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Data-Driven Equitable Planning for Urban Resilience: Innovation, Risk, and Outcomes in Boston, New Orleans, and Norfolk

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Abstract

Coastal cities around the world seek to mitigate the intensifying impacts of sea-level rise and stormwater on urban infrastructure and human safety and well-being. Our comparative case study of Boston, New Orleans, and Norfolk examines how cities use data and smart technologies to inform resilient infrastructure planning, with a focus on equity and social justice outcomes. Drawing on Kitchin's (2021) critical framework of data as socially constructed, we analyze how data is defined, collected, and deployed in coastal resilience planning in each of these cities. Findings demonstrate how data practices can reinforce existing power dynamics. The comparison points to three critical factors affecting equitable data-driven resilience planning: (a) centering community participation in determining what data is collected and how it is used; (b) making technical data accessible and meaningful to diverse audiences; and (c) implementing transparent monitoring mechanisms that enable communities to track progress and address unintended consequences. This study contributes to a nuanced understanding of the opportunities and challenges in using data for equitable urban resilience planning, offering insights for policymakers and urban planners grappling with similar challenges globally.

Keywords

climate adaptation; coastal cities; community engagement; flood mitigation; infrastructure improvement; public policy; risk management; urban development; urban governance; urban resilience

1. Introduction

As coastal cities worldwide face the impacts of climate change, data-driven approaches to resilience planning have become central to urban adaptation strategies. The stakes for getting data-driven coastal resilience planning right are considerable. By 2050, sea levels along US coastlines are projected to rise

10–12 inches on average, threatening infrastructure valued at over $1 trillion (National Oceanic and Atmospheric Administration, 2022). Traditional risk assessment approaches, which often rely on property values and cost-benefit analyses to determine where protective measures should be implemented, frequently overlook social vulnerabilities. With global cities investing billions in climate adaptation infrastructure every year (UN Environment Programme, 2021), it becomes urgent to understand how data practices shape outcomes. Decisions made today about what data to collect, how to analyze it, and how to translate it into policy will determine not only physical infrastructure but also patterns of advantage and disadvantage for generations to come.

Our study examines how three coastal cities in the US—Boston, New Orleans, and Norfolk—approach data-driven climate resilience planning while also grappling with legacies of segregation that have concentrated vulnerable populations in flood-prone areas. Although they face similar climate vulnerabilities, there are distinct institutional approaches to data governance in each city, providing unique insights into how different data practices might shape equity outcomes. By analyzing how these cities define, collect, and communicate resilience data, we highlight the opportunities and challenges of integrating social justice considerations into urban climate adaptation.

While the academic literature discussed below has begun to emphasize the central role that equity and social resilience play in climate resilience, there is less consideration of the central role that data practices can play in this. There remains a significant gap in understanding how data practices themselves—the ways in which information is collected, analyzed, and deployed in decision-making—either challenge or reinforce existing inequities. Data-driven approaches are often taken for granted without acknowledging the limitations and both implicit and explicit bias in the data and data management processes. As Kitchin (2021) argues, data is not neutral but rather socially constructed, reflecting the values, priorities, and power structures of those who collect and deploy it. This critical perspective on data has not been adequately integrated into analyses of climate resilience planning, especially given that data-driven decision-making increasingly determines which communities and assets receive protection. While these approaches utilizing data analytics offer more precise measurement to guide interventions, they may inadvertently reproduce or amplify existing social disparities if not implemented with careful attention to equity considerations.

This study addresses this gap by exploring the data practices underpinning coastal resilience planning in three American cities, each with distinct approaches to climate adaptation. We focus in particular on the ways in which data practices either challenge or reinforce existing inequities and examine how different approaches to data collection and community engagement can shape outcomes for historically marginalized communities. In doing so, this study extends resilience scholarship by emphasizing the critical role of participatory data governance in addressing systemic inequalities.

The article is organized as follows: The following section introduces the literature on climate resilience and the ways in which this has evolved to address social equity concerns. We then elaborate on our analytical framework, drawing from Kitchin's (2021) critical perspectives on data, which examine how data is socially constructed, governed, ethically managed, and made accessible. We then introduce our three case studies and discuss why a comparison of these three cities in particular provides a useful juxtaposition from which to draw these conclusions. Each city is then explored in detail. We conclude with a synthesis of the lessons learned across all three cases and what recommendations can be drawn from these.

2. Climate Resilience

To understand how data practices shape equity outcomes in climate adaptation, it is essential to first examine the evolution of climate resilience as both a theoretical concept and a practical framework for urban planning. The development of resilience theory has increasingly incorporated social equity concerns, yet the role of data practices in either advancing or hindering these equity goals remains underexplored. This section traces the theoretical development of climate resilience principles and their real-world application.

The concept of resilience is often traced back to Holling (1973, p. 14), who wrote of it as "a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between the state variables." The concept of climate resilience builds on this ecological concept, referring to a system's capacity to endure disruption associated with climate change. One of the most highly cited definitions is the one offered by the Intergovernmental Panel on Climate Change: "The capacity of interconnected social, economic, and ecological systems to cope with a hazardous event, trend, or disturbance, responding or reorganizing in ways that maintain their essential function, identity, and structure" (Lonsdale et al., 2024). Widely adopted by practitioners, such as those part of the Resilient Cities Network, the concept provides a holistic framework that recognizes the ability to address physical challenges (e.g., storms and floods) and social stresses that exist in a community (e.g., economic hardships and social inequality; Resilient Cities Network, n.d.).

The concept of resilience has evolved across a variety of fields in the past 50 years since Holling's pioneering work. However, climate resilience has emerged as a distinct focus that extends beyond traditional engineering or ecological resilience paradigms, which primarily concerned the ability of a system to adapt to disturbances and recover normal functioning. For example, early frameworks of resilience tended to focus on the functionality and recovery of systems and prioritized technical efficiency and stability over social considerations (Harris et al., 2023; Martin-Breen & Anderies, 2011). By concentrating on outcomes over processes, these frameworks gave inadequate consideration to how they were reached or who they benefited (Raciti et al., 2023). Thus, these models largely overlooked how systemic inequalities shape communities' abilities to adapt to and recover from climate challenges (Doost et al., 2023; Lioubimtseva et al., 2024). In contrast, the contributions of social resilience theory have aimed to ameliorate these shortcomings (Keck & Sakdapolrak, 2013). These emphasize power relations and community capacities, whereas ecological resilience stresses adaptation and engineering resilience concentrates on system recovery (Norris et al., 2008). For example, several recent reports on flood infrastructure planning emphasize community resilience and collaboration (Hughes et al., 2022; National Association for the Advancement of Colored People, 2021). Scholars now advocate for more process-oriented approaches that build capacities, foster community connections, and ensure effective and equitable governance (for example, see Doost et al., 2023; Meerow et al., 2019).

All of this suggests that there is a rising understanding that social, economic, and political inequality significantly influences vulnerability to climate threats, in theory at least. As climate impacts intensify, it has become increasingly evident that resilience frameworks must address not just the physical infrastructure challenges but also the social disparities that shape vulnerability and adaptive capacity. This recognition has led to the integration of social resilience frameworks that consider power dynamics, community capacity, and social equity (Ungar, 2011) and has led to calls for more comprehensive strategies across domains

and growing awareness of the interdependencies of ecological, engineering, and social systems (Davidson et al., 2016).

