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Barriers to Accessing Emergency Water Infrastructure: Lessons from Flint, Michigan

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ABSTRACT: Several high-profile cases of water service interruption have occurred in United States communities over the last decade, halting the usual operations of water infrastructures. In these situations, governments and NGOs have created emergency water infrastructures, such as bottled water distribution sites, to meet residents' water needs. This paper examines the accessibility of such emergency water distribution sites by analysing the case of Flint, Michigan. Drawing on interviews with community leaders in Flint who administered the city's bottled water distribution programmes, this paper identifies barriers to access in the city's emergency water infrastructure that stem from and deepen pre-existing socio-spatial inequality. This research identifies the need for government emergency preparedness guidance to incorporate a more comprehensive notion of accessibility that considers the social, political, and economic factors that affect the usability of these sites.

KEYWORDS: Water, Disaster Response, Infrastructure, Accessibility, Flint, USA

INTRODUCTION

In recent years, several communities in the United States have experienced prolonged water service interruption, halting the usual operations of water infrastructures. For example, when Winter Storm Uri brought freezing temperatures to southern states like Texas and Mississippi in February 2021, water infrastructures broke down in cities throughout the region (Sierra Club, 2021). Following the storm, Jackson, Mississippi, operated under a boil-water advisory for a month (Judin, 2021). In 2019, the Environmental Protection Agency (EPA) warned Newark, New Jersey, residents of high levels of lead contamination, urging residents not to use the water coming to their homes (Natural Resources Defense Council, 2021). Eight years after the initial contamination of tap water in Flint, Michigan, the replacement of lead service lines is still ongoing (Kelly, 2022). Rural areas in western states, too, have faced water service interruptions, with wells going dry due to drought conditions (Flaccus and Howard, 2021; Hope, 2021). Stephen Graham (2010) has described infrastructures as "precarious achievements" that "need constant support and maintenance". Under the combined challenges of climate change (Environmental Protection Agency, 2016) and the financial burden of replacing ageing, unsafe systems (Qureshi and Shah, 2014; Allen et al., 2018; Grigg, 2019), the proper functioning of water infrastructure is growing more precarious. As such, water infrastructure breakdowns are a rising concern for communities in the United States.

As part of its emergency preparedness resources, the EPA (2011) offers guidance for creating emergency water supply infrastructures to meet drinking water needs during infrastructural failures. Points of Distribution (PODs) – sites where people can collect bottled or treated water – are a key aspect of these emergency infrastructures. Points of Distribution have been created in cities like Newark (Natural Resources Defense Council, 2021), Jackson (Judin, 2021), and Flint (Flint Cares, 2020), where they have

operated for months or years at a time. Whether operating for short or extended periods,¹ the accessibility of these infrastructures is important for ensuring all community members have the water needed for drinking, cooking, and hygiene. However, little research has been done to examine the accessibility of such emergency water distribution sites.

The guiding document for creating emergency water infrastructures, developed in collaboration with the American Water Works Association, is called *Planning for an Emergency Drinking Water Supply*. It has been included in emergency preparedness collections curated by professional associations (e.g.; WaterISAC) and numerous state governments throughout the United States. In this document, the EPA emphasizes the importance of the accessibility of water distribution sites, noting that in spite of large amounts of available bottled water, people faced difficulties obtaining it during the Hurricane Katrina recovery in 2005 (Environmental Protection Agency, 2011). However, accessibility is narrowly conceptualized in this document, focusing solely on the physical locations of distribution sites and recommending centrality and proximity to population centres.

Academic study of these water distribution sites has used a similarly limited conceptualization of accessibility. A 2021 study of Flint's emergency water distribution infrastructure examined its accessibility through the lens of location (concerned with distance and travel time to distribution sites) (Kim et al., 2021). While an important factor to consider, this focus on location and proximity as the primary means of determining accessibility has been widely critiqued in the broader water accessibility literature. Defining accessibility only in terms of spatial coverage (e.g.; where are resources available, how proximate are they to populations, etc) overlooks a wide variety of other factors (e.g.; infrastructural quality; economic, social, and political dynamics) that influence who can successfully gain access to water (Satterthwaite, 2003; Zawahri et al., 2011; Obeng-Odoom, 2012; Enqvist et al., 2020).

In this paper, I build on these critiques to examine the accessibility of water distribution sites more holistically, studying the case of the Flint Water Crisis with attention not just to the physical location of these sites but to the social, economic, and political dimensions of these spaces that support or disallow certain people from accessing water. This case study draws on interviews (conducted with leaders of community organisations who organized Flint's emergency water infrastructure) and participant observation at water distribution sites. This research uncovers several barriers to access experienced by portions of Flint's population when trying to use the city's emergency water infrastructure. As such, this research contributes to the literature on water accessibility (which has underexamined water insecurity in the Global North, see Ranganathan and Balazs, 2015) and can guide emergency preparedness planning toward more equitable water access in times of crisis.

The rest of the article proceeds as follows. First, I review the water accessibility literature, explicating the need for researchers and policymakers to incorporate factors beyond spatial coverage in their conceptualizations of accessibility. Then, in the subsequent case study, I identify barriers to access in Flint's water distribution programmes, showing how the city's emergency infrastructures arose from, and deepened, pre-existing conditions of socio-spatial inequality. Finally, I discuss the implications of this research for planning more accessible emergency water infrastructures.

