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Cover Page Footnote

Our Rising Scholar section features articles by outstanding high school students. Julia Shen is a high school student at Detroit Country Day and has published two journal papers with numerous awards including prestigious Siemens and MIT Inspire.

Rising Scholar:

Flint Water Crisis: Impacts on Human-Environmental Interactions and Reflections for Future Solutions

Sixty-six miles northwest of Detroit, bordering the Flint River is Flint, a city in Genesee County in central Michigan, home to approximately 100,000 residents. In April 2014, the Flint water crisis erupted. Flint's drinking water became contaminated after its water supply source switched from Detroit to the Flint River as a result of the city budget shortage. It was one of the largest-scale, most intensively-reported water crises in our nation's history, and it had huge economic, psychological, medical, and educational implications for local residents.

On April 16, 2013, the city of Flint joined a new regional water system to conserve money by obtaining water from Lake Huron instead of buying treated drinking water from Detroit's Karegnondi Water Authority. However, this new pipeline system from Lake Huron would not be accessible for three years. To meet immediate needs, the city of Flint decided to use water from the Flint River via a city-owned treatment facility, without any prudent planning or precautionary water testing.¹ The Flint River water was over sixteen times more corrosive than the city's regular water supply source, so it was not surprising that after the switch, the highly-corrosive river water immediately damaged the interior of the already-aging pipeline system in Flint, causing the leaching of lead of service lines and solder joints into drinking water.² Soon after, local residents began noting unusual changes in the water and filing complaints. For instance, LeeAnne Walters, a resident of Flint and a mother of four children, reported that her whole family was their losing hair, and many other citizens noted the water's abnormally strong smell and murky color.³ On October 13, 2014, the General Motor plant in Flint even refused to

use the river water as it was causing car parts to rust.⁴ However, the city officials and a hired consultant insisted that the water was safe to drink, despite the presence of sediment and discoloration. The lead contamination was not acknowledged for an entire year—until a manager from the Environmental Protection Agency finally informed Michigan officials on February 26, 2015, that the water chemistry indicated that a number of contaminants from the pipes were leaching into the water system.⁵ The city then admitted that it had flunked a Safe Drinking Water Act, and six months later, state officials publicized new data analysis, which revealed that a significantly higher number of children had elevated lead in their blood following the water switch.⁶ On October 2, 2015, Michigan Governor Rick Snyder announced that the state would be buying water filters and testing for lead levels in schools. Later that month, the water supply was switched back to Detroit. Unfortunately, the aging pipe system and public health had already undergone irreversible damage. More time and more funding was needed for Flint to fully recuperate, and on December 9, and 10, 2016, the U.S. Senate and the Congress approved approximately 120 million dollars to go towards the city's recovery from the water crisis.⁷ However, that amount is simply not enough to cover the multitude of repercussions from the water crisis, and can serve only as temporary relief.

During the past two years, the media extensively covered a range of issues related to the Flint water crisis, and similarly, in academic fields, numerous technical papers have been published in journals and conference proceedings.⁸ Most of these studies focused upon certain elements of the crisis in particular, namely infrastructure, children, health, and education—yet little was devoted to study this event from a systematic viewpoint of human-environmental interactions. An abundance of existing discussions focus on the effects that poverty, race, and environmental injustice had on the crisis—and admittedly, these factors did play a vital role in

the occurrence of the Flint water crisis—but many studies still neglect analyzing the fundamental causes of the crises. To shed light on the fundamental causes of the crisis, the two main objectives of this study are to analyze the impacts of the crisis from the perspective of human-environmental interactions and to reflect on the event for future solutions from a perspective of economic development of post-industrial regions. The next section of this paper offers an analysis of the impacts of the Flint water crisis on human-environmental interactions on the basis of existing data, and the third section proposes a number of future solutions to avoid similar tragedies.

Impacts on Human-Environmental Interactions

Human-environmental interaction is traditionally defined as the people change their environment and the environment changes them.⁹ In an ecosystem that consists of environment and human, any impact on one would eventually affect the other, and vice versa.

