

Flint

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Published online: 16 April 2016

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“Water is the driving force of all nature.”

Leonardo da Vinci

“Water and air, the two essential fluids on which all life depends, have become global garbage cans.”

Jacques Yves Cousteau

“Saving our planet, lifting people out of poverty, advancing economic growth... these are one and the same fight. We must connect the dots between climate change, water scarcity, energy shortages, global health, food security, and women's empowerment. Solutions to one problem must be solutions for all.”

Ban Ki-moon

For its entire history, the city of Flint's fortunes have been closely tied with the fortunes of the automobile industry. During the late nineteenth century, Flint was a major center in the Michigan lumber industry, and with the ready access to lumber, the city became a leading manufacturer of carriages, earning its nickname “Vehicle City” [1]. General Motors was started in Flint, and the famous Flint Sit-Down Strike of 1936–1937 played a major role in the subsequent formation of the United Automobile Workers union [1]. Both General Motors and Flint became a powerhouse shortly after the end of World War II. However, after General Motors declared bankruptcy in 2008, the city of Flint sank into a deep and prolonged economic depression, which has continued to this day. Total employment in the Greater Flint area, which includes all of the surrounding municipalities in Genesee County, MI, has decreased by over 40 % since 1980 [2]. The area ranks near the bottom of the state in almost every social (unemployment, domestic violence, violent crime, and drug abuse) and public health (preterm birth, infant mortality, and life expectancy) statistic [3, 4]. All of these points pale in comparison to what occurred when the city switched its water supply to the Flint River.

Governor Rick Snyder declared a state of financial emergency in 2011 and appointed an Emergency Manager who was charged with cutting costs and

reducing the city's \$15 million budget deficit [3, 5]. Flint had been obtaining its water from the city of Detroit (whose source of water was nearby Lake Huron and the Detroit River) since the early 1960s. The cost of water had nearly doubled between 2004 and 2013, prompting Flint's city council to approve a proposal to switch to the Karegnondi Water Authority on March 25, 2013 [3, 5, 6]. The switch would allow the city to obtain water directly from Lake Huron (bypassing Detroit) at a savings of nearly \$19 million over an 8-year period [5]. Unfortunately, the new proposal would require completion of a new regional water pipeline, which would not be finished until 2016. In addition, the Detroit Water and Sewerage Department responded to the proposal by giving the Flint city council a one-year termination notice. As a stopgap measure, the city's Emergency Manager signed a contract to utilize the Flint River as the primary source of water until completion of the new regional pipeline. Ironically, local leaders reportedly celebrated the contract with a toast of the Flint River water [5].

Almost immediately after the switch to the Flint River water source, the city's residents began to raise concerns regarding the color, taste, and odor of the water coming out of their faucets [4, 5, 7]. The water from the Detroit Water and Sewerage Department was significantly less corrosive (due to low chloride and presence of a corrosion inhibitor) compared to the Flint River water (high chloride, no corrosion inhibitor) [6]. Addition of the corrosion inhibitor was allegedly discontinued as yet another cost-savings measure [8]. The water supply was so corrosive that General Motors reportedly stopped using it at one of their local engine plants because the water caused too much damage to engine parts [5]. Combined with the city's aging network of lead-based water pipes, the corrosive Flint River water leached lead from the pipes and into the city's water [3, 5, 6]. Other hard metals released from the corroded lead pipes inhibited chlorine-based disinfectants in the water, which subsequently led to increased bacterial contamination of the city's water [5, 6, 8]. Just four months after making the switch to the Flint River water supply, the city was forced to advise residents to boil their water due to high levels of *Escherichia coli* bacteria [5]. The public health department also noticed a disturbing increase in the number of Legionnaire's disease cases [8].

A study performed by investigators at Virginia Tech University reported increased water lead levels [4, 9]. A subsequent study led by local pediatrician and public health expert Mona Hanna-Attisha, MD, MPH, reported increased blood lead levels in children under age 5 years, with neighborhoods with the highest water lead levels reporting the highest increase. Notably, no significant changes in blood lead levels was noted in children living outside the city [3]. Lead's neurotoxicity can adversely impact a child's motor and cognitive development. Children are at a higher risk of lead toxicity compared to adults [3]. Lead poisoning from contaminated water is particularly likely in infants fed reconstituted formula [3, 4, 6]. Unfortunately, the response by government officials was perhaps too late, though the long-term impact of this public health crisis will not be known for several years [5]. Only relatively recently has the Flint water crisis reached a national audience. Both Republican and Democratic candidates for US President have focused attention on this particular issue.

The Flint water crisis has also highlighted one other important issue. As Ban Ki-moon suggests in his quote at the beginning of this commentary, there are so many factors that impact the health of any community. The so-called social determinants of health have received far too little attention in the USA. Health

policy experts like to point out that the USA spends more money on health care than any other country in the Organization for Economic Co-operation and Development (OECD), yet has the lowest life expectancy and highest infant mortality of all of these countries [10]. However, the US health care delivery system functions more like an acute care delivery system. Importantly, health care expenditures (adjusted for gross domestic product) are not significantly associated with traditional indicators of health (e.g., infant mortality, life expectancy) [10]. Rather, social services expenditures are more relevant, and the USA spends significantly less on social services compared to its OECD counterparts. The Flint water crisis certainly highlights how so many other factors impact overall health. The USA will see significant improvements in infant mortality and life expectancy, not through additional investment in the acute care delivery system as it currently exists today, but rather through increased investment in social services programs directed at reducing poverty, improving the safety of the water supply, and increasing access to preventive care [11].

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