UNDERSTANDING WATER ACCESS

A commonly invoked concept, water access is defined in a wide variety of ways in both academic and policy contexts (e.g.; in the Human Right to Water and Sanitation). Therefore, it is important to explain how access is understood and analysed in this paper. Following the definition of access put forth by Ribot and Peluso (2003), I understand access as "the ability to derive benefits from things". This approach to understanding access extends beyond assessing the presence of resources; a resource is not accessible

¹ EPA guidance is focused on short emergencies that last under 21 days.

unless a person is *actually able* to gainfully use it. Ribot and Peluso's (2003) theory of access stands in contrast to a common but limited approach to studying water accessibility – using water infrastructure availability (i.e.; coverage) as a proxy for accessibility (Satterthwaite, 2003; Zawahri et al., 2011; Obeng-Odoom, 2012; Enqvist et al., 2020). Chronicling the presence or absence of water infrastructure in an area is a useful starting point in understanding the geography of water access. It allows for gaps in infrastructural coverage to be located and, in that way, identifies a barrier to water access. However, the presence of water infrastructure should not be considered synonymous with access because additional factors influence whether people can derive benefits from the water infrastructure near them. For example, is the water safe to consume? Poor water quality prevents people from accessing water even when infrastructures are present (Satterthwaite, 2003; Obeng-Odoom, 2012; Smiley, 2013; Martinez-Santos, 2017; Enqvist et al., 2020; Beard and Mitlin, 2021). Likewise, does the infrastructure work reliably? That is, does it consistently supply a community with safe water or only intermittently? Infrastructure that is not reliable in its functioning also presents a barrier to water access (Satterthwaite, 2003; Zawahri et al., 2011; Smiley, 2013; Enqvist et al., 2020).

Economic, social, and political factors must also be considered in analyses of people's water access. Even when high quality water infrastructure exists in an area, it is not an accessible resource if its use is unaffordable (Zawahri et al., 2011; Obeng-Odoom, 2012; Smiley, 2013; Beard and Mitlin, 2021). Socio-political conditions further influence who can gain access to water and under what conditions. As Sultana (2011: 166) explains:

Resource claims are always about power and control, and locally-mediated customs and conventions influence who has access to what resources. As such, access to natural resources and control/ownership can be very different for different groups of people, and are linked to their overall bundles of power... While access is often discussed in terms such as proximity, distance, time needed, and physical burdens, it is also linked to socio-cultural factors such as class barriers, power relations, gendered spaces, and emotional labour needed to negotiate water rights.

In other words, water access is "a product of structural and institutionalized power" (Meehan, Jurjevich, et al., 2020: 3). People's differing experiences of a community's social geography can significantly influence the accessibility of water. For example, studies of water access in Bangladesh and Kenya have shown that water access is differentially distributed depending on people's status in social and kinship networks (Sultana, 2011; Bukachi et al., 2021). People with disabilities often face difficulties obtaining water (Groce et al., 2011; Kuper et al., 2018; Dosu and Hanrahan, 2021). Similarly, in the United States, the water access needs of unsheltered populations are often neglected by policymakers (e.g.; enacting regulations that require that public toilets be locked closed during the night) (Wescoat et al., 2007). Evaluating the accessibility of water resources, then, requires attention to how social power and marginalization influence communities' waterscapes.

This paper examines the accessibility of one specific aspect of American waterscapes: emergency water infrastructures, such as bottled water distribution sites, used during periods of infrastructural failure. As such, my focus is on a component of the water system that is created in response to barriers to access (e.g.; unreliable infrastructure or unsafe water quality). A common hegemonic myth is that such barriers do not exist in the United States; that the country lives up to the 'modern infrastructural ideal' of universal, safe, reliable water infrastructure (Graham and Marvin, 2002: 200; Linton, 2010; Meehan, Jurjevich, et al., 2020). As a result, water insecurity in the United States and other Global North countries is an overlooked problem (Ranganathan and Balazs, 2015).

In contrast to the hegemonic myth, research shows that there are numerous barriers to water access in the United States. Studies of household plumbing conditions in the United States have identified communities that lack reliable water infrastructure in a country often assumed to have universal water infrastructural coverage (Wescoat et al., 2007; Jepson and Brown, 2014; MacDonald Gibson et al., 2014; Pierce and Jimenez, 2015; Leker and MacDonald Gibson, 2018; Deitz and Meehan, 2019; Meehan,

Jurjevich, et al., 2020; Pauloo et al., 2020; London et al., 2021). Water quality problems have occurred throughout the United States and are a growing concern as the country's infrastructure ages (Pierce and Gonzalez, 2017; Allaire et al., 2018; Allen et al., 2018; Kenney et al., 2020). Many Americans face water bills that are higher than the affordability thresholds put forth by the United Nations (water costs should be under 3% of household income), leading to service disconnections for those who fall behind on payments (Mack and Wrase, 2017; Teodoro, 2018, 2019; Vanhille et al., 2018; Swain et al., 2020).

These barriers to water access in the United States are not experienced evenly. The burden of water insecurity frequently falls on indigenous populations (McGregor, 2014; Curley, 2021), non-white racial groups (Jepson and Brown, 2014; MacDonald Gibson et al., 2014; Switzer and Teodoro, 2017, 2018; Leker and MacDonald Gibson, 2018; Montag, 2020), and those at the economic margins, such as people experiencing homelessness (Speer, 2016; DeMyers et al., 2017; Hale, 2019; Bae and Lynch, 2022). These inequities have resulted from colonial and racialized practices of water infrastructure provisioning and governance (see Gerlak et al., 2022), such as practices of municipal underbounding (drawing jurisdictional boundaries to exclude certain communities from incorporation into the municipality) in North Carolina, which deprived Black communities of adequate water and sanitation infrastructure (Leker and MacDonald Gibson, 2018; Meehan, Jepson, et al., 2020). Within these structural conditions of racial capitalism and settler colonialism, Gerlak et al. (2022) remind us that "multiple marginalised identities compound one another to shape experiences of water inequality", requiring an intersectional approach to understanding barriers to water access in the United States.

