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Policy Implementation on the Flint Water Crisis

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Flint Michigan Water Crisis: A Policy Brief

Proposing integrated methods helpful for managing water crisis.

Introduction

The world is made up of 75% water and it may seem unbelievable that water scarcity still exists. It's one thing to have access to water, but having access to clean water is a major problem not only in developing countries around the world, but in developed countries such as the United States. That's right! The U.S. which is considered one of the best developed countries worldwide, is facing a crucial water crisis that's affecting millions of people. In 2014, The Flint Michigan Water Crisis became a public health crisis that shocked the nation. Residents and civilians in Flint were experiencing a change in their water quality that led to numerous health effects and even deaths. This issue led people to question the safety and well-being of fellow Americans. The problem began in April of 2014 when the city switched its water supply from the Detroit Water and Sewerage Department to Karegnondi Water Authority, but decided in the meantime to use Flint River as an alternative option to start flowing water throughout the city. Almost immediately, residents of Flint started complaining about the quality of the water. By that time, many pipes had sustained major corrosion and it became easy for lead to leach into the water. A major health problem that arose from this crisis was high lead levels in women and children, which can lead to learning disabilities, behavioral problems and stunt growth. With this paper I will be conducting a research analysis of the Flint Michigan Water crisis. At the end, I will construct a guide for the city of Flint (which includes the city's emergency managers, the Michigan Department of Environmental Quality, and the Environmental Protection Agency), with recommended solutions to mitigate the crisis and prevent other crisis from happening as well. These suggestion can be used towards implementing future policies. This paper will understand the pre-existing causes and history of the crisis, analyze data such as lead testing sampled from Flint River, evaluate the short and long term effects of health hazards on children and families, highlight progress made by the state and city on behalf of those affected, and formulate ways to produce positive outcomes for a majority of the population. These solutions may not fix the crisis, but they could be used to slow down the effects it's having on people. Studying this particular issue is important because it will shed light on the mismanagement and lack of urgency taken to fix the water contamination issue in Flint before it became a huge crisis that affected millions of people.

Photo: Ryana Garza, Detroit Free Press

Background

What is happening and Why?

The Flint Michigan water crisis has been an ongoing battle for the past 5 years now. Researchers have shown that the problem started when the city switched its water supply from the Detroit Water and Sewerage Department to Karegnondi Water Authority in April of 2014. The objective was to save money, which city officials projected would save the region $200 million over 25 years, according to City Council meeting minutes, but now it seems that the city will be spending over millions of dollars to replace and restore damages done to the pipes and continuously supply clean water to its residents through water filters or bottle services. As the issues of lead poisoning and child mortality arose, case workers and researchers took some time to understand the issue at hand and how it all started.

The current water crisis in Flint, Michigan did not start with the water supply switch in April of 2014. In fact, Flint has been dealing with water supply issues since the 60's, and the outbreak of the 2014 crisis was just the climax of it all. The issue of saving money via the switch in the water supply has also been a developing change in Flint's history as well. Michigan, especially Flint, was a destination for African-American migrants from the South. It's population started exploding as people started coming to General Motors plants and this really brought about a start in the crisis. Why?

