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Impact Assessment of the Washington D.C. and Flint, Michigan Water Crises

Waruni G. K Senanayake

Western University, wseanay@uwo.ca

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Introduction

The primary technical factor behind the Washington D.C. water crisis (2001-2004) was the transition of disinfectants in November 2000, mandated by the disinfected byproduct rule [1,2]. This switch involved moving from free chlorine to chloramine with the goal of reducing disinfection byproduct levels, especially trihalomethanes (THMs). It's important to note that this change was not driven by cost-saving motives, unlike the situation observed in the Flint, Michigan crisis (2014-2016). In Flint, the decision to switch the water source from Lake Huron, where water was treated with orthophosphate for corrosion control, to the Flint River in April 2014 was solely driven by cost-cutting considerations [3, 4,10].

Impact Assessment: stakeholders

These two crises had far-reaching effects on various aspects of society, economy, health, and the environment. The decision made by officials had a direct and substantial influence on the elevated Pb levels in drinking water, leading to increased exposure of the community to hazardous Pb levels.

Washington D.C. Stakeholder (community)

The high Pb levels (only documented evidence: Pb level > 300 ppm in 157 houses and Pb level > 15 ppm in more than 1,000 houses) were discovered in drinking water tests in the Washington D.C. crisis [2]. Approximately 42,000 children were exposed. In addition, there was a notable rise in miscarriage cases (2,000 instances) and fetal mortality rates (200 fetal deaths) recorded [5]. Consequently, the Water and Sewer Authority (WASA) in Washington's city recommended the practice of running taps for 30 seconds to one minute before using the water for drinking or cooking. Notably, while this measure aimed to mitigate lead (Pb) exposure, it often resulted in the unintended consequence of community members having to discard drinking water to safeguard against Pb contamination [6]. Additionally, it recommended that community members consider buying bottled water and investing in a home water treatment device.

The officials granted free blood tests exclusively for children below the age of 6 [6]. However, the district did not provide a screening program for adults or children aged 6 and above. Reportedly, individuals were required to invest \$100 in having their water tested by an independent company [6]. WASA is only responsible for the management of pipes within the public areas. In contrast, the section of the pipe that extended through private property and served a residence falls under the responsibility of the homeowner. As a result, property owners face the decision of whether to replace these pipes, a choice that could incur significant costs, potentially amounting to several thousand dollars (estimated approximately \$3,000) as indicated by WASA officials [6, 7].

Washington D.C. Stakeholder (government/ officials)

Also, The Environmental Protection Agency (EPA) distributed more than 30,000 water filters to concerned residents [7, 8]. According to environmental engineer Marc Edwards from Virginia Tech, the magnitude of the issue in Washington D.C. was approximately 20 to 30 times greater than that in Flint, Michigan [7]. In the district, there are a total of 130,000 water service lines serving residential customers. Of this number, approximately 23,000 are composed of Pb, with the remaining lines constructed from

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copper, according to officials. These Pb pipes are distributed across the city [6]. By 2010, the D.C. water utility has promised to replace all 23,000 Pb service lines on public property, committing \$300 million to this endeavor [8]. As well, under the guidance of the EPA, the district allocated \$97 million for the replacement of 17,000 service lines [9]. In addition to that, the Washington Aqueduct integrated orthophosphate into the city's water treatment process, resulting in the oxidation of Pb. Public education efforts were introduced to increase awareness of the public.

Flint Michigan Stakeholder (community)

Lack of awareness regarding the factors behind the Washington D.C. crisis played a role in the unfolding of the Flint water crisis. About 8,000 children in Flint, Michigan, may have been affected by Pb-contaminated water during the crisis [11]. A straightforward calculation suggested that the enduring societal expenses attributable to Flint's Pb-poisoned water could reach approximately \$400 million. This amount greatly exceeds the supposed \$5 million in savings Flint had hoped to achieve by switching to the Flint River from Lake Huron [11].

Besides, several consequences were generated due to the Pb poisoning, such as reduced lifetime earnings, lower educational attainment, higher health costs and increased crime by not taking action to reduce children's blood Pb levels to less than 10 µg/L. Peter Muenning, an associate professor of public health at Columbia University, has mentioned that these social costs could be quantified as a loss of \$50,000 per Pb-affected child [11]. The water contamination crisis in Flint inflicted undeniable harm on residents' reproductive health. An analysis of health records spanning from 2008 to 2015 revealed alarming statistics: fertility rates in Flint decreased by 12%, and fetal death surged by 58% following the switch to the Flint River as the water source in 2014 [12]. Furthermore, babies born during the crisis exhibited lower birth weights. Lead exposure also heightened the risk of hypertension among pregnant women, potentially impacting their decisions regarding breastfeeding. Additionally, the health repercussions of lead exposure in Flint's children elevated the likelihood of impaired cognitive function, behavioral disorders, hearing impairments, and delayed puberty [12]. Due to limited access to affordable, high-quality healthcare, including reproductive healthcare, many black women, and women with lower incomes in Flint continue to face significant barriers in obtaining the essential care they require [12].