This broader context is important in examining the accessibility of emergency water infrastructures. First, it highlights the reality that emergency water infrastructures only respond to the needs of a subset of water insecure communities in the United States: those who lose access to water because of acute infrastructural failures. They are not put in place to address the needs of populations who face chronic insecurity because of unaffordable water or infrastructural exclusion. Second, it underscores the importance of the intersecting forces of racism, colonialism, and economics in shaping water access. Infrastructural failures should not be interpreted as mere technical failures, but as failures tied into socioeconomic power relations. The infrastructural breakdowns that led to the long-term use of emergency water infrastructures in Flint, Jackson, and Newark all occurred in majority-minority cities (cities where most of the population is non-white). As such, I am attentive to the fact that barriers to access in these emergency response infrastructures add new layers of inequality onto an already inequitable infrastructural system.

FLINT'S EMERGENCY WATER INFRASTRUCTURE

In April 2014, Flint, a city of nearly 100,000 people, switched its drinking water source from water supplied by the Detroit Water and Sewerage Department to the Flint River. Following the faulty advice of the Michigan Department of Environmental Quality, Flint did not use corrosion control (chemical treatments that prevent pipes from corroding) in its treatment of the Flint River water. Without corrosion control, the water began to erode the city's pipes, causing lead and bacterial contaminants to leach into the water. Following the switch, households throughout Flint reported rusty and brown water accompanied by a foul odour. People began complaining of rashes and hair loss. Residents urged the local government to return the city's water source to the Detroit Water and Sewerage Department due to the decline in water quality, which residents believed was harming people's health. Despite residents' concerns, city officials and members of the Michigan Department of Environmental Quality continued to state that the water was safe. It was not until September of 2015, when data compiled by paediatrician Dr. Mona Hanna-Attisha and environmental engineering professor Dr. Marc Edwards in collaboration with Flint activists (who organized water sample collection across the city) demonstrated the presence of elevated lead levels in the water and children's blood, that residents' suspicions were confirmed (Hanna-Attisha, 2019; Pauli, 2019; Carrera and Key, 2021).

The poisoning of Flint's water was not a randomly occurring accident. Flint was especially vulnerable to this infrastructural failure because of its history of racialized disinvestment and deindustrialization, driven by structures of racial liberalism and racial capitalism. Once a thriving city built on the wealth of General Motors, the community experienced massive economic upheavals when the automotive industry began relocating out of the city in the late 1970s. Before and alongside this deindustrialization, Flint's Black neighbourhoods were devalued by redlining and discrimination from financial institutions (Highsmith, 2014). American property laws, rooted in liberal thought in which whiteness (as well as maleness) has historically been a precondition for claiming and retaining property, have contributed to the devaluation of property in Flint (Ranganathan, 2016). Redlining policies in particular designated non-white neighbourhoods as too 'high risk' for government-backed mortgage lending, curtailing Black homeownership and depressing property values in these areas. The real estate industry, too, has used race to structure development in profitable ways throughout the Flint area's history, as happened with blockbusting tactics used to drive the flight of white Flint residents to the suburbs (Highsmith, 2015). Intersecting forces of racial liberalism, racial capitalism, and deindustrialization hollowed out and disinvested Flint (Pulido, 2016). By 2014, Flint's population was half of what it had been at its peak. The population at that time was 57% Black, and 42% of the population lived below the poverty line (US Census Bureau, 2014). The erosion of the city's tax base as people and industry left the city, the cost of maintaining infrastructures designed for a much larger population, and cuts in revenue sharing from the State of Michigan left the city in a precarious financial position (Fasenfest, 2017).

In 2011, the city was placed under 'emergency management' by the State of Michigan. Michigan's emergency management laws provide the State oversight over municipalities and school districts determined to be in fiscal distress, suspending normal democratic governance and appointing an emergency manager tasked with restructuring the city's finances and operations for greater fiscal stability (The Local Government Fiscal Responsibility Act, 1988). These emergency managers are tasked with imposing austerity conditions on cities in order to avoid or reduce the likelihood of municipal default. Because of the racialized nature of disinvestment in Michigan, emergency management has disproportionately affected majority-Black cities in the state. Between 2008 and 2013, 51% of Michigan's Black population was governed by an emergency manager for some period of time (Lee et al., 2016). The emergency management system was initially designed in the late 1980s to prevent financial 'bailouts' of majority-Black cities like Detroit by the State of Michigan. The emergency management system builds on an assumption that majority-Black cities' financial difficulties stem from irresponsible governance by local politicians rather than from structural disadvantage created by histories of racially discriminatory state and federal policy. Such an erasure of history presents the imposition of austerity measures on already impoverished populations as justified and forecloses the possibility of the redistribution of wealth from white communities to these cities as a fiscal solution (Heil, 2022).

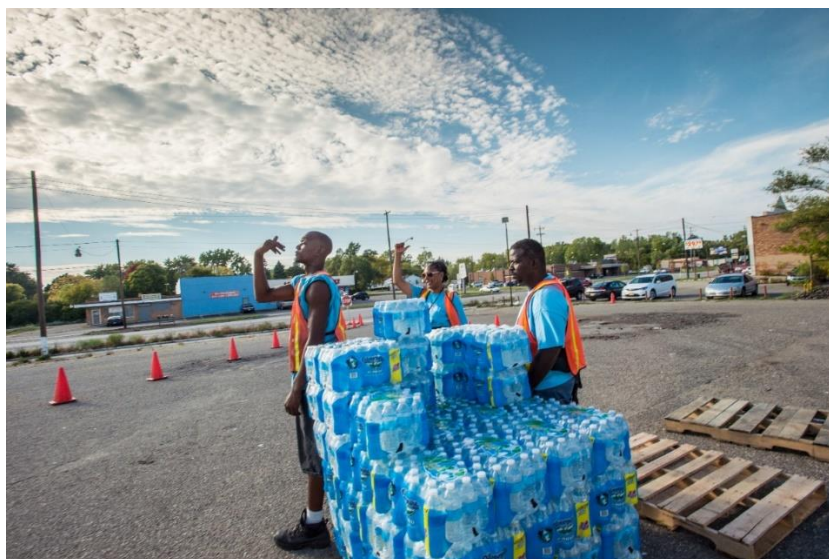
In Flint, the city's emergency manager Ed Kurtz oversaw the decision to switch the city's water source to the Flint River as a cost-saving measure while the city waited for the construction of a new pipeline that would support a new regional water authority (the Karegnondi Water Authority). It was anticipated that this new authority would offer Flint lower water rates in the future. Corrosion control was skipped to avoid the cost of investing in the required equipment, which would become defunct once the new pipeline was put in place, an action that was deemed acceptable by the Michigan Department of Environment Quality (Pauli, 2019). Risks were taken by the city's emergency managers in order to advance Flint's fiscal stability, placing the burden of these risks on the city's racialized and impoverished population, who lacked democratic oversight in these decisions.