3. Analytical Framework

Given the central place of equity in the conceptualization of climate resilience, our study seeks to explore how this is reflected (or not) in the often data-driven approaches to climate resilience planning. Our analytical framework draws directly from Rob Kitchin's (2021) critical examination of data practices, identifying four key dimensions and applying these to coastal resilience data practices in our three case studies. Kitchin challenges the notion of data as neutral, instead framing all data as a product of and therefore a reflection of the social and political context in which it was gathered and analyzed. He emphasizes the importance of diverse knowledge systems, particularly those traditionally marginalized by technocratic approaches. This includes local, experiential, and indigenous knowledge that may be overlooked in favor of "expert" technical data. The integration of these diverse knowledge systems is critical for developing more equitable and effective resilience strategies. This perspective provides a critical lens for examining how data practices in resilience planning may reinforce or challenge existing power dynamics and inequities.

This also aligns with emerging trends in climate resilience scholarship, calling for more situational and contextual approaches to data. For example, Brodie et al. (2024, p. 140) argue, "environmental data power is also a tool that can be wielded by communities, activists, and political groups towards environmental justice." Taking a similarly critical perspective, Nost (2018) argues that the influence of environmental modeling on policy development is due more to political, financial, and technical factors than to the model's accuracy. C. Johnson and Osuteye (2019) observe that data-gathering procedures themselves can either challenge or reinforce existing disparities. Traditional loss databases and city-scale resilience frameworks often overlook the everyday risks faced by marginalized communities, while community-generated information techniques may offer more equitable approaches to knowledge production. Thus, they argue that communities that have traditionally been the subjects of data collection rather than active contributors to the creation of knowledge must be given the authority to influence the gathering, interpretation, and application of resilience data about them. In coastal resilience planning specifically, Craig (2022) and Goytia (2024) show how more transparent flood risk information could create fairer conditions for both residents and potential property buyers. Yet the accessibility and interpretability of such data often varies across communities, potentially reinforcing existing inequities. These insights suggest that data can be both a tool of marginalization and of empowerment, depending on how it is governed and deployed.

We therefore draw from Kitchin's (2021) specific critiques, framing these as four broad dimensions that we utilize to examine how data practices in resilience planning may reinforce or challenge existing power dynamics and inequities:

1. Data as socially constructed: Data is not neutral but reflects the values, priorities, and power structures of those who collect, analyze, and deploy it. In resilience planning, this means questioning what is measured, by whom, and for what purpose.
2. Data sovereignty and governance: Communities should have rights regarding data about them, including input into how it is collected, interpreted, and used. This is especially important for communities that have historically been subjects of data collection rather than active participants in knowledge creation.

3. Ethics of data collection: Data practices should be guided by principles of care, accountability, and transparency, with attention to potential harms and benefits.
4. Infrastructure and access: The technical systems through which data is collected, stored, and analyzed can either enable or restrict equity, depending on who can access and use these systems.

These four dimensions are operationalized, and the analytical framework is defined in Figure 1.

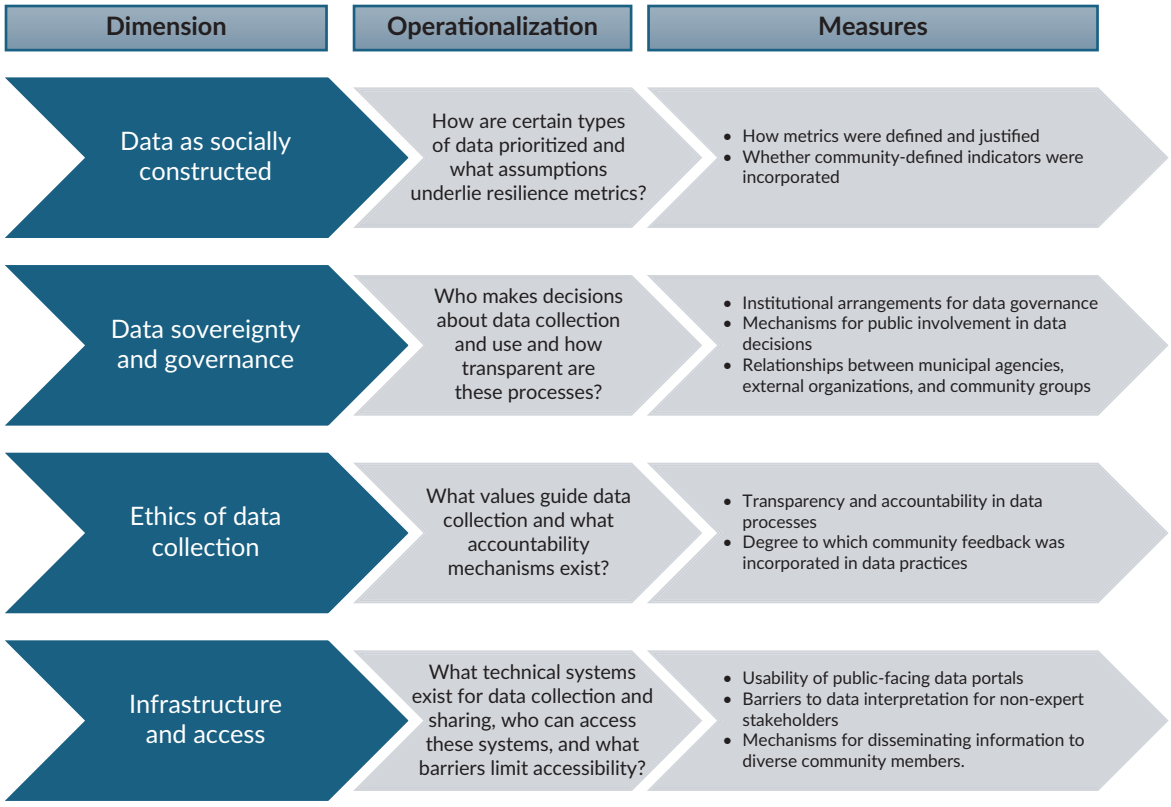

Figure 1. Analytical framework. Source: Adapted from Kitchin (2021).

4. Methodology

To more closely explore the ways in which these data-driven approaches have implications for equity in climate resilience efforts, this study examines three US coastal cities: Boston, New Orleans, and Norfolk, and their coastal resilience efforts in particular. The specific coastal contexts vary: New Orleans contends with subsidence and deltaic processes, Norfolk seeks to balance military infrastructure with residential needs, and Boston is developing its waterfront even as it must manage vulnerabilities that stem from historic land reclamation. Still, they all share the common challenges of sea-level rise and increased flooding.

All three cities were among the first American cities selected for the 100 Resilient Cities Network in 2013 (The Rockefeller Foundation, n.d.). Participation in the program provided each city with resources to hire chief resilience officers and develop comprehensive resilience strategies. It also meant they were all early adopters of this approach to urban resilience planning, which recognizes that the ability to address physical challenges—like storms and floods—is impacted by the social stresses that exist in a community—like economic hardships

and social inequality (Resilient Cities Network, n.d.). Their participation in this network thereby provides a common starting point for examining how data-driven approaches to resilience planning have evolved over the past decade, particularly in addressing issues of equity and social justice.

The demographic makeup of these three cities also makes them an interesting comparison. Most notably, all three are rated as having "high segregation" (Othering & Belonging Institute, n.d.). New Orleans in particular ranked in the top ten of most segregated statistical areas for 2019, while Boston ranks in the top ten metropolitan areas with the greatest increase in segregation between 1990 and 2019 (Menedian et al., 2021). These demographic realities intersect with the geographical risks each city faces. In Boston, historically redlined and segregated neighborhoods like East Boston and Dorchester have higher populations of racial minorities and lower-income residents and face elevated flood risks from sea level rise due to their coastal location. In Norfolk, many predominantly Black neighborhoods, such as Tidewater Gardens and other areas in the St. Paul's district, are in low-lying areas with poor drainage infrastructure, issues that only worsen with sea level rise. New Orleans presents the starkest example. Historical patterns of segregation pushed many African American residents into lower-lying areas of the city, particularly those below sea level. The Lower Ninth Ward, which was devastated during Hurricane Katrina, exemplifies how racial segregation led to Black residents being concentrated in areas most vulnerable to flooding. This neighborhood was originally considered less desirable real estate precisely because of its flood risk, and discriminatory housing practices concentrated minority populations there.

