmental Health and Education*, Agency for Toxic Substances and Disease Registry, 2 July 2019, [https://www.atsdr.cdc.gov/csem/leadtoxicity/who\\_at\\_risk.html](https://www.atsdr.cdc.gov/csem/leadtoxicity/who_at_risk.html).

<sup>44</sup> VanDerslice, James. "Drinking Water Infrastructure and Environmental Disparities: Evidence and Methodological Considerations." *American Journal of Public Health*, American Public Health Association, Dec. 2011, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3222486/>.

water infrastructure. Since centralized water systems are too expensive for the geography of the area, many Navajo people rely on unregulated wells, springs, or livestock troughs to meet their needs, which can be unsafe because groundwater is contaminated by the 500+ abandoned uranium mines nearby.<sup>45</sup> Increasing funding for water systems and strengthening the community's capacity to come up adaptive strategies is necessary for the welfare of this group.

“From large-scale water disconnections in Detroit, Baltimore, and other cities, to lead contamination in Flint, to other types of contamination in Georgia and New Mexico, to the lack of access to water for indigenous peoples in the Navajo Nation, disadvantaged communities across the country face immense challenges.”<sup>46</sup>

### *Flint, MI*

The water crisis in Flint, Michigan received national attention after the city switched its drinking water supply from the Detroit's system to the highly polluted Flint River. The switch resulted in a change in the pH of the water, dissolving the natural mineral barriers protecting the water from the lead pipes. This led to high levels of lead contaminating the water supply. Inadequate preparation and assessment resulted in major health issues among Flint residents and high levels of contaminants in the water. Beginning in 2014, the water crisis resulted in the death of twelve people suffering from Legionnaires disease was linked to lead contaminated water. At least 10,000 children were exposed to lead from their water pipes, which also caused a 58

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<sup>45</sup> *Closing the Water Access Gap in the United States: A National Action Plan*. US Water Alliance. 2019, p. 40. [http://uswateralliance.org/sites/uswateralliance.org/files/publications/Closing%20the%20Water%20Access%20Gap%20in%20the%20United%20States\\_DIGITAL.pdf](http://uswateralliance.org/sites/uswateralliance.org/files/publications/Closing%20the%20Water%20Access%20Gap%20in%20the%20United%20States_DIGITAL.pdf)

<sup>46</sup> Winkler, Inga, and Catherine Coleman Flowers. “America's Dirty Secret: The Human ... - Columbia University.” *America's Dirty Secret: The Human Right To Sanitation in Alabama's Black Belt*, 2017, <http://hrlr.law.columbia.edu/files/2018/01/IngaTWinklerCatherineCole.pdf>.

percent spike in fetal deaths.<sup>47</sup> Not unlike other cities experiencing similar issues, Flint is an example of the consequences of negligent oversight and deteriorating infrastructure. This served as a national wakeup call to the importance of effective water infrastructure and exemplified how inequalities compound each other.

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<sup>47</sup> Berg, Lauren. "Clean Water and the Environmental Justice Movement." *Shared Justice*, Shared Justice, 12 June 2019, <https://www.sharedjustice.org/most-recent/2019/6/12/clean-water-and-the-environmental-justice-movement>.

## Research Design

A systematic literature review was conducted to identify the various factors contributing to water infrastructure inequality in the United States. Data was grouped into categories including community exposure, census data, and potential health hazards. Using census data software, population characteristics from each of the cities discussed were analyzed to determine how they compared to the water infrastructure issues they face. Census data was also used to create spatial distributions of areas with high water insecurity to draw conclusions about how geography plays a role in the U.S. water infrastructure crisis.

### *Census Data*

Figure 3 shows a hex map depicting the spatial distribution of households lacking piped water access from 2013 to 2017. The lighter colors indicate areas with higher numbers of unplumbed households and water infrastructure violations. There are prominent clusters showing water infrastructure inequality in areas along the east coast, major West Coast cities, and in the Four Corners region which includes the Navajo Nation. This suggests that water insecurity and plumbing poverty clusters in highly populated urban areas.