The water crisis has required the creation of new social resources in Flint, such as expanded health care services, community education campaigns, and new emergency water infrastructure created to provide residents with safe water. This response has been coordinated by a group of area non-profits (collectively known as 'Flint Cares') led by the United Way of Flint and Genesee County with major funding support from the Mott Foundation and the Flint and Genesee County Community Foundation (Hanna-

Attisha, 2019). Flint's non-profit sector has played a leading role in creating and sustaining bottled water distribution programmes throughout the crisis.² The non-profit sector created initial bottled water distribution programmes in late 2015 as donations of bottled water began arriving in the city when the city's water quality became international news (Fonger, 2015; Johnson, 2015).

In January 2016, the State of Michigan declared a state of emergency in Flint. It began to contribute resources for the administration of bottled water distribution sites, mobilizing state police and the National Guard to support the operation of Point of Distribution Sites or PODS. Initially, five PODS were opened throughout the city, operating six days a week between noon and 6:00pm (with extended operations until 8:00pm on Tuesdays and Fridays). People would come to these sites, usually by car, to collect bottled water, filters, replacement filter cartridges, and water testing kits (Flint Cares, 2020). Under the terms of a lawsuit settlement brought against the City of Flint and State of Michigan (Concerned Pastors for Social Action vs. Khouri), the State agreed to operate the PODS until Flint's water tested below federal Lead and Copper Rule standards (15 parts per billion). Having reached that threshold, the State began closing the least trafficked PODS in August 2017 (Goodin-Smith, 2017). In August 2018, the State of Michigan closed the remaining PODS. While this action was in accordance with the requirements of the legal settlement, many Flint residents still had not regained confidence in the quality of water piped into their homes (Acosta, 2018).

Figure 1. Bottled water distribution site in Flint, Michigan on 5 October 2016. Photo by Lance Cheung. U.S. Department of Agriculture. [Public Domain](#).