This study analyzes how these three cities define, construct, and deploy data in their resilience planning, with the aim of better understanding the opportunities and challenges in developing equitable approaches to urban climate adaptation. Our methodology focuses on conducting a critical comparative review of resilience planning processes across the three cities, utilizing official planning documents and other publications to build profiles of data practices in each city. The case study profiles were built using four primary categories of documents:

1. Official resilience planning documents: City-produced resilience strategies and planning documents published between 2013 (when all three cities joined the 100 Resilient Cities Network) and 2025. These included: for New Orleans—The Gentilly Resilience District project plan (City of New Orleans, 2018), the city's hazard mitigation plan (Office of Homeland Security and Emergency Preparedness, 2021), and *A Priority List for Climate Action in New Orleans: Net Zero by 2050* (City of New Orleans, 2022); for Norfolk—*Norfolk Resilient City* (City of Norfolk, 2015), *Norfolk Vision 2100* (City of Norfolk, 2016), and the Virginia Community Flood Preparedness Fund Grant Application (City of Norfolk, 2021); and for Boston—The series of neighborhood-specific Coastal Resilience Plans developed between 2017 and 2022 for Charlestown, Downtown/North End, South Boston, Dorchester, and East Boston/Charlestown (City of Boston, 2025)
2. Scholarly evaluations: Academic analyses of each city's resilience planning efforts, including peer-reviewed articles published in the last decade that specifically address data practices and equity considerations.
3. Media coverage: Local news reporting on resilience planning efforts in each city, focusing on coverage that documented community responses to planning processes and implementation. Sources included the Boston Globe, New Orleans Times-Picayune, and Virginian-Pilot.

4. Evaluation and assessment reports: Reports from non-governmental organizations, research institutes, and government oversight bodies that evaluated the implementation and outcomes of resilience planning. These included *The Inaugural Boston Climate Progress Report* (Fitzgerald & Walsh, 2022), reports from the Boston Green Ribbon Commission (Foster & Johnson, 2020; Plastrik, 2023), and the Louisiana Equity Metrics Framework (Habans et al., 2023).

Our selection criteria prioritized documents that: explicitly discussed data collection, analysis, and deployment in resilience planning; addressed equity considerations or community engagement in data practices; provided insights into institutional decision-making processes regarding data; and documented community perspectives on data access and usage.

It is important to note that the use of secondary sources for community responses represents a limitation of this study. While the documents analyzed included substantial reporting of community perspectives, these are necessarily filtered through the interpretive lens of researchers, journalists, and planners. Direct engagement with community members through interviews or participatory research was beyond the scope of this particular study.

Once the profiles were established, we then applied the framework outlined above (see Figure 1) to gauge how data practices reflect and shape power dynamics in each context. This approach allowed us to evaluate the social and political dimensions that determine whose knowledge counts, whose needs are prioritized, and whose voices are heard in adaptation decision-making. The following sections present each case study, followed by an analysis comparing the three cities on the measures in the analytical framework. The concluding section contrasts the data practices of the three cities and presents recommendations for local planners and policymakers.

5. Case Study Results

5.1. New Orleans

Data-driven planning is useful for all cities, but none more so than New Orleans. Situated within a natural basin, the city faces an array of flood risks from river surges, storms, and heavy rains. Occupied by indigenous peoples in the prehistoric era, the region was home to European settlements by 1700. The history of New Orleans is that of technological innovation, as the city's residential area expanded after the early 20th-century improvements in water pumping systems allowed for drainage of several area swamps, wetlands, and marshes and the expansion of the city's levee system in the 1930s (Campanella, 2006). Currently, land subsidence is exacerbating this situation, as the city slips lower each year with regard to sea level (D. R. Johnson et al., 2015). In the past, the area's coastal wetlands provided natural barriers to help protect the city, but they are predicted to continue to shrink in the years to come (Hobor et al., 2014).

New Orleans has a checkered history regarding governmental transparency and effective delivery of municipal services. At the dawn of the 21st century, the city continued to struggle in the face of increasingly sophisticated expectations around municipal data. Many of the city's IT staff were employed on a temporary basis, and the geographic information systems functions typically performed by a city division were outsourced. Factual and timely city data was in short supply (Gardere et al., 2020). The Greater New Orleans

Community Data Center (later known simply as The Data Center) was established in 1997 with a mission of "democratizing" regional data by making it relevant and accessible to the public (Martin, 2023). The Center's role evolved from providing demographic data to becoming the region's source for climate resilience information, reflecting both the organization's growth and persistent gaps in public data infrastructure.

Hurricane Katrina fundamentally transformed New Orleans' approach to data. In August 2005, the storm devastated the city, leaving nearly 2,000 people dead and entire neighborhoods abandoned and in disrepair. Historically, many of the least desirable and most dangerous areas of the city were home to low-income Black residents, tying climate resilience dramatically to patterns of discrimination and social inequity (Jayawardhan, 2017). In the years following the storm, demand spiked for accurate and granular data of all types as The Data Center drew up to 120,000 users per month (Gardere et al., 2020).

During the following decade, the city joined the wave of municipalities sponsoring open data initiatives, establishing an open data policy in 2016 (Gardere et al., 2020). The data available on the city's open data portal (see Figure 2) remains limited even today, however. The site features relatively few datasets and none focusing on climate resilience and flooding, topics that are addressed instead by The Data Center's website (City of New Orleans, n.d.). This limited array of data reflects broader and long-lasting challenges in data coordination across agencies. The relegation of critical climate resilience data to a non-governmental entity begs the question regarding data governance: Who ultimately controls and is accountable for this essential public information?