Infrastructure is, more or less, intrinsically linked to humans and their environment in a chain of relatedness, with each component impacting the other in a considerable number of ways. From an infrastructural point of view, eighteen months worth of exposure to corrosive Flint River water not only severely damaged the interior of the water supply lines in Flint, but also caused the leaching of lead from the pipelines into the drinking water. Initially, as a short-term fix to the complication, the pipelines were treated with phosphates to form a scale layer that inhibited any further damage. Flushing the phosphates through the pipelines demanded simultaneous cooperation from all the households in order to treat all the water lines thoroughly. Nonetheless, this solution could only alleviate the problem of the damaged interior of the service lead lines for only a short period of time, and without any guarantee on the final result. For a permanent solution to the damaged pipelines, a complete replacement of all lead service lines is

imperative. This would involve replacing all the water lines in the front yard and driveway of each household in the city. Doing so is estimated to cost over 1.5 billion dollars, according to Flint's mayor, Karen Weaver, and the collateral impact on residents' daily life would also be painfully inconvenient.¹⁰ Up until October 26, 2016, lead service lines were replaced in only two hundred twenty-four Flint homes out of more than 17,000 households and at that time, construction companies still did not have all the information on the locations of century-old underground line systems, as many drawings of the pipelines were misplaced.¹¹ The replacement of the lead service lines will be both an extremely slow process and will involve exceedingly costly construction work.

The well-being of nature and the planet humans inhabit ultimately depends upon the decisions made and how they modify the environment. Needless to say, this devastating water crisis did not occur out of nowhere, or simply by chance. The roots of the crisis can be traced decades back to 1966, when Flint's automotive industry dumped 26.5 million gallons of waste per day into the Flint River.¹² In 1999, more than 22 million gallons of human, industrial, and commercial waste was poured into the Flint River after a subcontractor digging a trench near the river ripped apart a seventy-two-inch pipe from the Flint Wastewater Treatment Plant. Moreover, though there were environmental regulations against companies directly dumping waste into the Flint River, illegal dumping frequently occurred.¹³ Over the course of a number of years, damage and pollution from numerous sources slowly amassed, and consequently, the river today is over sixteen times more corrosive than other water sources and highly polluted. While polluted drinking water is less likely to severely affect people's health and well-being in developed countries as compared to developing countries, the Flint water crisis has served as a much-needed warning that developed countries are susceptible to a drinking water crisis as well.¹⁴

To extend the Flint water crisis to a national scale, the likelihood of similar crises in the future should not be neglected. According to Jared Skye at BA Environmental Science in Louisiana, the water quality in many nearby waterways is so poor that scientists advise people against consuming fish due to the sheer number of toxins that have accumulated inside the them.¹⁵ The toxic water itself can potentially cause a multitude of cancers, as illustrated by the so-called “Cancer Alley” in the Mississippi Delta region, where toxins accumulated from the industrial runoff and dumping along the Mississippi river, resulting in blood dioxin levels that are nearly three times higher than the national average.¹⁶ Likewise, the Animas River running between southern Colorado and northern New Mexico was recently contaminated by mining waste from the Gold King Mine with high levels of toxic metals, including lead, arsenic, and cadmium.¹⁷ In many other instances, drinking water pollution persists for years, with accumulated or deposited toxins that are immensely difficult to clean or remove. After witnessing the tolls that polluted drinking water took on the residents of Flint, it is only logical that we prevent such a horrendous occurrence from happening elsewhere as well by taking appropriate environmental precautions. As Barry Commoner, one of the founders of the modern environmental movement once stated, “Environmental pollution is an incurable disease. It can only be prevented.”¹⁸

Many of the recent efforts to help Flint recover are limited to temporary solutions, such as providing water filters and bottled water, along with the replacement of a few water pipelines. Though these do provide temporary relief, the fundamental causes of the pollution are still left unaddressed. It is of the utmost importance to remember that the Flint Water Crisis was not solely a result of a poor governmental decision to switch water sources, but rather an accumulation of decades of pollution by the people. Accordingly, to prevent future devastations

similar to Flint, it is essential for us to locate and constrain all major sources of pollution along not only the Flint River, but also all other rivers.

Perhaps the most negatively impacted age group in the Flint water crisis was children, whose health and education both suffered immensely. To illustrate, United Way estimated in 2016 that anywhere from 6,000 to 12,000 children, or over 12 percent of the total population and 43 percent of the population of children under eighteen years old, were exposed to elevated levels of lead water over the course of the Flint water crisis.