Well, as more black people migrated to

Photography by Scott Atkinson

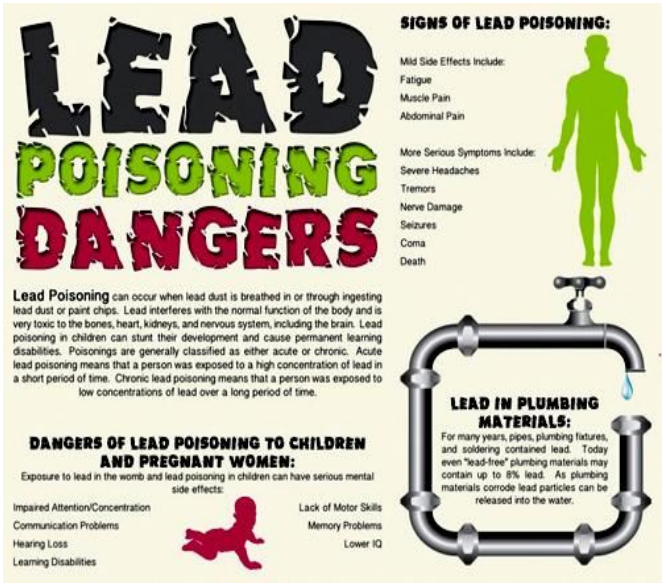
Michigan the more diverse it was coming and with desegregation laws that broke down the system, Flint's population started to decline, as a lot of these white middle-class and upper-class folks left. This led to a decline in the total population in Flint, but an increase in their infrastructure. So fewer and poorer people were expected to pay to support a water system meant to service twice the number of Flint's population at that time, which consisted of residents and industrial plants as well, and with Flint being a majority-black city where 40 percent of people live in poverty, leads researchers to understand how the crisis began to form. The pipes were built with large circumferences to support all the water that they needed. So this directly relates to how unaffordable the water was for residents. It directly relates to how this infrastructure was disintegrating, and it also meant that the folks who lived in areas where there was a lot of vacancy had water that was much riskier to drink because the water sits for a longer period of time, so pipes that go over stretches of vacant land has more time to absorb the corroding lead and iron and other contaminants from the pipes.

So now fastforwarding to 2014, we can see that Flint's been dealing with the issue of corrosion and infected pipes for many years now and it took the water crisis of 2014 to bring the problem to light. This leads to many unanswered questions and various solutions to this crisis. Like if Flint's had less vacancy at the time, would the issue of stagnant water still exist? Or is lead poisoning, birth defects, learning disabilities etc. and any other health issues that resulted from the water crisis, issues that started in the past, but is now showing its effects? These are questions the my researches has projected solutions too and answers that could put this crisis into perspective.

Some may ask why is it so important to study this crisis as a whole? Well, if we look at the history and previous events leading up to the crisis, we can better understand what went wrong in the city's maintenance of the water distribution system. It is important to shed light on the mismanagement and lack of urgency taken to fix the water contamination issue in Flint. Some, if not, most of these problems that resulted from the crisis was due to lack of care on the city's part in protecting and ensuring clean and safe water for its residents. Residents, especially children, are experiencing life-threatening health issues that resulted from the crisis. Throughout the rest of the paper, I examine the effect of lead on a sample number of population and generally show how lead has contributed to health factors such as low fertility rate, increased Blood levels in children and high fetal death rates.

Key Points

- Flint water crisis was the result of lead leaching into Flint river.
- Lead is a heavy metal with toxin which can causes severe health problems and death at high levels of exposure.
- Lead is particularly dangerous to children because their growing bodies absorb more lead than adults do and their brains and nervous systems are more sensitive to the damaging effects of lead.
- Humans have been exposed to lead for hundred of years, however there is no safe level of lead that is good for the body, regardless of the limits and regulations set by various health departments.



Source: Global GPN

Total trihalomethane (TTHM) concentrations in the Flint distribution system

The elevated levels of lead found in the drinking water of residences in Flint have had a profound effect on the level of trust within the community and the state, the economy of the region, and the health and well-being of the residents of Flint and the surrounding communities. The analysis of TTHM in the Flint distribution system is based on an extensive review of the monthly operating reports (MORs) and other reported documents from the water treatment facilities, and from personal communications with plant operators and managers.Starting in summer 2014, a number of violations occurred. *Escherichia coli (E. coli)* and total coliform violations resulted in the issuance of three boil-water alerts within a 22-day period during summer 2014.. As shown in Table 1, total trihalomethane (TTHM) concentrations at several sampling locations exceeded the 80 µg/L regulatory limit, set by Michigan Department of Environmental Quality (MDEQ), during May and August 2014. What this indicates is that TTHM- which is an environmental pollutant that is considered cancerogenic- has become a major chemical compound found in Flint river that has contributed to some of the health effects such as E.coli. Between May and August of 2014, the various locations sampled show high volumes of TTHM found in those specific areas and that is when residents of Flint started experiencing color change to their water supply. With the multiple boil advisories put into place after August 2014, the table shows that TTHM has lowered in counts, but still significantly high enough to spark health issues. Boil advisories played a significant role in keeping TTHM levels at a low count.