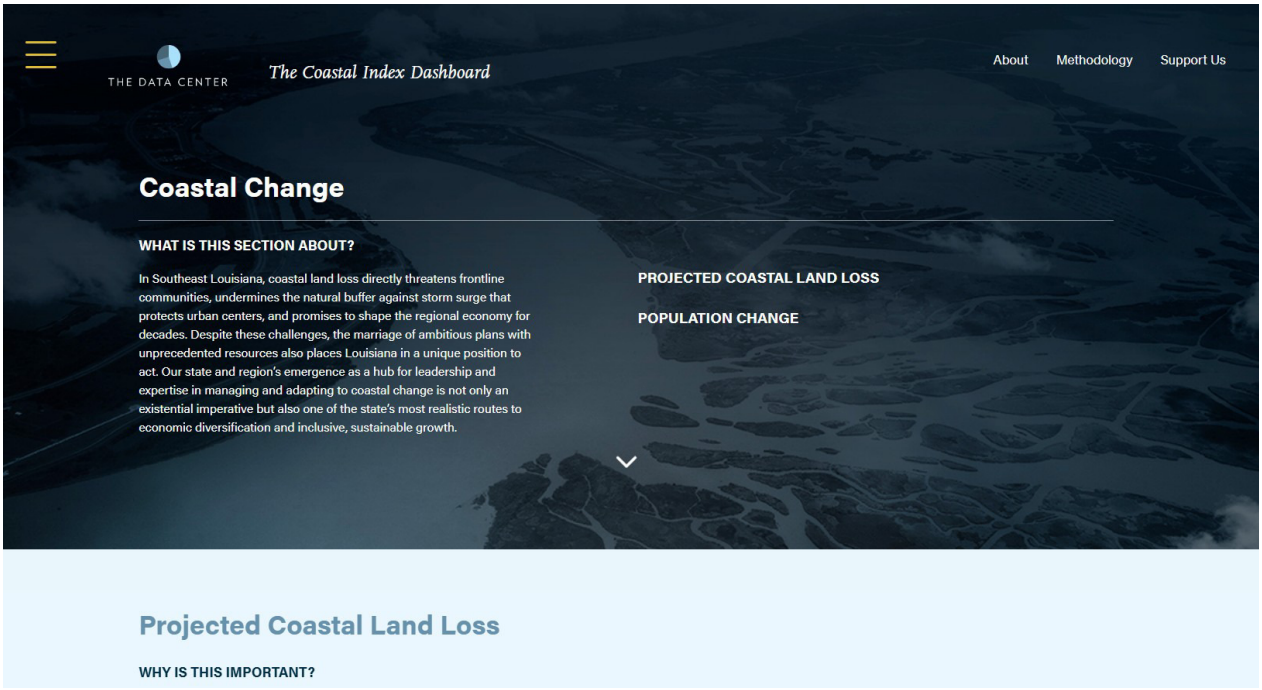

Figure 2. New Orleans: The Data Center coastal index dashboard. Source: The Data Center (n.d.).

The BlightStat program exemplifies both progress and ongoing challenges in data management. Modeled on the Baltimore CitiStat program, the BlightStat system began in 2010 under the Mitch Landrieu administration (Gardere et al., 2020) with the goal of facilitating the elimination of 10,000 blighted properties within four years. The initiative included public meetings where city staff came together to review

data and assess progress, marking a departure in a city accustomed to little transparency around data. BlightStat data included information gathered about each parcel from municipal city divisions, including code enforcement and the city attorney's office. An online tool, "BlightStatus," was produced by Code for America fellows in 2012, making the data more accessible and easier to use. Two years later, the city boasted of having eliminated nearly 13,000 blighted properties. BlightStat is sometimes cited as a turning point in the city's relationship to data, as the potential usefulness of data sharing and transparency was more widely understood. While BlightStat demonstrated data's potential for addressing specific urban challenges, it also demonstrated the extent to which data collection is shaped by broader cultural values and priorities. Definitions of "blight" are not monolithic, and centering its elimination prioritized specific perspectives that would not have been universally held. This exemplifies Kitchin's critical framework around the social construction of data.

New Orleans has made progress in terms of data gathering and sharing in recent years, but the city's data practices still reflect and enforce social inequities. Recent state-level efforts include The Data Center and the Louisiana Governor's Office framework for climate equity metrics, which recommends creating tailored data resources for various audiences through an interactive hub exploring indicators like hazard exposure, income, and inclusive economic growth (Habans et al., 2023). While this framework has great potential, it has not yet been implemented. In the wake of Hurricane Katrina, some neighborhoods, such as Broadmoor, used existing social and institutional connections to gain access to data regarding permitting; other less well-connected communities struggled without such access (Gardere et al., 2020). Although over 300 government datasets are now publicly available, the city's crucial climate resilience data remains housed by The Data Center. This arrangement raises some ethical questions about accountability and transparency that align with Kitchin's framework. That is, who ensures this data is collected and utilized in ways that serve vulnerable communities, and what recourse do residents have if they believe their needs are not being represented?

New Orleans uses tools like the Social Vulnerability Index, which draws upon over a dozen census variables to identify the relative vulnerability of various neighborhoods to environmental hazards such as hurricanes and flooding and facilitate complex multivariable analysis (Office of Homeland Security and Emergency Preparedness, 2021). Regional organizations work to ensure equitable access to resources and information. The Water Collaborative focuses on public education and water policy to ensure equitable access to water (City of New Orleans, 2022), and the Neighborhoods Partnership Network fosters connections and information sharing between neighborhoods to leverage public and private investments (City of New Orleans, 2020). Despite these efforts, data integration and privacy concerns persist, and stakeholders often disagree about priorities and risk assessment (Rumson et al., 2017).

In recent years, New Orleans has attempted to implement data-driven planning around climate resilience. Funded by a $141 million grant from the National Disaster Resilience Competition, the Gentilly Resilience District project showcases the potential and challenges in this area (City of New Orleans, 2018). The project is designed to minimize flood risk and limit land subsidence. More broadly, it seeks to center water and land management in urban development by addressing stormwater and other potential risks through the implementation of green stormwater infrastructure (Trust for Public Land, 2023). Although the project has ambitious data collection and visualization goals, the project reflects the gap Kitchin identified between technically sophisticated efforts and community-centered data governance.

The project makes extensive use of data. The Trust for Public Land's Climate and Smart Cities New Orleans Decision Support Tool allows users to visualize climate equity concerns such as demographic data in an interactive geographic information systems format (Trust for Public Land, 2023). A comprehensive digital database of infrastructure plans, spatial data, and surveys will be used in planning and design (Office of Homeland Security and Emergency Preparedness, 2021).

Despite these plans, the Gentilly Resilience District has faced extensive logistical challenges and delays. A US Department of Housing and Urban Development (2024) audit cited several factors for the delay, including Covid-19, hurricanes, a cyberattack, and insufficient coordination, staffing plans, and progress monitoring, as well as misallocation of costs.

Our analysis finds that New Orleans' data practices reflect both progress and challenges in climate resilience planning. Institutional arrangements and culture shape data governance and resilience planning. Initiatives like BlightStat demonstrate the potential power of data-driven resilience solutions, while the city's continued reliance on The Data Center reflects an ongoing gap in municipal agency capacity. Key stakeholders in the city have undeniably moved toward greater data transparency. Under-resourced offices, miscommunication, and project delays amplify the persistent social inequity that continues to plague the city and pose continued risks associated with rising climate threats.

5.2. Norfolk

Positioned at the mouth of the Chesapeake Bay in the Tidewater region of Virginia, Norfolk developed as an important colonial port in early America, much like Boston and New Orleans. The growth and development of military and transportation in the city, along with the continued growth of the central business district, reflect significant sunk costs and concomitant difficult decisions about urban and regional planning in the face of climate change.

Norfolk's climate challenges are related to preserving vital national security infrastructure, including important commercial shipping and the world's largest naval base, while shielding established residential and commercial districts from rising flood dangers. With one of the greatest rates of sea level rise on the East Coast, coastal storms pose a serious risk to a city that is relatively flat and mostly below 15 feet and sinking (City of Norfolk, 2021). The city's climate resilience plan, The Norfolk Vision 2100, aims to use a data-driven approach to balance competing commercial, military, and residential flood risk management (City of Norfolk, 2015).

Norfolk's approach to resilience planning is unique in that it integrates military and civilian demands. One example of this integration is the city's collaboration with Palantir Technologies, Inc (a publicly traded company specializing in software platforms for data analytics), to create an innovative Resilience Data Dashboard (see Figure 3). This system allows for better operational reactions and decision-making in both the military and civilian sectors by integrating important city data, such as building rules, permits, flooding statistics, and service calls (City of Norfolk, 2015). Similar to The Data Center arrangement in New Orleans, this raises questions about who controls and who has access to critical resilience data and whose interests are prioritized.