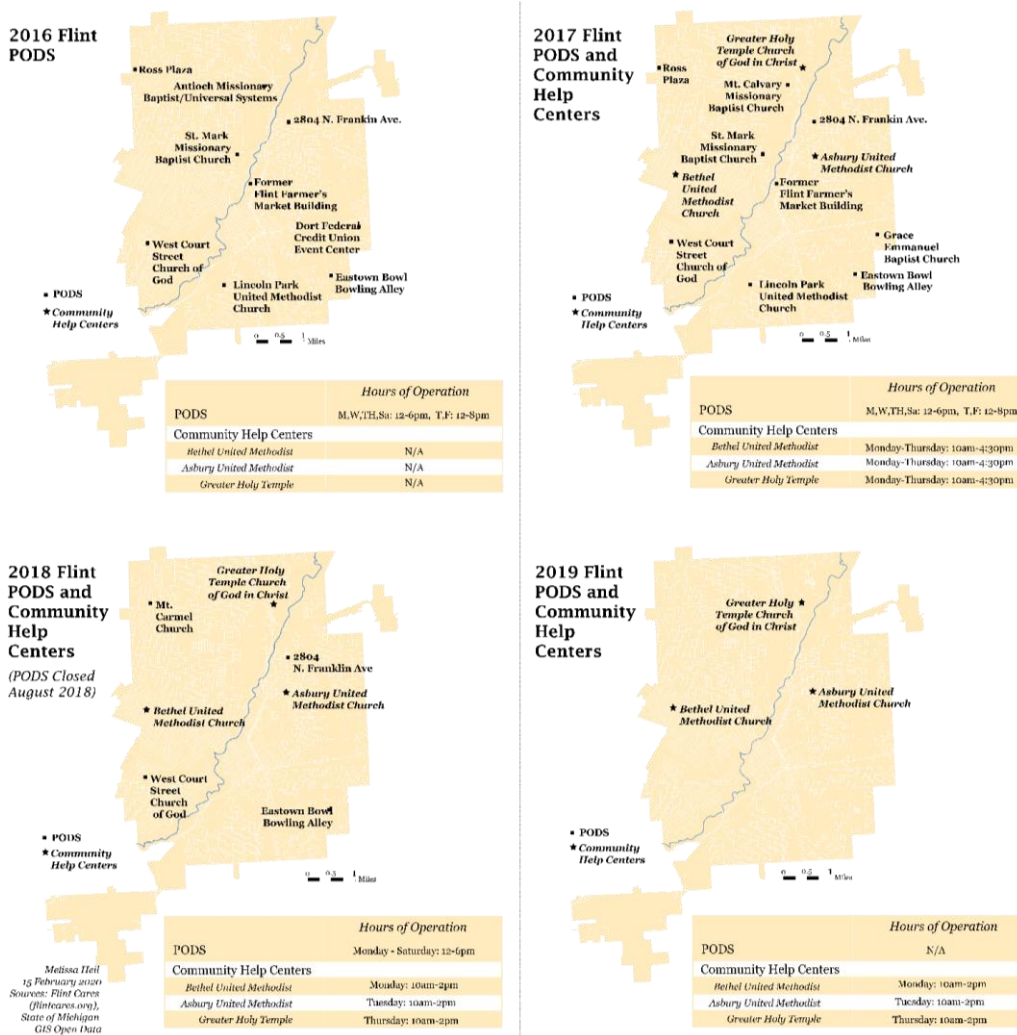


In addition to the PODS, Flint Cares created an additional resource, Community Help Centers, in 2017 to connect Flint residents with water and wrap-around health and social service programmes. These centers, designed by Flint Cares leaders as water distribution sites and social service hubs, operate out of three churches located in different parts of the city (Flint Cares, 2020). The sites have an indoor and an outdoor component. Outside, cars line up for blocks. They pull into the churches' parking lots where they can receive cases of water and food, some of which have been specifically selected to counteract

² Bottled water distribution programmes were coupled with distribution of water filters designed to be attached to faucets. Many Flint residents lack trust in the efficacy of water filters. Reasons for this include concerns over failing to use the filter properly (e.g., running hot water through a filter makes it ineffective), the filter's protection against biological contaminants like *Legionella*, and deep distrust of any water that flows through the city's pipes (Pauli, 2019 for more information; see Flint Cares, 2020).

the health effects of lead exposure. Inside, several social service agencies and city representatives are available to answer people’s questions about water quality and testing, health care opportunities, and general social service needs.³ Since the PODS were closed in 2018, Community Help Centers have been Flint’s primary resource for bottled water distribution. Several grassroots organisations also sporadically organize water distribution events for residents, with most operating similarly to the PODS.

Figure 2. Flint bottled water distribution sites between 2016 and 2019.



³ Community Help Centers operate based on donations from Nestle Water (branded as 'Ice Mountain') to the ire of many water activists. Nestle has been allowed to bottle groundwater from central Michigan extremely cheaply (drawing 130 million gallons of water a year at a rate of 400 gallons per minute for a one-time fee of \$5000 and \$200 annual renewal fee (Malewitz, 2019)). It has been condemned not only for extracting and commodifying a natural resource but also for damaging the local water system and its ecosystem (Agence France-Presse, 2018). As Nestle has come under scrutiny from environmental activists, it has widely touted its ongoing donations to Flint in a wide-reaching PR campaign that includes extensive television advertising in Michigan (Malewitz, 2019). Since the closure of the PODS, the Community Help Centers are the most robust bottled water distribution system in Flint (Nestle began donating 100,000 bottles a week in 2018, a much smaller amount of water when compared to early PODS operations in 2016, when the State of Michigan provided an estimated 1,560,000 bottles per week (Wang et al., 2019; City of Flint, 2020) but are riddled with contradictions found in corporate philanthropy; their apparent benevolence in helping people survive day-to-day is based upon a system of extraction that ultimately makes the same people less secure (Kohl-Arenas, 2015).

METHODS

This paper's analysis of the accessibility of Flint's emergency water infrastructure is based on a combination of interviews and participant observation conducted in Flint in 2019. Semi-structured interviews were conducted with non-profit, philanthropic, and resident community leaders involved in the creation and operation of Flint's bottled water distribution programmes, as well as the work of helping residents to navigate them. Interviewees were selected through a combination of purposive (e.g.; leaders of non-profit organisations providing water aid) and snowball sampling (i.e.; additional employees or community leaders suggested by interviewees). The interview protocol asked how their organisations had responded to the water crisis, the rationale for their approach, and their perspectives on the efficacy of the city's emergency water infrastructures. Interviews lasted between 30 minutes and two hours. To promote forthright responses, interviewees were granted confidentiality for themselves and their organisations. As such, interviewees' identities have been anonymized. Interviews were recorded and transcribed. In addition, participant observation was conducted at two bottled water distribution programmes in Flint. This participation enabled me to observe Flint's emergency infrastructures in action, seeing how people interacted with distribution sites and corroborating information shared with me in interviews. When the fieldwork was conducted in 2019, the PODS were already closed. As such, this research relies on interviews and news reporting from the period to assess their operations.

Table 1. Interviewee characteristics.

	Number of Interviewees
Non-profit Leaders (<i>Organisations Providing Water Aid</i>)	9
Philanthropic Leaders (<i>Organisations Funding Water Aid</i>)	3
Resident Community Leaders (<i>e.g.; Block Club Captains</i>)	4
Total	16

BARRIERS TO ACCESS

The following case study presents barriers to access in the operation of bottled water distribution programmes. As an organising framework for the case study, I use Young's (2021) categorization of the factors that affect water accessibility: physical factors, economic factors, cultural factors, and political factors. Within each category, I assess the 'mechanisms of access' in Flint's emergency water infrastructure, a concept borrowed from Ribot and Peluso's (2003) theory of access. This refers to the specific aspects of people's social and economic conditions that enable or disable their ability to benefit from resources – conditions such as their access to technology, access to capital, access to knowledge, and access to social identity.

Physical access

The first dimension to consider is physical access: whether users of Flint's emergency infrastructure can physically obtain water. Like water distribution systems in many places that lack piped household water, the bottled water distribution site model relies on site users' labour to move water from the distribution site to the household. The differential ability of Flint households to perform this labour shapes the sites' accessibility. Describing analogous infrastructural arrangements in the Global South (i.e.; places lacking piped household water), Geere and Cortobius (2017) explain how the labour of water-fetching makes water sites unevenly physically accessible:

When water is obtained by water-fetching, 'the availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems, and production' at the household level is dependent on the ability of household members to negotiate access to off-plot sources, carry sufficient quantities of water home and

safely store it... older adults, orphans, people living with long-term conditions, disability or facing social stigma may be less able to access and carry water, and therefore particularly vulnerable to household water insecurity.

