

# The Negative Effects of Urbanization on Surface Water Quality

By

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July 30, 2018

## Abstract

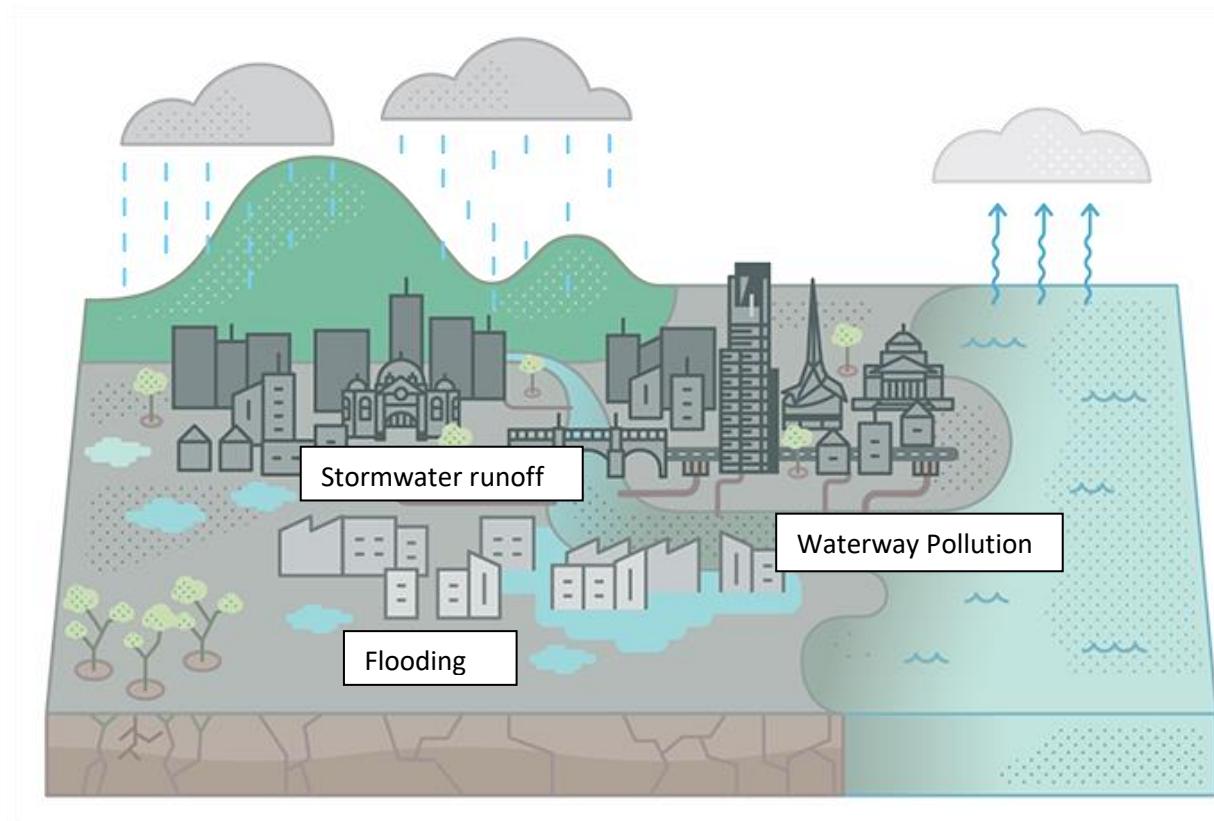
Around 55% of the world's population lives in urban areas, this number is expected to increase to 68% by 2050 [1]. 80% of the population in the U.S. lives in urban areas [2]. This increasing urban population is placing severe amounts of stress on water resources. It has become important to understand the impacts of urbanization on surface water quality. This paper investigates the deterioration of surface water quality due to rapid urbanization altering the natural water cycle. In order to investigate the impact of urbanization on surface water quality, data was collected from Cypress Creek, McKellar Lake, Bateman Bridge, and Baker's Pond over a period of four days. Chemical water testing was applied to analyze the surface water quality; data was also collected from books and scientific articles. Several solutions were found while analyzing data such as encouraging industries to reduce pollution at the source, educating the local population on urbanizations effects, and planning ahead to decrease the amount of stormwater runoff due to impervious surfaces.

*Keywords:* Surface water quality, stormwater runoff, urbanization, natural water cycle, impervious surfaces.