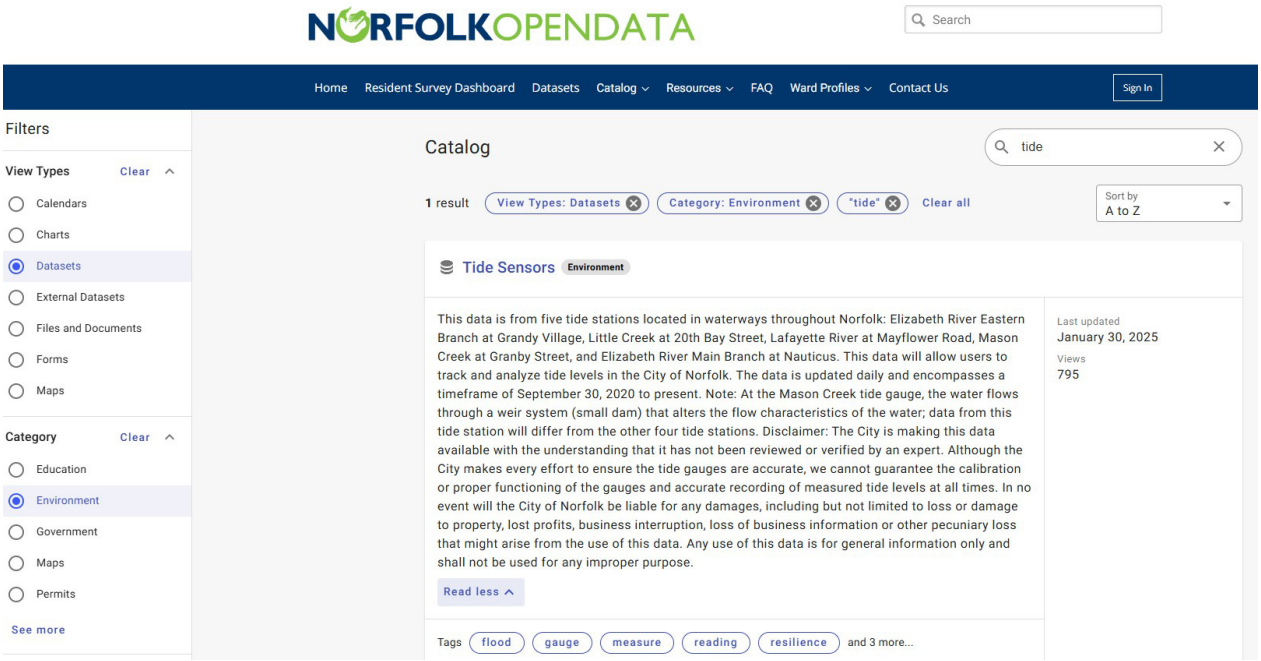

Figure 3. Norfolk open data. Source: City of Norfolk (n.d.).

All cities must coordinate inherent challenges with multiple jurisdictions of municipal, state, and federal jurisdiction. Norfolk's multijurisdictional challenges are extreme, with the strong military presence and the position at the mouth of the Chesapeake Bay. This requires creative solutions for data coordination. Some of the coordination with diverse stakeholders is managed by the office of the chief resilience officer, but there remain difficulties associated with the disparate institutional agendas and data platforms (City of Norfolk, 2015). The data landscape is further complicated by commercial port operations. Public and commercial sector organizations must carefully coordinate to integrate shipping and commerce data with flood planning (City of Norfolk, 2016). While sophisticated data-sharing methods have resulted from this collaboration, it remains unclear how well these systems work for everyone in the community (Ruckert et al., 2019). Technical sophistication does not necessarily mean ease of access or equitable access for diverse community stakeholders.

As part of its resilience plan, Norfolk has proposed a coastal flood mitigation project that includes a major seawall in the Elizabeth River. As the largest (proposed) public infrastructure project in the history of Norfolk, the $2.7 billion floodwall project needs to be understood in the context of complex relationships, community involvement, equity considerations, and data-driven decision-making in climate resilience planning. The project is controversial for several reasons. One key criticism of the project is that several majority-Black neighborhoods, including Berkley and Campostella, are excluded from the benefits of the project (Ruckert et al., 2019). In this way, the project reflects embedded assumptions about what kinds of assets are worth protecting. The US Army Corps of Engineers and other agencies led technical studies that included economic impact analyses, storm surge data, and sea level projections. This data-driven strategy reflected conventional cost-benefit calculations that frequently prioritized property values over social equality considerations (Ruckert et al., 2019). Many residents are concerned about the disproportionate number of resources allocated to the seawall project, while under-resourced areas would not see any difference in their flood risk (Hafner, 2023). Data are not value neutral, and that is demonstrated in public

debate about the Coastal Resilience Plan in Norfolk. The Coastal Resilience Plan inspired significant community outrage for a variety of reasons, particularly because of the way data was used to identify protected areas. Residents in historically underserved neighborhoods that experienced environmental injustice and redlining in the past challenged the fairness of decision-making procedures and the allocation of resources to some projects at the expense of others. Community organizer Kim Sudderth's observation that "it struck me, like, 'Oh my God, it's happening again' " illustrates how data-driven infrastructure choices reflect and perpetuate past discriminatory trends (Hafner, 2023). Some residents expressed strong disapproval of both the data collection procedure and the lack of transparency in the planning process. Lawrence Brown, president of the Campostella Heights Civic League, emphasized how the project was proceeding "really without our knowledge," highlighting significant problems with data sharing and community involvement (Morrison, 2023).

Traditional cost-benefit calculations prioritize economic assets and property values. This strategy disadvantages communities with lower property values, even if they have considerable social and cultural significance. The Federal Emergency Management Agency (FEMA) and the Army Corps of Engineers' models find it difficult to provide much protection and support for people with low property values (Hafner, 2023). The Environmental Defense Fund criticized this narrow focus on storm surge at the expense of chronic flood risk, which disproportionately affects lower-income areas (Hafner, 2023). There are some efforts noted by city planners to change the way that cost-benefit is to be calculated by the Federal Emergency Management Agency during times of disaster.

Even with regard to the sophisticated Resilience Dashboard, there is growing tension between the use of institutional data collection (such as flood sensors and sea level monitors) and community knowledge. Historic African American neighborhoods like Tidewater Gardens are experiencing what Kitchin would describe as a lack of "dominion" over data used to make decisions about flood prevention. This uncertainty highlights the fact that technically sophisticated data collection does not necessarily lead to equitable access for all community members, consistent with Kitchin's critical framework. This challenge is most apparent when residents see the allocation of public resources in the business districts along the Elizabeth River to protect high-value property, while at the same time, the cost-benefit analysis does not yield significant investments in neighborhoods with lower property values.

Public input in community charettes in different neighborhoods (Resilient Norfolk, 2025), along with news reports (Hafner, 2023), suggests that different stakeholders across the city engage with data and public decision-making differently. Part of that difference has to do with the legacy of bias and discrimination, and that bias is embedded in the data. Community input is an indication of the differing degrees of participation with and trust in official data systems, even though those data systems are robust and relatively accessible. Project planners have begun reevaluating their methods for gathering and valuing different forms of data to include social equity criteria to complement conventional cost-benefit evaluations and integrate other forms of community knowledge. These concerns about public engagement and equity in decision-making have included critical reflection on the use of data in resilience planning and inspired public officials to devise more inclusive methods for gathering and analyzing data and valuing local knowledge and diverse perspectives. In the end, the scale of the floodwall project and the controversy around it have forced the city to think differently about equitable data practices in resilience planning and public decision-making in general.