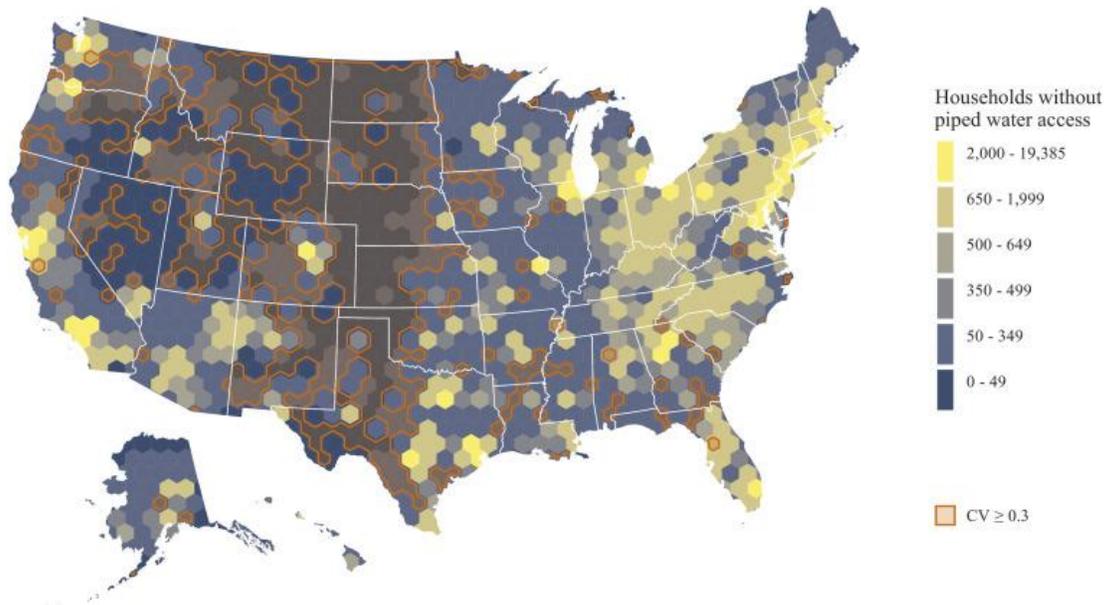


Figure 3: Households without piped water access

## Results

Drawing on statistical analysis and regression modeling of census data, the findings indicate that inadequate infrastructure and higher costs of water systems are strongly correlated with income and minority status. Butts and Gasteyer describe the problems that subsequently follow: “This results from postindustrial divestment and subsequent depopulation of particular urban areas. As a result, decreased demand actually increases prices, since water infrastructure costs are fixed, and this phenomenon disproportionately disadvantages people of color – who make up the majority of the great industrial cities.”<sup>48</sup>

<sup>48</sup> Butts, R., & Gasteyer, S. (2011). ENVIRONMENTAL REVIEWS & CASE STUDIES: More cost per drop: Water rates, structural inequality, and race in the united states--the case of michigan. *Environmental Practice*, 13(4), 386-395. doi:<http://dx.doi.org/10.1017/S1466046611000391>

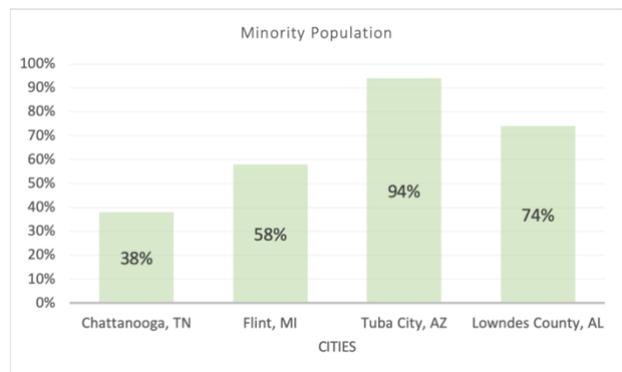
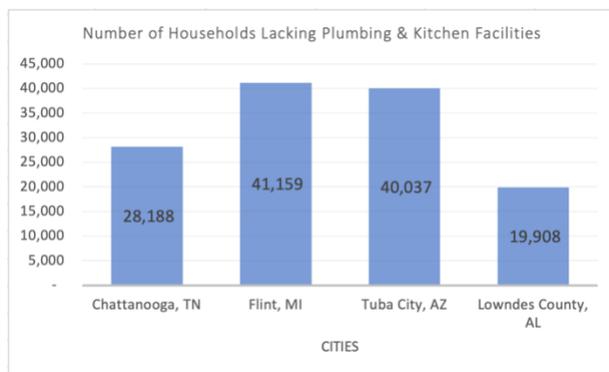
Race and Hispanic Origin	Chattanooga city, Tennessee	Flint city, Michigan	Tuba City CDP, Arizona	Lowndes County, Alabama	United States
Population Estimates, July 1 2021, (V2021)	NA	NA	X	9,965	331,893,745
<b>PEOPLE</b>					
<b>Race and Hispanic Origin</b>					
White alone, percent	60.7%	38.4%	4.7%	26.0%	76.3%
Black or African American alone, percent (a)	31.0%	54.0%	0.6%	72.4%	13.4%
American Indian and Alaska Native alone, percent (a)	0.1%	0.3%	93.3%	0.3%	1.3%
Asian alone, percent (a)	2.9%	0.5%	0.1%	0.5%	5.9%
Native Hawaiian and Other Pacific Islander alone, percent (a)	0.0%	0.0%	0.2%	Z	0.2%
Two or More Races, percent	3.6%	6.0%	0.7%	0.7%	2.8%
Hispanic or Latino, percent (b)	6.9%	4.6%	1.8%	1.9%	18.5%
White alone, not Hispanic or Latino, percent	56.5%	36.3%	4.6%	25.1%	60.1%