## Introduction

Did you know that the natural water cycle is being disrupted due to rapid urbanization as small towns grow into large cities? As cities grow, a plethora of things happen that harm the quality of surface water. Surface water is water that comes from any form of precipitation. In the unaltered water cycle some of this water is soaked into the ground. However, due to the increase of impervious surfaces such as houses, buildings, roads the water, which is usually soaked up by the ground, is blocked by these impervious surfaces which causes an increase in water runoff and a decrease in surface water quality. These changes in the natural water cycle have a significant effect on the quality of fresh, clean water that is available for human use.

### Urbanizations Effect on the Water Cycle



The figure above explains the three major effects urbanization has on the water cycle: stormwater runoff, flooding, and water pollution. Stormwater runoff is created when precipitation comes in contact with urban surfaces. The water becomes contaminated with several pollutants such as metal, pesticides, and litter. This stormwater washes into a stormwater drain. Unfortunately, these drains usually do not have any type of treatment systems which means these pollutants may be carried directly into the waterways. Flooding can occur due to large volumes of stormwater collecting on sealed surfaces flowing into the stormwater drains and exceeding its capacity. [3]

Rapid runoff reduces the amount of water available to infiltrate soil to recharge aquifers; this often results in lower stream flows. Additionally, when a stream's hydrology is altered, this degrades the physical habitat from channel erosion which reduces spawning, feeding, and living spaces for aquatic life.[4]

I hypothesize urbanization has several effects on surface water quality. However, the main effect of urbanization is areas of watershed being covered by pavement, sidewalks, buildings, etc. The covering of these areas creates an increase of stormwater runoff and land erosion. As this erosion continues, sediment and other pollutants are washed into streams. This increases the chance of flooding, which is harmful to the surface water quality.

The discussion section of this paper aims to answer

- how population growth affects the quality of surface water
- how urbanization causes damage to aquatic habitats
- what happens when little to no sewage management systems are in place

### **Materials and Methods**

In order to find the amount of recyclable trash from the total amount of trash collected at McKellar Lake, trash was gathered and collected into two bags. One bag contained recyclable trash and the other contained non-recyclable trash. The trash was collected, weighed in kilograms, and then the total was divided. Water was collected from Cypress Creek, Bateman Bridge, and Baker's Pond the amount of copper, phenols, chlorine, and dissolved oxygen were then tested using vacuum vials and a photometer. Testing at Cypress Creek and Bateman Bridge occurred three times; however, due to weather conditions, testing at Baker's Pond only occurred once. A dipping net, pan, and a dichotomous key was used to collect and identify micro-vertebrate such as mayflies, mollusks, and right handed snails found at Bateman Bridge.

### **Results**

The amount of material collected from McKellar Lake that could have been recycled was 82% while the non-recyclable trash was 18%.

The following table shows the amount of copper, phenols, chlorine, and dissolved oxygen found

Sample	Copper	Phenols	Chlorine	Dissolved Oxygen
1	0.00ppm	0.15ppm	Undetectable	15.83ppm
2	0.01ppm	0.08ppm	0.00ppm	14.78ppm
3	0.00ppm	0.13ppm	0.00ppm	13.59ppm

at Cypress Creek on 6/5/18 at 1:09 A.M.

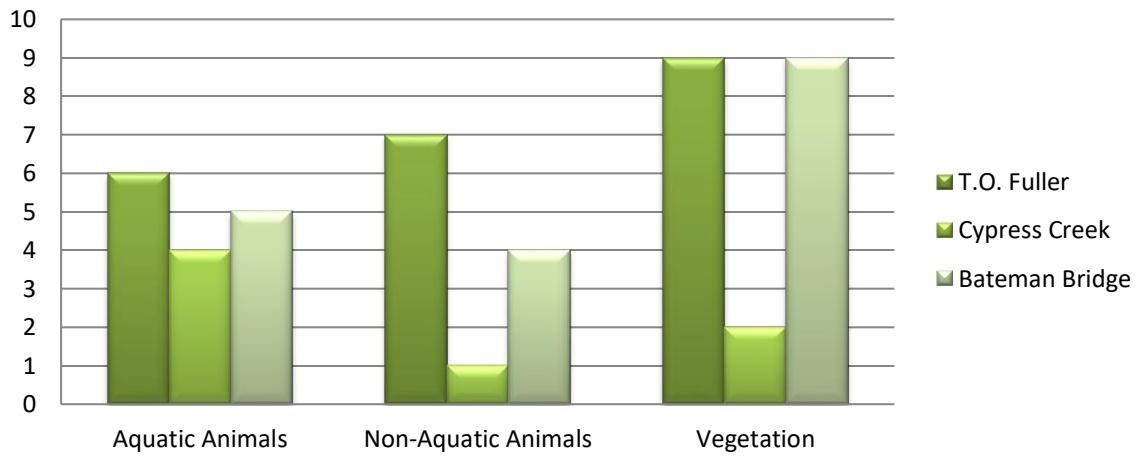
The following table shows the amount of copper, phenols, chlorine, and dissolved oxygen found at Bateman Bridge on 6/6/2018 at 12:40 A.M.