The ability to transport water from the distribution site to a person's home is crucial for them to benefit from the emergency water system. Water is heavy and difficult for many people to carry. Cases of bottled water can weigh between 25 and 40 lbs (11 to 20 kg) depending on the number and size of bottles in the package. In 2017, a survey of Flint residents found that households used an average of 14.7 cases of water per week for a variety of daily tasks including cooking, brushing teeth, bathing, washing hands, and household cleaning (Flint Cares, 2018). Conservatively, bottled water distribution sites relied on Flint residents' ability to move at least 350 lbs (159 kg) of water each week. For many people, this water is heavy to lift into cars, difficult to carry for long distances while walking, awkward to transport on public transit, and hard to move from cars and porches into kitchens. Moving cases of water is more taxing for bodies of all abilities than merely turning on a faucet (for an excellent description of these physical burdens in the everyday lives of Flint women, see Radonic and Jacob, 2021).

PODS and Help Centers were designed around an assumption of automobility (Urry, 2004); that people would move these heavy loads by driving to water distribution sites and transporting the water in their cars. However, when the PODS were opened in 2016, 19.5% of Flint households did not have regular access to a vehicle (US Census Bureau, 2016). In interviews, Flint community leaders shared that people without a personal vehicle had difficulty using water distribution sites because the heavy cases of water were difficult to move onto and off of buses and to carry from bus stops to their houses. As one non-profit leader described it:

When the PODS opened up, it became easy for people with cars to go get water. If I didn't have a car, I would have had to walk to the POD and carry cases of water home. So, you would see people taking grocery carts from grocery stores, and then filling them up with cases of water, and walking down the street to get back to their houses. A lot of people, even though there was water available, did not have access to it.

Some people reported abandoning water on the street out of exhaustion because it was too heavy to transport from the bus stop to their home, like this neighbourhood leader who would get water for her neighbours in addition to her own family:

I didn't have transportation at the time. So, if I couldn't get a ride with somebody, I would take a wagon and walk there. Just to get the water, I would actually take the wagon, load it up and bring it back. And if I found out that my neighbours didn't have water, I'd make the trip three or four times. I tried to bring water home on the bus. And I would be so tired from volunteering getting water for my neighbours that I would leave it right where I got off because it couldn't get any further. I mean, I don't know how many cases of water I left right there at the bus stop and said to myself, 'well, hopefully, somebody can utilize this water'.

Ribot and Peluso (2003) identify access to technology as one of the 'mechanisms of access' that allow people to benefit from resources. Flint's emergency water infrastructure sites are far more accessible for people with access to automotive technology than those without. Given the expense of purchasing and maintaining ownership of a vehicle, the assumption of automobility likely creates higher burdens for low-income households. Moreover, within disproportionate class burdens, the burden of physical access is likely also racialized because a higher portion of Flint's Black and Hispanic/Latino populations lived at or below the poverty line in 2016 than the city's white population (50.37% of Hispanic/Latino, 45.33% of Black/African-American, and 35.24% of the non-Hispanic white population are estimated to have lived at or below the poverty line in 2016) (US Census Bureau, 2016).

Recognising that it was difficult for some Flint residents to travel to water distribution sites, a home delivery programme known as the Access and Functional Needs programme was created. This programme was only available for senior citizens and people with disabilities – only a portion of the Flint residents who may have had difficulty getting to the water distribution sites. When the State of Michigan

stopped operating the PODS, this programme was shut down as well. A coalition of faith-based and grassroots organisations took over providing water to the Access and Functional Needs population, delivering water now once a month rather than once a week (Weaver, 2017). Many of these people's water needs are also met by family and neighbour networks who will fetch water on their behalf. For this reason, one non-profit leader identified informal networks of neighbour-to-neighbour aid as a lynchpin in the functioning of the city's emergency infrastructure.

The water-delivery programmes help improve access to water for some populations, but physical access barriers remain. Home delivery programmes often leave water outside on a porch rather than placing it inside the house. Water distribution sites will load water into a vehicle, but there may be no one available to unload it. While now closer to a resident's home, those cases are still too heavy for many people to lift, including many older people and people with disabilities. This creates a 'last 10-foot' problem as some people struggle to get the water from their garage or porch to their kitchens and bathrooms where it will be used. As one community leader described:

There were so many houses where I know seniors live, where the water actually remained outdoors because they couldn't bring it in. The water was stacked on their porches, especially where there were wheelchair ramps. A lot of time, the water was stacked on the porches because they couldn't get it in the house. You know, it's easier to take a plastic bag, and pull out a few bottles and carry them in the house and to carry that whole case.

Bottled water left outside or in cars in the heat may not be healthy to drink due to potential BPA contamination from the plastic material used to create the bottle (Fan et al., 2014). So, while the water was physically close to residents, their inability to relocate it to a safe storage location compromised the water's safety. Flint Cares (2020) has offered guidance to residents on where to store their bottled water (i.e.; out of the heat and sun), but getting water to a suitable storage location is not always easy.

Flint's emergency bottled water distribution programmes have introduced a significant change in the mechanisms of access used to obtain water in the city. In the past, the city's plumbing system facilitated physical access to safe water in households and public places. The emergency infrastructure is based upon new mechanisms of access for physically obtaining water: a combination of different technologies (cars vs. pipes), labouring bodies with the capacity to carry water to where it will be used, and social networks (e.g.; family members, neighbours) or social service programmes for those who cannot perform the labour of moving water themselves. These changes in mechanisms of access mean that physically obtaining water is most challenging for people who are already disadvantaged, such as low-income households who cannot afford an automobile.