Figure 4: Race and Hispanic Origin of Selected Cities

Income & Poverty	Chattanooga city, Tennessee	Flint city, Michigan	Tuba City CDP, Arizona	Lowndes County, Alabama	United States
Persons in poverty, percent	17.6%	37.3%	24.8%	21.9%	11.4%
<b>PEOPLE</b>					
<b>Income &amp; Poverty</b>					
Median household income (in 2020 dollars), 2016-2020	\$47,165	\$30,383	\$54,171	\$33,634	\$64,994
Per capita income in past 12 months (in 2020 dollars), 2016-2020	\$32,241	\$17,638	\$18,015	\$21,298	\$35,384
Persons in poverty, percent	17.6%	37.3%	24.8%	21.9%	11.4%

Figure 5: Persons in Poverty in the United States

In each of the cities studied, US Census demographic data were linked to aggregated water quality or violation data from the community water systems serving that area.<sup>49</sup>



<sup>49</sup> VanDerslice, James. “Drinking Water Infrastructure and Environmental Disparities: Evidence and Methodological Considerations.” *American Journal of Public Health*, American Public Health Association, Dec. 2011, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3222486/>.

## Discussion

The purpose of this study was to analyze the impacts of water infrastructure inequality in the United States and draw conclusions about common characteristics associated with these inconsistencies. Compared to the overall US population, the results found that households with highest level of water insecurity are more likely to be minorities with lower median incomes. To evaluate the accuracy of this data, historical records were referenced to indicate what materials were used to build the original infrastructure and the age of the systems. We can draw conclusions about water infrastructure issues in the US based off population characteristics of cities with high infrastructure inequality. Affordability disparities are in large part amplified by the disproportionately high levels of poverty in these areas. This information informs communities and legislative bodies about climate adaptive strategies needed to combat these environmental injustices. Many advocates of environmental justice recognize the inequities that exist within the distribution of environmental laws and regulatory actions.

## *Limitations*

One limitation of this study is the limited availability of existing research about water infrastructure inequality in the United States. There has been thorough research in other parts of the world connecting social inequality to infrastructure and environmental conditions. However, there are disadvantages with this analysis because the generalizability of the results may not be an accurate reflection of the rest of the population.<sup>50</sup> As the federal government begins investing more into infrastructure equity initiatives, more data will be collected, allowing for more comprehensive research to be conducted.

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<sup>50</sup> Cherian, Tesros. "Analysis of the Soil Lead Contamination Issue of South Chattanooga." *University of Tennessee at Chattanooga*. pg. 21, 2021.

Data involving disparities in drinker water infrastructure are difficult to quantify because they are typically do not involve sociodemographic characteristics of the communities themselves. Underreporting with federal agencies can also affect the ability to accurately report on water quality and infrastructure issues.

### *Recommendations*

Changing the culture across the nation to treat water as a basic human right is necessary for successful implementation. Prioritizing long-term investments in infrastructure will better equip vulnerable communities with the tools needed to sustain healthy lifestyles. “The agency’s most recent nationwide surveys of local governments and utilities conservatively estimated approximately \$473 billion needs to be invested within the next twenty years to bring our nation’s infrastructure up to environmental and public health standards.”<sup>51</sup> Investing in remediation projects and updating infrastructure would result in safer spaces to live as well as a healthier surrounding environment. Despite bearing the brunt of environmental problems, minority communities frequently have little to no political power. Numerous studies have also found a close correlation between the siting of undesirable land uses and a community’s voting rate, which less politically active communities suffering greater environmental justice problems.<sup>52</sup> Creating spaces for quality education and outreach may help this issue. Addressing

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<sup>51</sup> EPA’s Role in Addressing the Urgent Water Infrastructure Needs of Environmental Justice Communities. National Environmental Justice Advisory Council, 1 March 2019, [https://www.epa.gov/sites/default/files/2019-10/documents/nejac\\_letter\\_nepa.pdf](https://www.epa.gov/sites/default/files/2019-10/documents/nejac_letter_nepa.pdf).