According to the CDC National Center for Environmental Health, elevated lead levels (around 5 micrograms per deciliter) are extremely detrimental to children's ability to learn.¹⁹ With blood lead levels falling between 5 and 9 micrograms per deciliter, students scored an average of 4.5 points lower on reading readiness tests, while considerably lower academic performance and test scores were reported among fourth graders with lead levels between 10 and 19 micrograms per deciliter. Among students whose lead levels reached higher than 25 micrograms per deciliter, many required special education, and even juvenile justice programs.²⁰

Mark Laidlaw, a researcher from the Royal Melbourne Institute of Technology, and a group of other U.S. scientists collected data suggesting that 7 percent of Flint children had a peak blood lead level of greater than 5 micrograms per deciliter, in the third quarter of 2014, in comparison to only 3.6 percent of kids in 2013.²¹ Mona Hanna-Attisha, a researcher at the Michigan State University, conducted a study revealed that the percentage of elevated lead levels (greater than 5 $\mu\text{g}/\text{dL}$) in a group of Flint children doubled from within the period of water crisis; in particularly severe areas, the percentage even tripled.²² This sudden increase meant that countless Flint children now had elevated blood lead levels compounded by malnutrition and poverty.

As stated by Philip Landrigan and David Bellinger, two of the most prominent researchers in lead poisoning²³

Lead is a devastating poison. It damages children's brains, erodes intelligence, diminishes creativity and the ability to weigh consequences and make good decisions, impairs language skills, shortens attention span, and predisposes them to hyperactive and aggressive behavior. Lead exposure in early childhood is linked to increased risk for dyslexia and school failure later on." These adverse effects of lead poisoning on learning and development were confirmed by a number of other studies, too.²⁴

From a physiological point of view, elevated lead levels in blood impede the development of children's central nervous system, resulting in both lower IQs and learning disabilities.²⁵ Furthermore, lead poisoning in children is often linked to socio-behavioral problems, including violent crime later on in life and juvenile delinquency. Many of the neurological effects that lead has on children persists into adulthood, when people poisoned by lead as children also have an increased risk for renal effects, cardiovascular hypertension, reproductive problems, and developmental problems in their offspring.²⁶

Positive progress has been made in Flint school district since the water crisis. The Genesee Intermediate School District has become a trusted source for donated water for many families and has been providing bus services to schools for those who do not have transportation means.²⁷ In April, 2016, Flint school superintendent, Bilal Tawwab indicated that the amount of calcium, iron, and Vitamin C would be increased in students' lunches to alleviate the after-effects of lead poisoning.²⁸ Teachers and volunteers have also been pushing an early childhood education program for the kids between three to five years of age to mitigate the negative effects on brain growth and development due to the elevated blood lead levels. Further, many schools are encouraging students to gain a deeper understanding of the negative effects of tainted water via science projects. Notably, Ms. Davis at Genesee STEM Academy stated that "My students'

lives will be better because they will be able to understand why water is a precious resource and what they can do in their community to reverse pollution's damage."²⁹

Reflections for Future Solutions

Although the Flint Water Crisis is no longer in the spotlight of national news, the Flint water crisis still has not been completely resolved—each and every day, the residents of Flint are still suffering from the countless repercussions of the crisis. To prevent any future occurrences of similar crises to nature, we must identify the roots of the crisis and brainstorm effective future solutions to fix it.

According to the US Census Bureau, between 2009 and 2013, about 41.5 percent of Flint residents lived below the poverty line, which greatly contributed to the city's budget shortfall, the primary cause of the city's switch of the water supply back to the Flint River in 2014.³⁰ The financial situation in Flint is so dire that during the crisis, most families did not even have their own water filters and were not even able to afford bottled water. Similarly, medical blood tests could not be regularly conducted because of the limitation of the healthcare plans of a large majority of Flint residents. Reuters recently reported that millions of American children in our nation do not undergo early lead tests.³¹ Malnutrition and poor living conditions in houses, many of which were built before 1940, only further aggravated the lead poisoning problem.³²

The Flint water crisis was, in a large part, caused by economic problems, which reflect the declining economic power of many post-industrialized regions. Many of these regions, after their early-twentieth century heydays, experienced an economic decline in the late 1970s, and now local manufacturers are now on the verge of dying out. As a result, the revenue income of the cities is continuously decreasing, leading to budget shortfalls for basic infrastructure

maintenance and upgrades. The Flint water crisis serves as an alarming wake-up call to the potential severity of the consequences of these budget shortfalls.

Government and local decision-makers must come to realize the critical importance of this issue and come up with plans to revitalize old industrial regions in particular, which are generally referred to as the Rust Belt (previously known as the industrial heartland of America) that includes New York, Pennsylvania, West Virginia, Ohio, Indiana, and the lower Peninsula of Michigan. One strategy is for the government to fund research and development heavily in Robotics and Automation, which will be the key technologies to re-vitalize the manufacturing activities in the twenty-first century. Innovative research and commercialization are crucial to the technological supremacy of this nation. If we are not at a leading position in these emerging fields, the revitalization of Rust Belt will not occur in the foreseeable future.