Economic access

For resources to be accessible, they must be affordable to people (Levesque et al., 2013; Young, 2021). While bottled water supplied at Flint's water distribution sites is free, there are indirect and opportunity costs associated with using the sites. Since the closure of the PODS in 2018, bottled water distribution at the Help Centers is only available three or four days a week, usually on weekdays in the middle of the day. It routinely takes two to four hours of waiting in line at these sites before water is received. As one non-profit leader described, "at those lines, sometimes people are there three hours in lines in their cars waiting to get a few cases of water". Distribution hours and wait times make bottled water inaccessible for many people who work traditional business hours or for whom waiting is unmanageable. As one community leader described it:

At the Help Centers, about 90% of the people in the cars waiting to get water are seniors. Do you know why that is? Because they're not working. I think they're getting it for their household because people our age are working, and we don't have time to spend two hours sitting in that line.

Wait times are long at water distribution sites. While waiting in line, households incur the costs of gas to keep their vehicles running during hot and cold weather. The expense of losing working time to collect water means that water distribution sites are primarily accessible for families with someone who is not working during these hours. Otherwise, it may be more cost-effective for families to purchase bottled water privately. Purchasing bottled water is a fixed expense that disproportionately places a financial burden on the working poor. Once again, the accessibility of bottled water distribution sites depends on households having the proper social networks – a connection to someone capable of spending several hours doing the labour of obtaining water. If that mechanism of access is not in place, the economic costs of purchasing bottled water are most burdensome for low-income households.

Culturally appropriate access

Water access is also shaped by the cultural appropriateness of the water distribution infrastructure (Young, 2021). Cultural considerations can influence which populations feel comfortable and safe in the process of accessing water infrastructures. They can also shape who has knowledge about the existence of services that could meet their needs. As Ribot and Peluso (2003) identified, knowledge is one of the mechanisms of access that influence whether people can derive benefits from a resource. As the water crisis began in Flint, communicating educational information about the city's water quality as well as information about where and when bottled water was being distributed was a critical first step in facilitating people's access to safe water. While information spread quickly over social media, this was not accessible for people with limited digital literacy. In 2015, only 73.3% of people had a computer (including a smartphone or tablet), and only 56.2% of households had an internet subscription, according to American Community Survey estimates (US Census Bureau, 2015). The local newspaper, *The Flint Journal*, had closed before the water crisis. To address the gap, Flint Cares's communications committee helped develop a new community-based print publication to share information about the water crisis. One non-profit leader explained how the community paper helped to grow knowledge of water distribution sites and other crisis-related services:

So many of us get our information on social media. On the [television] news, they'll give you a quick blurb about something and say, "for more information, go to our website". We have a huge population of older people and even baby boomers that just don't use the internet for anything. So, if you can't give it to them in print or on TV, then they're missing it. We really don't have a newspaper anymore. They're the reason we have a community newspaper now, to help fill that gap.

Additionally, there were delays in news of the water crisis reaching non-English speaking populations – particularly Spanish speakers and Deaf community members who primarily communicate in American Sign Language (Flint is home to the Michigan School for the Deaf, which has operated there since 1854). Information about emergency water infrastructures, shared through media or community meetings, was not always translated or interpreted for non-English communicators. Delays in developing communications about the city's water response in languages other than English meant that portions of Flint's population struggled to obtain knowledge of the resources available to them. Portions of the Deaf community in Flint, for example, were unaware of the crisis months after State and non-profit leaders had begun the emergency response. Keeping up to date on changing information about the emergency infrastructure is difficult as well. As one leader from the Deaf community described:

The Michigan School for the Deaf has been here for 150 years, but people still don't know how to work with Deaf people. Like, for example, the mayor makes announcements and there's an interpreter there, but the newscasts typically don't cover the interpreter, they'll just swing over and then back to the mayor, so the interpreter's information is lost.

The response to the crisis was initially led by a network of non-profit organisations that did not primarily serve non-English speaking populations. One non-profit leader described how, upon reflection, there had been perspectives overlooked in the planning process:

Everyone involved in planning the response brought multiple perspectives, but we didn't reach out very well to [all of the] community groups because, you know, everybody was trying to move in this extremely emergent and really intense crisis. What we didn't do is spend a whole lot of time saying, "this group traditionally has been excluded from things. How do we include them in this effort?"

The marginal position of non-English speakers in Flint's non-profit sector became transferred into the realm of water access when the communication needs of these communities were overlooked in the initial emergency response.

Political access

The final dimension of water accessibility in Young's (2021) framework, political access, refers to the ways government actions and regulations shape access to water. Early in the emergency response in Flint, police and National Guard members ran water distribution sites. As part of the process for receiving water, police and military personnel asked residents for identification as evidence of residency in Flint, checking their eligibility to receive water. Asking for identification presents a barrier to undocumented people and low-income people who may lack official identification documents (Sanders et al., 2020). Undocumented households feared that by using the site, they would become more visible to state agencies, potentially revealing their immigration status. One non-profit leader described the harm of identification checks for the undocumented population early in water distribution sites in Flint:

At the beginning, the National Guard and state police were asking for IDs, so that automatically excluded the undocumented population. Now, that's not a huge component of the Flint population. But it's enough. So anyway, the governor then changed his thing to say, we're not going to require ID, we're just going to ask for it. To which I responded if the police ask you for your ID, is anyone really going to feel like you can say no? So, by that time, everyone knows undocumented people are not going to these sites.

Additionally, reports spread through the city that police checked the IDs supplied at water distribution sites for outstanding warrants, arresting people as they sought water. As one Flint social service official described it:

The police began running the distribution. And they began running people's licenses and arresting them on-site for outstanding warrants. So, people were being picked up. People began to be afraid to go to the water distribution, especially if you were someone who would be more likely to face discrimination: if you were LGBT, if you are undocumented, if you were an injecting drug user, if you were experiencing homelessness... There just were so many gaps and holes in your ability to just access clean water without being criminalized, punished, or made to feel like you somehow had to justify why you needed it.