<sup>52</sup> Hamilton, James. *Testing for Environmental Racism: Prejudice, Profits, Political Power?*, Journal of Policy Analysis and Management (1995). <http://hrlr.law.columbia.edu/files/2018/01/IngaTWinklerCatherineCole.pdf>

this environmental inequity on a federal level is necessary to reduce the disproportionate burdens these communities face.

I am hoping that this research brings a new understanding of the water infrastructure crisis in the U.S. and can be applied to community education initiative, policy development, and advocacy to achieve safe and affordable water access for all people.

### *Policy Reforms to Support the Environmental Justice Movement*

Answering the question of how to combat environmental injustice requires legislative action from federal and local agencies. Many land use policies have historically been tools for segmenting people and concentrating pollution in communities of color. However, community outreach and education can transform these same tools into methods for addressing the burdens brought on by environmental injustice. As a result of sustained advocacy from environmental justice activists and public health experts, agencies such as the EPA have created tools to describe the cumulative impacts and identify areas of concern, setting funding priorities and target regulatory and enforcement attention.<sup>53</sup>

On December 3, 2021, the U.S. Environmental Protection Agency invited the city of Chattanooga to apply for a \$186 million Water Infrastructure Finance and Innovation Act loan to go towards Wastewater Compliance and Sustainability Projects.<sup>54</sup> This would dramatically improve the state of water infrastructure in the city and alleviate many of the water quality issues the community faces. Just recently, the Justice40 Initiative was created under the Biden

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<sup>53</sup> “NRDC: Environmental Justice.” *Tishman Environment and Design Center*, 2019, [https://assets.nrdc.org/sites/default/files/justice\\_eng.pdf](https://assets.nrdc.org/sites/default/files/justice_eng.pdf).

<sup>54</sup> *EPA’s Role in Addressing the Urgent Water Infrastructure Needs of Environmental Justice Communities*. National Environmental Justice Advisory Council, 1 March 2019, [https://www.epa.gov/sites/default/files/2019-10/documents/nejac\\_letter\\_nepa.pdf](https://www.epa.gov/sites/default/files/2019-10/documents/nejac_letter_nepa.pdf).

administration to ensure that federal agencies deliver 40 percent of the overall benefits of climate, clean energy, affordable and sustainable housing, clean water, and other investments to underserved communities.<sup>55</sup> The Bipartisan Infrastructure Law goes hand in hand with this initiative, helping clean up toxic PFAS chemicals and strengthening community resilience to climate change. This law will invest \$55 billion to expand access to clean drinking water through the investment in infrastructure.<sup>56</sup> Green infrastructure is also a innovative solution to the water crisis in America. This type of infrastructure is a form of Low Impact Development that utilizes vegetation and natural hydrologic processes to manage and treat storm water. It is beneficial for both the environment and communities in urban spaces as it catches pollutants, decreases runoff, and helps clean groundwater. This type of infrastructure is an excellent alternative to the traditional models that are currently failing. Transformative investments like these are crucial for effectively combatting environmental injustice in communities across the United States.

The Supreme Court has ruled that Title VI authorizes federal agencies to adopt certain regulations that prohibit discrimination.<sup>57</sup> The EPA is also held responsible for providing any alternatives that may be “less discriminatory.” Despite this, there are still several inadequacies in the distribution and allocation of water infrastructure resources.

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<sup>55</sup> “Fact Sheet: A Year Advancing Environmental Justice.” *The White House*, The United States Government, 26 Jan. 2022, <https://www.whitehouse.gov/briefing-room/statements-releases/2022/01/26/fact-sheet-a-year-advancing-environmental-justice/>.

<sup>56</sup> “Fact Sheet: A Year Advancing Environmental Justice.” *The White House*, The United States Government, 26 Jan. 2022, <https://www.whitehouse.gov/briefing-room/statements-releases/2022/01/26/fact-sheet-a-year-advancing-environmental-justice/>.