TABLE 1

Location	TTHM concentration *µg/L*			
	May 21, 2014	**Aug. 21, 2014**	**Nov. 21, 2014**	**Aug. 18, 2015**
1	162.4	145.3	58.6	67.9
2	75.1	112	36.2	53.6
3	111.6	127.2	33.3	60.2
4	79.2	181.3	33.9	72.0
5	106.4	196.2	93.6	93.5
6	82.2	112.4	50.1	65.9
7	88.2	144.4	53.6	69.4
8	96.5	118.3	41.1	54.9

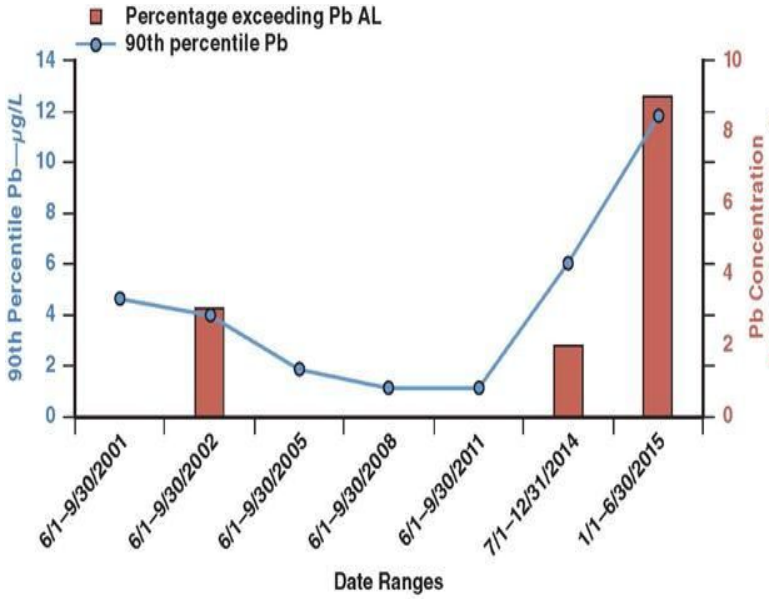
Source: U.S. National Library of Medicine

Evaluating Water Lead Levels During the Flint Water Crisis.

Lead in Flint's Residents Homes

To minimize water lead exposure, the U.S. Environmental Protection Agency (USEPA) Lead and Copper Rule (LCR) requires that water utilities monitor water lead levels (WLLs) throughout the system at residents' taps and implement optimized corrosion control treatment. No more than 10% of first draw samples from high-risk homes may exceed the lead action level of 15 µg/L.Specifically, the LCR high-risk sampling approach requires utilities to collect at least 50% of samples from homes with lead service lines (LSLs) or from every home with a LSL if there are not enough to satisfy 50% of the sampling pool. The Flint River was a more corrosive and unstable water source, which did not have either optimized corrosion control or added orthophosphate corrosion inhibitors. In addition, to address a disinfection byproduct violation, the water operators switched from sulfate-based to chloride-based coagulants.

In this analysis, The city was required by the LCR to conduct sampling for lead and copper in certain areas in Flint.The first round of sampling revealed that the 90th percentile lead concentration was greater than that observed during the previous five rounds of testing by the end of the second six-month sampling period, the 90th percentile lead level was almost three times greater than that observed in the previous 15 years



Sampling and analyses were required for compliance with the Lead and Copper Rule.

AL—action level, Pb—lead

Source: U.S. National Library of Medicine

After much publicity regarding the lead problem, on Oct. 16, 2015, the source water for the City of Flint was switched back to treated Lake Huron water supplied by DWSD, with approximately 1 mg/L phosphorus to inhibit corrosion. Because the lead levels measured in the water remained high in some houses, on Dec. 9, 2015, the concentration of the phosphate corrosion inhibitor was increased by adding an additional ~2.5 mg/L phosphoric acid (P).