As stated above, many populations in the city were wary of unwanted police attention at distribution sites. One non-profit leader described police presence at the distribution site and identification check process as making the sites "places that were quite dangerous for vulnerable populations". As a result, some community leaders organized smaller, 'no questions asked' distribution sites at local community organisations using private donations of bottled water. By placing this moment of state surveillance into water distribution site operations, the criminal justice and immigration systems were integrated into the geography of water access. As police asked for identification in order to use the site, the performance of documented, un-criminalized citizenship became a functional prerequisite for accessing water.

The practice of checking IDs has been suspended. Help Centers and other grassroots water distribution programmes do not ask for identification. They operate under the assumption that individuals who seek

water need it, regardless of their ability to produce documentation of Flint residency. In the words of one such aid organizer:

[We don't ask for I.D.] because we feel that if you're going to come to a water distribution and wait for upwards of an hour to get water that you probably need it. And it would have also just added another step to the distribution that makes it take longer.

Not requiring people to show their I.D.s makes water distribution sites more widely accessible and speeds site operations.

DISCUSSION

Building and sustaining Flint's emergency water infrastructure has been a remarkable achievement made possible by the tireless efforts of Flint residents and community leaders. But like the piped infrastructure that preceded it, Flint's emergency response infrastructure is also a precarious achievement, one whose accessibility has points of breakdown and, as such, has not always met the water needs of all Flint residents. Bottled water distribution programmes integrate new aspects of a community's social, political, economic, and infrastructural landscape into systems of water provisioning. In the case of Flint, social service agencies, houses of worship, transportation infrastructure, media, police, the National Guard, and peoples' daily time-space activities were all integrated into the city's new emergency water infrastructure. Each of these systems, spaces, and institutions is characterized by its own forms of socio-spatial inequality, which then became integrated into the city's water provisioning system. While Flint's water access was not necessarily equitable before the crisis (along dimensions of affordability, quality) (Food and Water Watch, 2018; Hanna-Attisha, 2019), the post-breakdown waterscape was one of deepened inequality because of the ways emergency water systems incorporated the socio-spatial inequalities of other spheres. The uneven accessibility of water distribution programmes contributed to an unequally experienced environmental and public health crisis in Flint.

These findings add to the scholarly literature on barriers to water access in the Global North. This literature has focused on barriers to access in the normal operations of water infrastructures, such as affordability barriers (Mack and Wrase, 2017), quality barriers (Pell and Schneyer, 2016), or gaps in infrastructural coverage (Deitz and Meehan, 2019; Meehan, Jurjevich, et al., 2020). By adding an assessment of emergency infrastructures, this research uncovers new barriers to access that emerge under crisis conditions. These barriers to access share much in common with barriers identified in the literature on water accessibility in the Global South. The importance of social networks in accessing water (Sultana, 2011; Bukachi et al., 2021), contending with the physical weight of water (Geere and Cortobius, 2017), and the economic costs of time spent on water-fetching (Hutton et al., 2007), have all been widely studied in a variety of Global South contexts. This points to the need to further break down North-South divides in scholarship and policymaking and to think relationally across different geographic contexts in the effort to better meet people's water needs.

To support more equitable emergency responses to water infrastructure breakdown, planning guidance should incorporate a notion of accessibility that centres upon people's ability to benefit from the resources being developed. The Environmental Protection Agency's current advice – defining accessibility only in terms of site location and centrality – is insufficient to ensure equitable infrastructures. The guidance fails to consider a range of other physical, economic, socio-cultural, and political factors that shape people's ability to access water from these sites. A more comprehensive understanding of accessibility is needed to plan water distribution programmes that are truly accessible to all community members during water quality emergencies.

Models for such planning advice already exist. For example, the Sphere Project, a non-governmental organisation that develops standards to guide humanitarian responses to disasters, identifies several social, economic, and physical factors to consider when creating emergency water infrastructures. These

include standards for maximum wait time (no more than 30 minutes), maximum distance to water points (500 metres), and adaptation of sites to suit different needs in a community on the basis of gender, HIV status, disability, and age (The Sphere Project, 2011, 2018). The 2011 edition of the *Humanitarian Charter and Minimum Standards in Humanitarian Response: The Sphere Handbook* from the Sphere Project advises emergency responders that only considering the availability of water is insufficient, stating:

Access and equity: Even if a sufficient quantity of water is available to meet minimum needs, additional measures are needed to ensure equitable access for all groups. Water points should be located in areas that are accessible to all, regardless of, for example, gender or ethnicity.

The Sphere Project's standards for humanitarian response engage a more robust, multi-faceted notion of accessibility than EPA guidance. In order for bottled water distribution programmes in the United States to become more equitable, they should incorporate a similar notion of access that prompts emergency response planners to identify physical, social, economic, and political factors that may present barriers to water access for marginalized community members during moments of infrastructural failure.

The case of Flint suggests that in order to do so, emergency preparedness protocols need to incorporate not just principles of distributive justice (e.g.; standards that consider physical, economic, cultural, and political dimensions of access to ensure emergency infrastructures are accessible to all), but principles of procedural justice as well. Without meaningful participation of marginalized populations in the planning and oversight of emergency water infrastructures, barriers to access are likely to be overlooked in emergency plans. As was noted earlier in this article, the lack of participation from Flint's Spanish-speaking and Deaf communities in the emergency response greatly delayed those communities' ability to benefit from the emergency infrastructure. Gerlak et al. (2022) recently observed that water justice cannot be accomplished without reconfiguration of:

participation in decision making and recognition of cultural identities, rights and practices. Water injustice is about more than distribution; it is also about the knowledge, meanings and discourses that shape water control and management.

Without such attentiveness to the dynamics of power and marginalization, emergency water infrastructures may not only reproduce, but also deepen communities' pre-existing inequalities.

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