Sample	Copper	Phenols	Chlorine	Dissolved Oxygen
1	1.00ppm	0.69ppm	0.19ppm	7.80ppm
2	0.98ppm	0.76ppm	0.22ppm	7.80ppm
3	0.97ppm	0.80ppm	0.23ppm	8.08ppm

The following table shows the amount of copper, phenols, chlorine, and dissolved oxygen found at Baker's Pond on 6/7/18 at 11:15 A.M.

Sample	Copper	Phenols	Chlorine	Dissolved Oxygen
1	0.98ppm	0.75ppm	0.08ppm	10.31ppm

**Aquatic species, non-aquatic species , and vegetation observed at T.O. Fuller, Cypress Creek, and Bateman Bridge.**



## Discussion

71% of the earth's surface is covered with water [7] which may cause some to think water is a never ending resource. However, only 3% of that water is considered to be fresh water. Additionally, around 2.6% of this fresh water is unattainable to humans. This leaves around 0.4% of useable water which must be shared with billions of people on earth.[9] The reality is water is finite. Water, a seemingly abundant resource which is vital to several everyday processes such as hydration, food peroration, and hygiene is finite.[8] As population increases so does the stress on the water resources of the region to supply everyone with water. What has changed is the amount of people living on earth, and thus, the amount of drinkable water required for human sustenance.[8] The United Nations reports that in the last century alone, water consumption has grown at more than twice the rate of population increase. It is estimated that by 2025, 1.8 billion People will live in water-scarce areas.[10]

In addition to the water shortage an increase in population also brings urbanization which causes environmental problems which can difficulty affect the quality of the water supply. Globally 1.1 billion people do not have access to safe drinking water and 2.6 billion people do not have an adequate sanitation supply which causes the death of 3900 children daily from waterborne diseases. In the US around 218 million Americans live at least 10 miles from a polluted water source. It is estimated that 40% of water in America is unsafe for fishing, swimming, or aquatic life.[10] A photo has been attached that shows a message that warns against eating any fish caught from a headwater, which is the source of a river or stream, because they may contain contaminates that can increase the risk of cancer or other serious illnesses in humans.



Water resources are vulnerable, which means their flow patterns and chemical properties can easily be altered by human activities<sup>[8]</sup>. The results from the chemical water testing showed Cypress Creek contained very low levels of both copper and chlorine. I believe the phenol level was high due to a car wash that was located downstream of where the water samples were collected. Fast moving water generally contains more oxygen than still water, because the rapid movement continually mixes the air into the water.<sup>[6]</sup> This explains why Cypress Creek, a fast moving body of water, contained high levels of dissolved oxygen on all three tests.

Dissolved oxygen is important to aquatic life because like people, fish and other aquatic organisms require oxygen to live. The process of transferring oxygen from water to blood is harder than transferring oxygen from air to blood. Which means it is critical that an adequate amount of oxygen is maintained in the water so this transfer can take place correctly and sustain aquatic life. Additionally dissolved oxygen is necessary to assist in the decomposition of organic matter in water. It is also important in other biological and chemical processes. This report states “Floodplain and bottom and hardwood forest habitat, which are important for birds and mammals have also declined due to bank instability, erosion and bank sloughing. Wildlife habitat in Cypress Creek is poor and fish movement is limited”(US Army Corps Of Engineers)<sup>[11]</sup> which is why, on the bar graph, Cypress Creek has the least amount of aquatic and non-aquatic animal sightings. Cypress Creek also has the lowest amount of vegetation due to its channelization; however, there were small patches of vegetation peaking through cracks.

The results from the chemical water testing showed Bateman Bridge contained high amounts of all three tested chemicals. It also contained the lowest dissolved oxygen levels out of all three bodies of water. The results from Baker's Pond will not get an in-depth analyzation because the tests were only conducted once. Baker's Pond had a plethora of vegetation; there was also a large amount of ticks, spiders, and other wildlife. There were no tests conducted at T.O. Fuller due to shallow muddy water. However, there were numerous animal tracks, a large number of trees, cattails and dragonflies.

This is a photo of different species of algae found on a fallen tree branch at Baker's Pond.