The Virginia Tech Flint Water Study

The Virginia Tech Flint Water Study Team started an independent water lead investigation in August 2015. Preliminary results of this random sampling indicated a serious system-wide lead contamination event–the elevated WLLs were

subsequently linked to an increased incidence of children with elevated BLLs

Table 1. Water Quality Results for August 2015 Sampling (n = 268)[a]

	Pb (µg/L)			Fe (mg/L)			PO_4^{3-} as P (mg/L)		
water quality statistics	**FD**	**1MF**	**3MF**	**FD**	**1MF**	**3MF**	**FD**	**1MF**	**3MF**
above reporting level[b]	85	59	47	100	99	98	99	99	96
median	3.5	1.4	<	0.12	0.10	0.10	0.09	0.08	0.07
90th percentile	26.8	11.3	6.6	0.42	0.27	0.25	0.20	0.14	0.12
percent exceeding[c]	17	6	4	14	8	6			
max	158.0	1,051.0	94.5	9.20	2.32	1.63	2.67	0.73	0.49

Source City of Flint. *Annual Water Quality Report*. **2015**.

FD = first draw; 1MF = 1 min flush; 3MF = 3 min flush.
Minimum Reporting Level (MRL): Lead (Pb) = 1 µg/L; iron (Fe) = 0.01 mg/L; phosphate (PO_4^{3-})= 0.03 mg/L as PO_4^{3-}-P.
Pb: USEPA action level of 15 µg/L; Fe: USEPA secondary maximum contaminant level of 0.3 mg/L;PO_4^{3-}: there is no USEPA drinking water threshold

Each water lead kit prepared at Virginia Tech included sampling instructions and three sampling bottles. In addition, a demonstration video of the sampling protocol was made available. After a minimum of 6+ hours of stagnation, residents were instructed to choose one drinking water tap (e.g., kitchen or bathroom faucet) to (1) collect 1 L of cold water at a normal flow (first draw sample); (2) flush the sample tap for 45 s and collect a 500 mL sample (1 min flush sample); and (3) flush the sample tap for an additional 2 min and collect a 125 mL sample (3 min flush sample). *

The water lead results from the survey of 268 homes in the first round of citizen led sampling (August 2015) indicated that there was a system-wide water contamination problem with lead being the driving factor. Specifically, the 90th percentile WLL from this survey was 26.8 µg/L, which was nearly two times the lead action level of 15 µg/L.

What can be concluded from this testing is that Flushing the tap water for several minutes reduced WLLs. The 90th percentile for 1 min flush samples was 11.3 µg/L, but 59% of samples still had reportable lead. This trend continued with additional flushing, as the 90th percentile for 3 min flush samples was 6.6 µg/L and 47% contained reportable lead. Overall, flushing reduced WLLs in most Flint homes, but there were still heath concerns about sustained low-to-moderate WLLs and spikes in water lead above the action level. Orthophosphate and chlorine added to water helps improve the water quality and reduce lead and bacteria. Research shows that flushing and adding anti-corrosive inhibitors such as phosphate helps reduces WLL which leads to reduce blood levels in children.

The Effect of Lead on Fertility and Birth Outcomes

There is overwhelming evidence that lead in water contributes to high rates of childbirth defects, low fertility rates and increased fetal deaths.

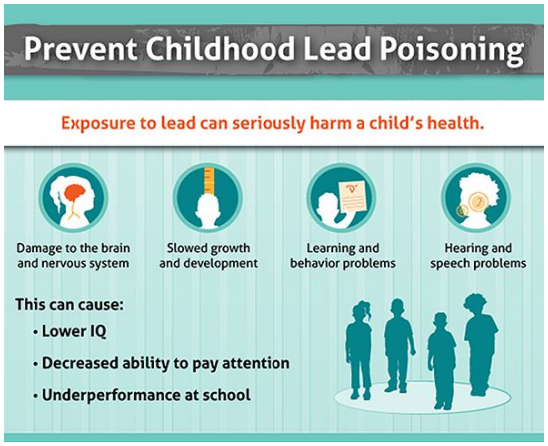
Table 2: Lead in Water on General fertility / Fetal Death Rates *(Source* Department of Economics, University of Kansas)