5.3. Boston

Originally, Boston was a small peninsula with hilly and uneven terrain, surrounded by marshes and tidal flats. Land reclamation over the centuries allowed the city to evolve and grow to accommodate its growing population and economy while reflecting the city's changing priorities and ambitions over time (Seasholes, 2018). Even in the 21st century, Boston has been held up as an example of how post-industrial cities can revitalize waterfronts to foster urban renewal, drawing from its rich maritime and industrial history to inform contemporary waterfront redevelopment projects (Marshall, 2001). The city's historical practice of filling tidal flats and marshlands, particularly in areas like Back Bay and South Boston, has created significant environmental risks, disrupting natural water flow systems and diminishing the protective capacity of wetlands and natural barriers (Penna & Wright, 2009; Seasholes, 2018). As climate change intensifies, these areas of the city are especially vulnerable, with sea levels rising nearly a foot over two centuries (Talke et al., 2018) and aging flood infrastructure struggling to address contemporary challenges (Mertz, 2016).

Boston developed a series of neighborhood-specific Coastal Resilience Plans between 2017 and 2022. These plans, grounded in research, modeling, and community engagement, identified vulnerabilities and potential interventions (City of Boston, 2025). The planning process emphasized a collaborative approach that brought together public agencies, private property owners, nonprofits, and community organizations through workshops, public meetings, and stakeholder consultations (Foster & Johnson, 2020). Climate Ready Boston (now the Office of Climate Resilience) focused on five coastal neighborhoods: Charlestown, Downtown/North End, South Boston, Dorchester, and East Boston/Charlestown. The combined plans cover all 47 miles of Boston's coastline. Each one involved significant community input and engagement while making a point to encourage ongoing public-private collaboration. The specific combinations of hard infrastructure and nature-based solutions (like living shorelines and restored wetlands) have been the source of conflict (Hadjis, 2022; Omoeva, 2022) but ultimately aim to address the unique needs of each neighborhood (City of Boston, 2025). While not entirely unique in this decentralized approach, Boston's Coastal Resilience Plans are distinctive for the level of integration between them, their comprehensive coverage, and the explicit connection between local plans and citywide policy.

While ambitious, the plans have faced criticism. The neighborhood-level focus itself has been critiqued as being too narrow (Hadjis, 2022) while raising broader concerns about inter-municipal coordination (Flint, 2021; Foster & Johnson, 2020; Omoeva, 2022). Although the establishment of the Office of Climate Resilience and cabinet-level leadership changes aimed to address these challenges (Boston Environment Department, 2024; Wasser, 2024), barriers remain. In particular, funding is a critical challenge, complicated by the fact that much of Boston's coastline is under private ownership. Dependence on private development creates uncertainty in the timeline and delivery of flood protection projects, and this reliance on the private sector has drawn particular criticism (Douglas & Carlock, 2024; Flint, 2021; Omoeva, 2022). Moreover, with estimates suggesting at least $3 billion is needed for 70 separate resilience projects, this dynamic raises questions about who benefits from and who pays for resilience measures (Fitzgerald & Walsh, 2022). Finally, while the slow pace of climate planning is understandable given the obstacles, critics are concerned that the pace is not enough given how immediate some of the climate effects are (Omoeva, 2022; Rickley, 2024). As oceanographer John Englander warns, "As good as Boston's current plan is—and it is among the best in the world at the moment—they're not thinking big enough. Nobody's thinking big enough" (Flint, 2021).

Another important area of concern relates to climate vulnerabilities disproportionately borne by low-income communities and communities of color. In the case of Boston's coastal flooding, these vulnerabilities manifest in a number of ways: disrupted transit access affecting work and healthcare access, revenue losses for small businesses, property damage costs, and housing displacement. These, in turn, increase the financial stress these populations already experience (Plastrik, 2023). The Office of Climate Resilience has formally recognized these challenges by emphasizing equitable outcomes and prioritizing frontline communities that face the highest climate disaster risks. Several key climate resilience planning documents incorporate climate justice principles, acknowledging historical injustices and emphasizing transparency and accountability for climate justice outcomes (Plastrik, 2023). However, the implementation of these principles has at times fallen short of community expectations. Although planners have tried, Boston's Climate Progress Report (Fitzgerald & Walsh, 2022) documents residents' frustration with the lack of meaningful engagement and transparency. This was particularly acute in communities like East Boston, Roxbury, and Mattapan, where residents reported feeling that their input was ignored or deliberately overlooked. Further concerns of green gentrification in neighborhoods like East Boston and Dorchester, though, remain an unresolved controversy (Rios, 2019).

These equity concerns motivate a closer look at just how equitable the data-driven aspects of Boston's coastal resilience planning actually are. With its concentration of universities and experts, it makes sense that Boston might be considered at the forefront of a data-driven approach to coastal resilience. Boston, too, maintains an open data portal with publicly accessible datasets on various climate and environmental indicators (see Figure 4). Yet, as with the other case studies explored here, Boston faces challenges with inequities that exist with the data itself, as well as in the way the community has been engaged with the data that drives the city's coastal resilience planning and decision-making.

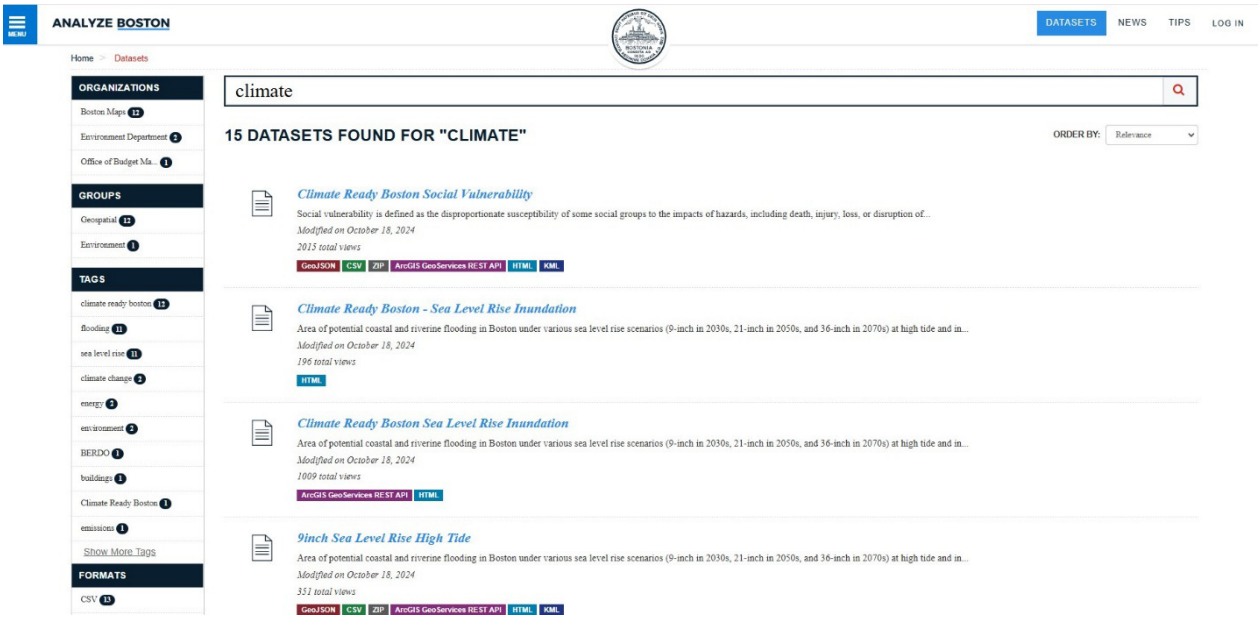

Figure 4. Analyze Boston open data portal. Source: City of Boston (n.d.).