Industries lining the shores of Lake Erie began dumping harmful pollutants into the lake. Waste from city sewers and pesticides from agricultural runoff also made its way into the waterways. As a result of this pollution, the lake began developing algal blooms which killed off fish due to lack of oxygen in the water. In 1972 as a solution to stop the dumping of harmful materials in the waterways Congress created the Clean Water Act.

The Cuyahoga River caught fire on June 22, 1969. Floating pieces of oil slicked debris were ignited by sparks from a passing train. The fire reached over five stories and lasted between twenty to thirty minutes due to all the oil and pollution. This fire caused around \$50,000 worth of

damage to a bridge and a railway trestle. This fire was the result of poor sewage and waste management. This river caught fire thirteen times, which caused people to say it was one of the most polluted rivers in the U.S. The legislature passed the National Environment Policy Act (NEPA) to manage environmental risks and regulate various sanitary-specific policies.

In July 2017 the water turned brown and fish began dying in Shakoka Lake due to an E. coli contamination. The water tested positive for elevated levels of fecal coliform and E.coli. A community member stated he was “scared to go swimming or eat any fish” from the lake. A nearby construction site is blamed for the water turning brown due to improper slit fence use.

If people do not start taking precautions history will repeat itself such as with Lake Erie, Cuyahoga River. These two bodies of water have one important common factor. Poor pollution and waste management, if Congress had created a waste management system beforehand then I believe there would not have been such severe consequences.

I believe urbanization has caused several negative effects on surface water quality; however, it may not be too late to make a change. After the algal blooms incident at Lake Erie the government stepped in and made the Clean Water Act. However; the government should begin planning ahead to preserve areas of watershed, there should be more education about surface water quality and what the public can do to create a difference before it is too late.

## References:

1. 68% of the world population projected to live in urban areas by 2050, says UN ( May 16, 2018) Retrieved from <https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html>
2. U.S. Urban Population Is Up ... But What Does 'Urban' Really Mean? (Mar 26, 2012) Retrieved from <https://www.citylab.com/equity/2012/03/us-urban-population-what-does-urban-really-mean/1589/>
3. How does urbanisation impact the water cycle? Retrieved from <http://urbanwater.melbourne.vic.gov.au/melbournes-water-story/how-does-urbanisation-impact-the-water-cycle/>
4. Effects of Urbanization on Stream Ecosystems (March,4,2014) Retrieved from <https://water.usgs.gov/nawqa/urban/html/findings/index.html>
5. How Urbanization Affects the Water Cycle Retrieved from <https://www.coastal.ca.gov/nps/watercyclefacts.pdf>
6. Dissolved Oxygen - Cary Institute of Ecosystem Studies [https://www.caryinstitute.org/sites/default/files/.../1C1\\_dissolved\\_oxygen\\_reading.pdf](https://www.caryinstitute.org/sites/default/files/.../1C1_dissolved_oxygen_reading.pdf)
7. What percent of Earth is water?  
(December 2, 2014) retrieved from <https://phys.org/news/2014-12-percent-earth.html>
8. Population and Water Resources (contrib. by FAO) Retrieved from <http://www.un.org/popin/fao/water.html>
9. How Much Water on Earth is Drinkable, and Why Do We Care? (April 10, 2018) retrieved from <https://worldwaterreserve.com/water-crisis/how-much-water-on-earth-is-drinkable/>
10. How does the Increase in human population growth affect the consumption of water resources? Retrieved from <http://environmental-issues.yoexpert.com/environmental-issues-general/how-does-the-increase-in-the-human-population-grow-1633.html>
11. Corps of Engineers, West Tennessee River Basin Authority releases Cypress Creek Study (January 20, 2016) Retrieved from <http://www.mvm.usace.army.mil/Media/News-Releases/Article/643757/corps-of-engineers-west-tennessee-river-basin-authority-releases-cypress-creek/>

12. Michael Rotman, "Lake Erie , " Cleveland Historical, Retrieved from  
<https://clevelandhistorical.org/items/show/58>.

13. Cuyahoga River Fire Retrieved from  
[http://www.ohiohistorycentral.org/w/Cuyahoga\\_River\\_Fire](http://www.ohiohistorycentral.org/w/Cuyahoga_River_Fire)

14. Maywood warned to avoid fishing and swimming in lakes after sewage leak. (July 19,2017)  
Retrieved from <http://www.wmcactionnews5.com/story/35925105/maywood-warned-to-avoid-fishing-and-swimming-in-lakes-after-sewage-leak>