	Non-Flint	Non-Flint	Flint	Flint	
Demographic Variables:	Pre-Water Change (N=269,151)	Post-Water Change (N= 59,057)	Pre-Water Change (N=10,623)	Post-Water Change (N=2,010)	Difference in Difference
General Fertility Rates	67.09 (5.01)	70.12 (2.87)	62.28 (6.81)	56.87 (6.76)	-8.45***
Fetal Death Rates	0.36 (0.99)	0.34 (0.13)	0.18 (0.34)	0.32 (0.43)	0.16

Note: Standard deviation for non-dummy variables, Standard error in parenthesis, *** p<0.01 (significant at 1% level); Source

Table 2 represents the universe of live births and fetal deaths in Michigan from 2008 to 2015. It compares these rates between women in Flint and outside of Flint, prior to and after the crisis.

Prior to the crisis, Non-Flint women had higher fertility rates when compared to women in Flint, but experienced doubled the amount of fetal death rates at 0.36%. Our results suggest that overall, health at birth decreased compared to other cities in Michigan. Women in Flint following the water change had a general fertility rate (GFR) of approximately 7.5 live births per 1,000 women aged 15-49 fewer than control women of the same age group, or a 12 percent decrease. Because the higher lead content of the new water supply was unknown at the time, this decrease in GFR is likely a reflection of an increase in fetal deaths and miscarriages. Fetal death rates increase by 0.1 deaths in Flint per 1,000 women aged 15-49 compared to control areas, or a 58 percent increase. As for women in other cities outside of Flint, the results shows a positive relationship in the cross-examination of fertility rates and birth outcomes. Fertility rates increased about 4% and fetal death rates decreased 2 percentage points for women outside of Flint. These results prove that the contaminated water in Flint harmed its resident by causing a negative impact on women and children's health outcomes.



Source National Center for Environmental Health

Table 3: Descriptive Statistics on Child BLLs by Phase Period. (*Source* Elsevier)

	Phase A		Phase B		Phase C		Phase D	
	Flint	Non Flint	Flint	Non Flint	Flint	Non Flint	Flint	Non Flint
BLL	2.382 (2.045)	2.112 (1.576)	2.972 (2.277)	2.297 (1.234)	2.683 (2.466)	2.286 (1.370)	2.295 (1.853)	2.209 (1.752)

Note: Phase A represents before the crisis, Phase B represents after the crisis prior to boil advisories, Phase C represents after boil advisories and Phase D represents the switch back to Detroit Water.

Excessive Lead Found in Children's Blood Levels.

Change in Flint's water source resulted in BLLs of 561 children exceeding 5 µg/dL. The Flint Water Crisis (FWC) is divisible into four phases of child water-lead exposure risk: Phase A) before the switch in water source to the Flint River; Phase B) after the switch in water source, but before boil water advisories; Phase C) after boil water advisories, but before the switch back to the baseline water source of the Detroit Water and Sewerage Department (DWSD); and Phase D) after the switch back to DWSD. Table 3 estimate water-lead attributable movements in child blood lead levels (BLLs) of Flint and Non-Flint children, that correspond with the four phases in the FWC.

The switch in water source (transitioning from phase A to B) caused the mean BLLs of children in Flint to increase by about 0.5 µg/dL, and increased the likelihood of a child being present with a BLL greater than 5 µg/dL. The switch from Phase B to C, caused BLLs to decrease about 50% from their initial rise following boil water advisories which helped decrease the mean to an average of 0.4 µg/dL. Lastly, with the switch back to Detroit water from Phase C to D and with continuous boil advisories, Flint children BLLs returned back to Pre-FWC levels which decreased the average BLLs mean to 0.3 µg/dL.