One problem is the technical nature that is inherent to a data-driven process. Here, Boston can learn much from McIntyre et al.'s (2024) findings on community engagement with extreme heat and air quality in East

Boston and Chelsea (a neighboring city), which found considerable barriers stemming from data accessibility and interpretation. Community members reported difficulty understanding technical metrics due to reliance on technical language and a lack of user-friendly visualization tools. The study's authors also found that insufficient climate forecasting data and longitudinal data on environmental exposures and their health impacts made it more difficult for community members to grasp "why should the average person care?" (McIntyre et al., 2024). A separate study of perceptions on managed retreat found similar views (Urban Harbors Institute, 2023). The issue is compounded by the reality that the average resident may not have the technical expertise required to access and interpret scientific findings, in addition to academic paywalls that may make it cost-prohibitive. These were found to further alienate non-expert stakeholders (McIntyre et al., 2024).

Despite comprehensive planning efforts, there are additional weaknesses in how Boston specifically has engaged the community with data throughout this process. Even data on the implementation process itself could be useful here. Malloy et al. (2022) found that there was insufficient transparency on things like team formation and selection processes, which makes policy evaluation difficult. Community members have reported getting the impression that agencies conducting public outreach often fail to share community input data with each other, even when addressing similar environmental issues (Belloy et al., 2021). Having data on the actual processes and the kinds of input that were generated is important for equitable, data-informed decisions. As McIntyre et al. (2024) point out, research conducted without local community involvement or feedback becomes "just data for data's sake."

Thus, there is room for additional input on how evaluation criteria are determined and what specific data is being collected. Community definitions of resilience are not always integrated into planning, which can then lead to unintended outcomes. Developing and monitoring metrics based on those definitions ensures that communities remain "on the path toward resilience as defined by the community" (Belloy et al., 2022, p. 10). Particularly in the early stages of climate resilience planning, evaluation criteria prioritized technical and financial feasibility, and in the process marginalized community needs. For instance, although equity was ranked a top priority by community participants in the planning for South Boston's plan, it was excluded from the final project report (Malloy et al., 2022). Notably, Boston did address these concerns in its next phase of planning.

Engaging the community at these stages helps to ensure that the indicators being tracked make sense. At present, there is insufficient tracking of key indicators like housing stock, health metrics, and certain climate impacts that would allow for the evaluation of resilience measures and any unintended consequences (Belloy et al., 2022). This is further complicated by the lack of transparency in private sector involvement discussed above further complicates evaluation of spending and outcomes (Flint, 2021; Omoeva, 2022; Rickley, 2024). Having a more collaborative, participatory monitoring process can help enable communities to address unintended consequences as they arise (Belloy et al., 2022). The Green Ribbon Commission has recommended the creation of a "climate justice scorecard" to track progress on climate justice outcomes in particular. This would include establishing a baseline along with key performance indicators, defined data sets for measurement, and user-friendly ways to share data with the community (Plastrik, 2023).

Inequitable data dissemination and access result in community members missing critical planning meetings and information. In one study, residents suggested that the city was not effectively utilizing existing resources,

such as the school system, to distribute information to families (Belloy et al., 2021). The absence of transparent and participatory monitoring mechanisms weakens trust and impedes effective evaluation of resilience efforts. Improved dissemination strategies, such as user-friendly data-sharing platforms and accessible metrics, are essential to fostering trust and community participation. Ultimately, the Boston case illustrates how even in contexts where inequalities are recognized as part of the planning process, there can be weaknesses in implementation that stem from these data management concerns.

6. Discussion

The preceding case studies reveal that data practices in coastal resilience planning are neither neutral nor inevitable. Rather, they reflect specific institutional choices, power dynamics, and historical legacies that shape whose knowledge counts and whose needs are prioritized. While New Orleans, Boston, and Norfolk each developed distinct approaches to data governance and community engagement, all three cities demonstrate how seemingly technical decisions about data collection, analysis, and deployment have profound implications for equity in climate adaptation. The following analysis synthesizes these findings through the four dimensions of our theoretical framework to identify patterns and mechanisms that go beyond individual city contexts. This synthesis is summarized in Table 1, and further insights follow.

Table 1. Case comparison analysis.

Framework	New Orleans	Norfolk	Boston
Data as Socially Constructed	Data priorities have included: • Technical data on flood risk • "Blight" data on abandoned and deteriorated properties post-Katrina • Social vulnerability indicators Assumptions about metrics have been shaped by experience with Hurricane Katrina and subsequent rebuilding priorities; definitions of "blight" in the context of historically marginalized communities; how vulnerabilities and risks are defined.	Data priorities have included: • Technical data on storm surges and flood events • Military and national security infrastructure needs • Commercial and shipping data • Property values • Economic impact • Social equity criteria Assumptions about metrics have been shaped by the way infrastructure and economic considerations have been prioritized; recent reevaluations to include social equity criteria.	Data priorities have included: • Technical data on risk projections • Property value and economic development • Social equity measures Assumptions about metrics have been shaped by formal recognition of climate justice principles; debates over who pays and who benefits from resilience measures; and whose definition of resilience is being used to develop the metrics.

Table 1. (Cont.) Case comparison analysis.

Framework	New Orleans	Norfolk	Boston
Data Sovereignty and Governance	• Critical climate resilience data housed in a non-governmental data center • Persistent coordination challenges across agencies • Formal open data policy established but with limited implementation	• Centralized approach integrating military and civilian data demands • Multi-jurisdictional challenges requiring coordination across federal, state, and municipal entities • African American neighborhoods lacking "dominion" over data used for flood prevention decisions	• Decentralized neighborhood-specific plans with citywide coordination • Multi-agency coordination challenges, including failure to share community input • Insufficient transparency on plan implementation processes and monitoring, as well as stemming private sector involvement
Ethics of Data Collection	• Vulnerabilities determined by historical patterns of discrimination and reinforced by BlightStat's focus • Uneven access to permitting data based on social and institutional connections • Despite efforts to address climate justice indicators as part of the Gentilly Resilience District project, implementation challenges have undermined these	• Concern over how data was used to identify protected areas and ultimately perpetuate discriminatory patterns • Growing recognition of the need to value local knowledge alongside technical data • Different stakeholders' varying engagement with data and decision-making	• The significance of private sector raises questions about who benefits from resilience measures • Despite formal recognition and efforts to address climate justice, there are weaknesses in community engagement with metric definitions, collaborative monitoring, and data dissemination
Infrastructure and Access	• The Data Center established to make regional data "relevant and accessible" • City's open data portal offered limited datasets, none on climate resilience • BlightStat online tool improved accessibility of property data, while the Gentilly Resilience District Project provided online visualization tools	• Sophisticated resilience dashboard maintained by the city • Differing levels of community trust and engagement with official data systems • Differing degrees of participation and trust in official data systems	• Maintains the Boston Open Data portal with publicly accessible datasets • Concerns raised about academic paywalls and technical expertise requirements for some data • Inequitable and insufficient data dissemination reported

In terms of the first dimension, data as socially constructed, the summary of the case studies in Table 1 provides confirmation that data is not neutral. Across all three cities, we observe a tendency to prioritize quantifiable economic and technical data over social equity metrics or community knowledge, especially in earlier stages of planning. Part of this stems from a bias toward technical expertise over local knowledge and

a desire for more quantifiable metrics over qualitative experience. Traditional cost-benefit analyses tend to emphasize economic interests, as we see in the case of the Bligh-State program's focus on property in New Orleans, on Norfolk's military and commercial shipping interests, and in the reality of private waterfront ownership in Boston. This type of analysis also tends to reinforce existing power structures. We see this in New Orleans, with more politically connected communities like Broadmoor having their data needs better represented and historical patterns of discrimination playing out in these processes. In Norfolk, residents of historically Black neighborhoods like Berkley, Campostella, and Tidewater Gardens reported feeling left out of the planning proceedings. Even in Boston, where planning processes were purportedly centered around equity principles, low-income residents and communities of color in vulnerable areas felt their input was not always incorporated. Where social equity metrics were eventually included, these too reflect assumptions about how vulnerabilities are measured and who is defining them. Though there are variations across the case studies, overall, these patterns align with Kitchin's framework, reflecting existing power structures rather than being neutral or objective.