Besides the federal funding allocated to address the water crisis, Flint also received financial support from the state, as detailed in the Flint Water 2020 [13]. Consequently, Flint residents received free bottled water under the State's funding program [13]. Furthermore, water filters and replacement filters were granted. Also, the Flint community was offered free water testing kits with the state funding program to ensure that water was safe. It is evident from Debaere's 2019 findings that the housing market in Flint was severely affected by the dropping of the local house value due to the Flint water crisis [13]. The crisis harmed small businesses economically. As a result, small businesses in Flint sought assistance from the Small Business Administration [13]. Furthermore, the decision by the state-appointed emergency manager to switch Flint's water source from the Detroit system had a substantial impact on local companies. For example, the General Motors plant ceased the usage of tap water due to corrosion in steel components [14].

Flint Michigan Stakeholder (government/ officials)

The Flint water crisis caused financial problems at different levels of government, from the national (Environmental Protection Agency/EPA 2020) to the local. It cost the federal and state governments millions in aid and settlement funds. The city of Flint received \$100 million from EPA to improve the drinking water quality for the Flint residents. Besides, The City of Flint was offered state financing, and the state had to use this funding to improve water quality, provide alternatives for the Pb-contaminated water, and replace the unsafe pipes which caused the unhealthy water [14]. Following a successful legal battle, the overseeing judge granted an approximate budget of \$626 million to address and rectify the Flint crisis. Around 80% of the settlement was funded to the children (especially those aged 17 and below) because they are the most adversely affected by the Flint crisis. A substantial segment of this 80% provided support and care of children 6 and under, given the health risks associated with Pb exposure in this age group [14, 15]. Ultimately, the Flint water crisis incident was recognized as the most substantial settlement ever recorded in the state's history [15].

Societal Impact Assessment

According to the United Nations, all individuals should inherit the right to life and protection of health regardless of their race, nationality, gender, religion, ethnic background, language, or any other defining characteristics [16]. In both cases, authorities violated the human rights of the right to life as the authority did not effectively communicate with the public and failed to adequately convey the urgency of the situation [2]. Thus, this situation damaged the public trust in the local drinking water supply.

The Flint community organized a national one-mile march to protest for clean water, putting significant pressure on the government in the Flint case and complaining about the water contamination with a foul odor and dark color [17]. Due to an increase in *E. coli* and total coliform bacteria in drinking water, the chlorine level was raised by Michigan's Department of Environmental Quality (MDEQ). Because of the high Cl concentration, the total trihalomethane (TTHM) concentration increased since chlorine interacted with organic matter in the water [17]. Thus, Flint was found to be in violation of the Safe Drinking Water Act due to the presence of a high level of TTHM [16]. A higher risk of developing cancer is associated with the presence of TTHM, a known carcinogenic [17]. Also, children who were younger than two years old during both crises are now experiencing significant health issues due to Pb exposure. These problems include cardiovascular and reproductive issues, neurological damage, cognitive decline and developmental challenges affecting both their mental and physical well-being [1, 19]. Poor decision-making by officials has placed pregnant women in Flint and Washington, D.C., in danger. For example, Pb exposure caused damage or death to the developing fetus and decreased fertility in the community [5,19]. According to the reproductive justice framework, officials disobeyed the rules of the right to have a child, not to have a child, and to raise children in a safe and healthy environment [20]. The federal Center for Disease Control and Prevention (CDC) declared unprecedented Legionnaires' disease spread in Flint because of a stable bacterial colony due to inadequately treated water [19]. According to a recent study, approximately 80% of 174 children from Flint who were exposed to lead now face intellectual disorders, necessitating extra educational support [19].

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Cost/Benefit Analysis

Two water crises; Washington D.C. and Flint, incurred significant financial costs for the cities of Washington D.C. and Flint, and the United States of America, amounting to millions of dollars.

	Washington D.C	Flint, Michigan
Direct Cost	<p>\$300 (D.C. water quality) [8] and \$97 million (District spent under the EPA guidance) [9] for replacing Pb service lines on public property</p> <p>Addition of orthophosphate (no exact cost was recorded)</p>	<p>According to the federal emergency declaration: \$623 [5, 15] million were allocated for relief (bottled water, Pb filters, water bill credits, water testing, health care, nutrients, and education)</p> <p>\$100 million [13] from EPA to improve the drinking water quality.</p> <p>The water crisis incurred costs of over 350 million dollars for the state of Michigan [13].</p> <p>The Governor of Michigan spent the bill of \$9.35 million to reconnect Flint to the Detroit Water and Sewage Department [21]</p> <p>Tripling of orthophosphate dose (no exact cost was recorded)</p>
Indirect cost	<p>Public education, free lead filters, blood tests [5]: costs unknown. Replacing Pb service lines on private property by house owner (> \$3000), cost of blood tests for adults and children aged 6 or above: not directly mentioned. The blood tests for children below 6 were free.</p>	<p>Flint homeowners had to spend for home improvements e.g., water heaters and new service line connections</p>

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Conclusion

The water crises in Washington D.C. and Flint, Michigan, had significant societal, economic, and environmental impacts because of legislative and policy neglect. Poor decisions by officials led to violations of human rights, and many residents were exposed to Pb. Without corrosion mitigation practises, societal and economical issues emerged, and to solve those issues, the cost of relief was high. Therefore, it is essential to follow corrosion mitigation measures to save money.

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