As for children not in Flint, BLLs increased by 0.2µg/dL from Phase A to Phase B. It decreased by a 1% change in average mean from Phase B to C and decreased by a 7% change in average mean as the city switched back to Detroit water in Pase D. The results from the table show that boil advisories and the return to the original water supply, helped improved BLLs in children especially those residing in Flint.

Policy Recommendations.

There needs to be action taken to control the level of leads found in Flint's water system in order to drive away the effect it's having on women and children's health. Studying this crisis, shows where the city lacked in managing the outbreak and the inefficiency in reassuring safety for its residents. The following recommendations are constructed as a step-by-step planning that will target certain projects Flint can use to help mitigate the crisis at hand.

Lead Control

Michigan Department of Environmental; Quality (MDEQ) should enforce anti-corrosion inhibitors in all water distribution systems.

- **This would control the rate of iron rusting and lead leaching into the water.**

Pipelines should be made with other components such as glass.

- **The chemical process in making glass is safer to the environment and disregards the use of metals which causes corrosion.**

Population-Scaling to Infrastructure

Produce and manage infrastructures that fit the population size in Flint.

- **It would be feasible to implement different pipelines that services residential living and industrial plants, infrastructures etc. separately because of their population scaling.**

Flint has experienced extreme population loss due to factors like the closure of automobile production facilities and the movement of residents, particularly white, middle-class residents, to the surrounding suburbs. As a result, there are fewer residents to pay property and income taxes, fewer people available to frequent—and thus keep in business—revenue-generating businesses that pay taxes, and more vacant structures that are blighted and reduce property values, which further reduce tax revenues.

The goal is to Increase population growth

- **If reducing servicing size is unfeasible, then the city should focus on bringing in business and residents into Flint to fill up vacant lands where the water system is not being used.**

Regional Development

If the notion of making the city smaller to fit its services (or vice versa) is not palatable, another option is to make the city's budget large enough to continue to maintain the existing level and quality of services, despite population loss. In order to make a city's budget large enough, a city must be able to tap the resources in its community and utilize the tax-revenue to create a more stable financial situation.

•This can be done by adjusting the amount of land available for development.

- **Allocating more space for affordable business to grow will attract more people into the city and increase revenue as well.**

•Implementing accessible resources

- **Increase the numbers of schools which would drive**

more students to be susceptible into the workforce and boost the economy.

•Provide better access to health services so people can take necessary precaution to keep themselves healthy and informed..

Economic/Budget Improvement

The city should cut back on money spent supporting a water system that is servicing twice the population size in Flint.

•A budget constraint should be in effect in order to allocate extra money spent on infrastructure.

Flint planners, and other city officials, were well aware of the poor state of the city's water system prior to the water crisis, but were unable to act due to the aforementioned financial challenges. There needs to be immediate planning for water infrastructure replacement,

- **The goal is to Invest in new technologies that will help repair old water systems.**

Emergency Management Laws

Where emergency manager laws exists, a few changes in the process of appointing and overseeing an emergency manager are made to alleviate subsequent failures. These changes would assure that the emergency manager hears and responds to the community's concerns. In short, more accountability is needed if emergency manager laws continue to be the primary approach for addressing municipal fiscal distress.

- **Emergency managers must consult with and incorporate advice from both the state and the appropriate local health departments (LHD).**
- **Emergency managers must be required to balance fiscal needs with protecting the public's health.**
- **Public health agencies should always be alerted to changes in environmental conditions—including water source—that may introduce new agents of disease or harm to the community, and should be required to engage in more rigorous monitoring following changes with potential adverse health implications**

With instant change in leadership, emergency management laws must be consistent with the expected norms of democracy rather than displacing democracy entirely.

- **These laws should require emergency managers to consider and respond to public comments—similar to administrative rulemaking.**
- **Provide a legal mechanism for local residents to formally complain to the appropriate state agency with oversight responsibility for the emergency manager.**

In order to incorporate efficiency in managing a crisis, it would be suitable to society's goals if the emergency management law replaces a single-person emergency manager with a three-person team comprised of a financial expert, a local government expert, and a federal expert. This will ensure that people's complaints and issues are taken seriously and dealt with swiftly.

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