It is equally important to strengthen existing regulatory and legal procedures to make sure that public officials are held accountable to their ignorance or fabrication of certain issues in handling the Flint water crisis and any similar future crises. During the Flint water crisis, city and state officials were initially reluctant to acknowledge the pipeline problem and slow in reacting to the crisis. If the crisis were handled without the officials' one-and-half-a-year delay, the damage to Flint's infrastructure and residents would have been significantly minimized. Additionally, prior to the switch to Flint River water, the city should have consulted many different sources for opinions and conducted a study to evaluate the quality of the proposed water treatment process. Unfortunately, instead of doing so, Flint hastily made the decision to switch within a single month. More inexcusably, the city did not even treat the Flint River water with anti-corrosion chemicals, which was a blatant violation of the Environment Protection Agency's (EPA) Lead and Copper Rule.³³

The Flint Water Advisory Task Force, which was comprised of five experts, reported that the Michigan Department of Environment Quality (MDEQ) improperly and inaccurately described the Flint water as being safe by producing sampling data that was flawed;³⁴ MDEQ's viewpoint was falsely considered as being accurate by other state, county, and city agencies such as the Michigan Department of Health and Human Services (MDHHD), ultimately failing to protect the health of the population in Flint. The FWATF concluded that the crisis was "a story of government failure, intransigence, unpreparedness, delay, inaction and environmental injustice."

Yet another shortcoming of the public officials is that the Michigan governor appointed only a single person as an emergency manager, who dealt with the crisis without appropriate consultation with local decision-makers. This blatant neglect on the checks and balances in public decision-making played a large role in the occurrence of this avoidable tragedy as well.

In essence, if public officials had prudently planned, diligently tested, and sought the advice of other groups, the crisis could have been averted.³⁵ Flint public officials who wrongly feigned ignorance and turned their backs on certain issues must be held accountable for their actions, and officials elsewhere should also be made aware of repercussions for making poor, uninformed decisions.

Currently, approximately one billion glasses of tap water are consumed by over 300 million Americans every day.³⁶ Based on a *New York Times* 2009 analysis, over 20 percent of our nation's water treatment systems had violated key provisions of the Safe Drinking Water Act in a five year period.³⁷ Since 2004, the water provided to over 49 million people in U.S. has contained both toxic chemicals and dangerous bacteria often found in sewage.

Continued law enforcement of the Clean Water Act is essential to reducing the amounts of the accumulated industrial runoff and to our recovery from the dire state that our water sources currently are in. Law enforcement of the Safe Drinking Water Act is also another vital step in tackling the problem at hand. Unfortunately, less than 6 percent of all polluters received fines or punishment from state or federal agencies, indicating that rigorous environmental regulations still have a long way to go.³⁸ Beyond punishing and fining polluters, how effectively we police our nation's 152,000 public drinking water systems is essential to providing clean water to everyone in this country. This requires new test protocols and sufficient manpower with support at both the state and federal levels.

Assessing the health risk from lead relies on an accurate quantification of lead concentration, and the existing Environmental Protection Agency standard of maximum contaminant level for lead needs to be improved for detection of water contamination problems.³⁹ In fact, environmental engineer Marc Edwards' study indicated that the EPA instructions on collecting water samples for lead analyses were biased towards underestimating the lead contents of the water samples.⁴⁰ In recent cases of lead water poisoning in Washington, D.C., Greenville, North Carolina, and Durham, North Carolina, the approved water sampling procedures failed in detecting the contamination.⁴¹ There are no standardized protocols for water sample handling with respect to the routine monitoring on human lead exposure.⁴²

Conclusion

This paper analyzes the Flint water crisis from a perspective of human-environmental interactions within an ecosystem, in which three major impacts of the crisis were a) infrastructural changes, b) irreparable damage to nature, and c) affected children's health and education. To avoid similar tragedies in the future, I identified three main future solutions: a)

overcoming economic issues, b) holding officials accountable, and c) routine enforcement of environmental protection acts. In particular, strategies were discussed to re-vitalize the Rust Belt (previously known as the industrial heartland of America) for reversing the declining trend of local economy. These solutions will be essential to eliminate the fundamental causes of similar crises.

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