<sup>57</sup> Kibert, N. (2001). Green Justice: A Holistic Approach to Environmental Injustice. *Journal of Land Use & Environmental Law*, 17(1), 169-182. Retrieved from <http://www.jstor.org/stable/42842786>

## The Need for an Intersectional Approach

The concept of environmental justice provides a framework for addressing environmental policy in a more comprehensive approach. The term “intersectionality” is based on Kimberlé Crenshaw’s work studying civil rights, structural inequality, and power systems in the United States. To create comprehensive solutions to environmental injustice, the recognition of intersectional environmentalism is necessary. Intersectionality is a core conceptual lens in understanding how various forms of social inequalities and environmental injustices interconnect. Intersectional environmentalism has been adopted as an analytical framework to identify overlap and guide conversations in these discussions.

“In the context of justice in climate change, intersectionality is increasingly being applied to examine the overlapping and interdependent systems of disadvantage and oppression that restrict people’s adaptive capacity and create new or exacerbate existing social-ecological vulnerabilities.”<sup>58</sup> The issue of water infrastructure inequality needs to be examined in a larger context that considers factors like geographic location, historical trends of discrimination, inequitable access, and external environmental factors. Integrated and multidimensional approaches like these are highly important to understanding vulnerability factors and solutions to combat water infrastructure inequality.

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<sup>58</sup> Djoudi, H., Locatelli, B., Vaast, C. *et al.* Beyond dichotomies: Gender and intersecting inequalities in climate change studies. *Ambio* **45**, 248–262 (2016). <https://doi.org/10.1007/s13280-016-0825-2>

## Conclusion

The water infrastructure crisis has contributed to many of the health disparities and inequalities that exist in communities across the United States. From infrastructure failures to the growing number of natural disasters triggered by climate change, the systems in place reveal the effects of water infrastructure inequality. Research has revealed that black communities are twice as likely to live without modern plumbing and Native Americans face more difficulty accessing clean water than any other group.<sup>59</sup> There is no one simple solution to the historical problem of environmental issues affecting these groups. They vary in complexity and scale addressing various aspects of the problem, from the environmental level to the social one. Many arguments claim that it will be impossible to resolve the water infrastructure issues without first addressing the underlying racial inequalities that exist. While this claim does hold validity, it is possible to create structures that enable positive change. Building awareness of the severity of the issue and investing in programs that aim to stabilize it are important beginning steps towards addressing the issue. It's crucial to solve these fundamental issues to tackle the larger systemic inequality challenges America faces. If the basic needs of disadvantaged communities are not being met, it will be impossible to guarantee equality in the long run. "Given the destructive impact of climate change and its connection with the antiquated water and sanitation infrastructure, we must also redefine, invest in, and build the infrastructure necessary to achieve this lofty goal."<sup>60</sup> There is

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<sup>59</sup> *Closing the Water Access Gap in the United States: A National Action Plan*. US Water Alliance. 2019, p. 40. [http://uswateralliance.org/sites/uswateralliance.org/files/publications/Closing%20the%20Water%20Access%20Gap%20in%20the%20United%20States\\_DIGITAL.pdf](http://uswateralliance.org/sites/uswateralliance.org/files/publications/Closing%20the%20Water%20Access%20Gap%20in%20the%20United%20States_DIGITAL.pdf)

<sup>60</sup> Damon, Opinion by Matt. "Opinion: Access to Clean, Safe Water Is Essential in the Fight against Climate Change." *CNN*, Cable News Network, 1 Nov. 2021, <https://www.cnn.com/2021/11/01/perspectives/matt-damon-water-climate-change/index.html>.

substantial evidence to support disparities in water quality systems because of race and poverty status, as they are some of the strongest predictors of water and sanitation access. “Aging infrastructure, deferred maintenance, changes in regulations, limitations on water resources, and outside stressors increase the complexity and cost of ensuring access to the basic public health needs of safe drinking water and adequate wastewater treatment.”<sup>61</sup> Through this research, the intersection of these factors coupled with historical trends of discrimination supports the argument that it is not simply an economic issue, but an environmental and social one.

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<sup>61</sup> Gray, Wayne, et al. “Environmental Justice: Do Poor and Minority Populations Face More Hazards?” *EPA*, National Center for Environmental Economics, Sept. 2010, <https://www.epa.gov/sites/default/files/2014->

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