The second dimension considers data sovereignty and governance, how it is collected and utilized. The case studies reveal interesting variations in terms of how centralized or decentralized these processes are, with Norfolk representing the most centralized approach to climate data management, and Boston the most decentralized with its neighborhood-centric approach. In the case of New Orleans, capacity gaps have translated to reliance on external data providers. All three cities face challenges in terms of multi-agency coordination. There is also limited transparency about how data decisions are made, with a lack of clarity and consistency on how community input is translated and incorporated into data processes. While we see efforts to collect data on historically marginalized communities vulnerable to climate effects, it remains data *about* those communities, and it is less clear how those communities can be directly involved with data governance.

This relates to the ethics of data collection in terms of the accountability and transparency of data processes. In all three cases, we do see efforts to articulate and measure social equity impacts. In the case of Boston, formal commitments to environmental justice were part of planning from the start. In New Orleans, the Gentilly Resilience District initiative represents a step forward. And in Norfolk, responses to community outrage have meant growing recognition of equity considerations. In all cases, there are weaknesses in implementation, however, and recognition does not necessarily come with accountability. Whether it is insufficient progress monitoring as in New Orleans, or room for more collaborative monitoring processes as in Boston, there is room for improvement.

The final dimension under consideration looks at infrastructure and access. All three cities do strive to make data accessible to the public. Boston through its Analyze Boston open data portal and Norfolk with its Resilience Dashboard. Although New Orleans Open Data does not include climate resilience datasets, these are available through the Data Center's website. However, these open data initiatives do not necessarily address fundamental accessibility issues related to digital divides. As discussed in the Boston case study, additional consideration is needed for improved dissemination strategies and techniques. Our comparison illustrates how the gap between data *availability* and meaningful *accessibility* particularly affects historically marginalized communities across all three cities.

Together, these findings advance Kitchin's (2021) critical data framework by providing a systematic application to climate resilience planning, while contributing empirical evidence for the social resilience theories advanced by scholars like Meerow et al. (2019) and Doost et al. (2023), who argue for more process-oriented approaches that build community capacity and ensure equitable governance.

7. Conclusion

Analysis of the experiences of Boston, Norfolk, and New Orleans lends insight into how data practices can challenge or reinforce existing inequities, particularly in communities that are vulnerable to climate impacts. Our comparison reveals systemic inequities across diverse urban contexts and offers a conceptual bridge between critical data studies and climate justice scholarship.

Each case demonstrates that data is not unbiased technical information. Instead, as Kitchin argues, data is socially constructed, and emerges from specific social, political, and institutional contexts. New Orleans' BlightStat program, Norfolk's flood wall controversy, and Boston's gaps in community engagement highlight the fact that the way data is constructed can perpetuate historical patterns of marginalization. Those developing and evaluating data metrics should consider the question: cost-benefit for whom?

Data governance can shape planning outcomes and either inspire or degrade community trust. New Orleans' reliance on external organizations for crucial climate data, Norfolk's challenges with integrating military and civilian data systems, and Boston's issues with private sector data coordination demonstrate how governance structures impact data accessibility and effectiveness.

Participatory approaches are critical. Meaningful community engagement in data collection, analysis, and decision-making can ensure that resilience measures address local needs and priorities. Traditional public comment periods and community forums are not enough to achieve this goal. Instead, impacted communities must be actively involved in determining what data is collected, how it is analyzed, and how it informs decision-making. Boston's evolution toward more community-defined indicators and New Orleans' growing emphasis on participatory data governance indicate the potential for more inclusive approaches, while at the same time highlighting challenges with implementation.

This research advances both critical data and urban studies by applying Kitchin's framework to climate resilience planning. The four-dimensional analytical framework offers a replicable approach for examining data justice in urban environmental policy, while our comparative methodology reveals how institutional arrangements and data governance structures produce different outcomes even under similar challenges. Empirically, we document specific mechanisms through which data practices exclude or empower communities, offering concrete guidance for practitioners seeking to implement more equitable approaches to urban climate adaptation.

7.1. Recommendations

Our case studies suggest several recommendations for cities seeking more equitable coastal resilience planning. First, centering equity and community participation is vital. Community engagement entails not just collecting data about vulnerable communities but actively involving them in determining what data is

collected and how it is used. Second, technical data should be made more accessible and meaningful to diverse audiences. This includes (but is not limited to) the inclusion of community-defined indicators and the development of more user-friendly platforms for data sharing and interpretation. Finally, more transparent and participatory monitoring mechanisms are needed that allow communities to track progress and address unintended consequences as they arise.

Social equity is frequently insufficiently considered in current methods of assessing performance in both climate and urban resilience. Ecological frameworks and socioeconomic techniques need to be better integrated with explicit attention to justice and equality considerations, even while ecological frameworks stress system-level analysis and socioeconomic approaches concentrate on neighborhood consequences. Accomplishing this integration requires creating measures that account for the acute and ongoing pressures faced by historically underserved communities, ensuring that underserved populations are actively included in resilience planning, establishing systems of responsibility for equitable results in resilience projects, and ameliorating the fundamental political and social issues that lead to vulnerability.

In addition to strengthening the processes for converting community knowledge into policy action, future efforts must concentrate on creating frameworks that prioritize social fairness. This entails paying close attention to the creation, interpretation, and deployment of resilience data to ensure the methods of measurement do not perpetuate exclusionary and marginalizing patterns.

7.2. Limitations and Implications

Several limitations do warrant acknowledgement. Reliance on secondary sources for community responses means perspectives are filtered through researchers and journalists rather than captured directly. Furthermore, document-based analysis captures formal data practices but may miss informal approaches that emerge during implementation. Future research in this area might be served by incorporating primary data collection with community members or employing participatory methods that engage communities directly in evaluating and redesigning data practices.

Although our focus was on three US cities, many of the patterns we have identified can apply across diverse urban contexts worldwide. Particularly in rapidly urbanizing coastal megacities in the Global South, policymakers should be cautious of data practices that reinforce power dynamics, technical barriers that exclude marginalized communities, and institutional arrangements that privilege certain knowledge. Beyond climate adaptation, our framework provides a template for evaluating data justice across urban policy domains as cities increasingly adopt “smart city” technologies and big data analytics.

As coastal cities continue to wrestle with climate change impacts, these lessons become increasingly crucial. While data-driven approaches offer powerful tools for resilience planning, their effectiveness ultimately depends on how well they address existing inequities and empower vulnerable communities. Building urban resilience necessitates a commitment to social justice and equity in addition to technical solutions. This requires addressing the structural injustices that increase vulnerability to climate hazards and ensuring that data infrastructure serves all populations rather than reproducing existing inequalities.

Conflict of Interests

The authors declare no conflict of interests.

LLMs Disclosure

Claude.ai was prompted for feedback on narrative cohesion and minor edits.

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