The Effects of Alkalinity on Water Pollution

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THE GLOBE PROGRAM

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Abstract

Many plants and animals rely on healthy water from rivers, lakes and oceans. However, these bodies of water tend to be polluted and dangerous for drinking and living in. Studies have shown that the presence of pollutants such as metal can be caused by high levels of alkalinity in water. This study aims to use the aforementioned knowledge of alkalinity to find out if it can predict the amount of pollution in a water source. By measuring if electrical conductivity is positively correlated with alkalinity, it can be discovered if a body of water's pollution level is rising if the alkalinity in the water rises. A correlation would mean that there is a way to find out if the water pollution of a body is increasing. In this specific study, no correlation was found between alkalinity and the increase of conductivity, but if further research were conducted, a correlation could be found, especially if more rivers were tested on more testing days.

Research Question

How does alkalinity affect conductivity?

If the alkalinity levels in a river are higher than normal, then there is a higher percentage of pollution in the water because the pH levels will be lower and the electrical conductivity will be higher

By answering this question, solutions can be found on how to deal with pollution in water due to higher levels of conductivity and alkalinity

Introduction

Although river water naturally will almost never have the pH of pure water, there are, unfortunately, many other circumstances that can cause river ecosystems to be unhealthy. After sufficient testing, it was discovered that there is a correlation of alkalinity, conductivity, and pH with the cleanliness of water and the objects in water. Even though testing for the pH of the water will provide further insight into its pollution levels and generally falls in response to dropping alkalinity, it doesn't have a reliable correlation with conductivity or alkalinity.

When runoff and other abrupt influx of chemicals and substances enter water, the acidity/basicity of the water drastically changes, changing the alkalinity accordingly. Drinking water shouldn't have a higher conductivity than 500 µS/cm (microsiemens per centimeter, unit for measuring electrical conductivity), but river water should be between 200-1000 µS/cm (Government of Northwest Territories, n.d). Conductivity higher than 1,000 µS/Cm indicates saline conditions in water, which are harmful to aquatic life (Northwest Territories, n.d). Higher alkalinity and conductivity are also correlated with a lower pH. This could imply that there is more pollution in the ecosystem, since water should not have high traces of metal in it.

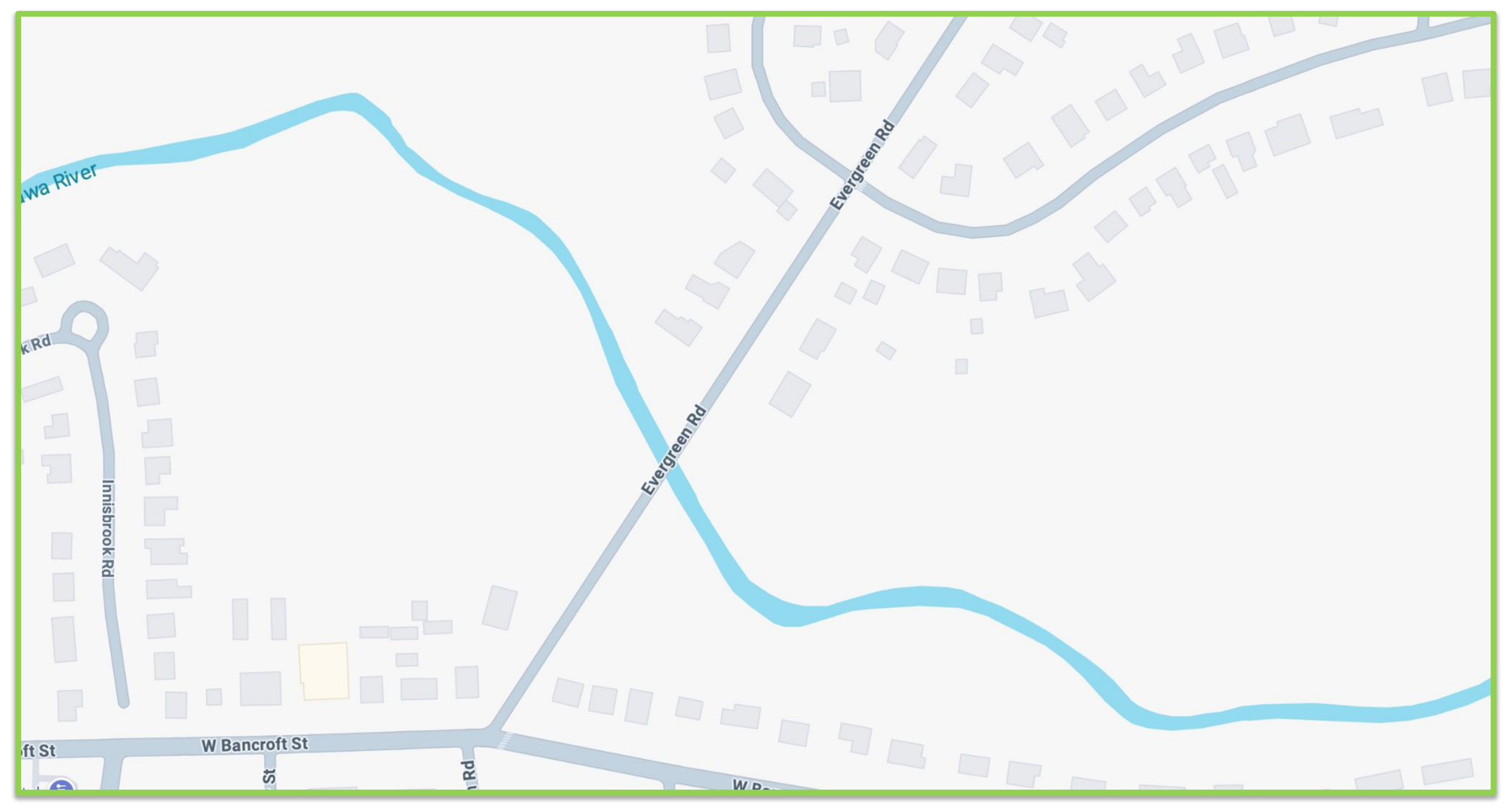
As tests will be conducted on local water sources, it is imperative to understand these points of data as it will betray their water's cleanliness. The hope, in the end, is for the tests to show the waters are in no danger of destroying the ecosystem. However, if there is enough data to relinquish those claims, further research will be conducted to see if the waters are truly polluted. If there is a lower alkalinity (lower pH) in a water ecosystem, then there will be a higher conductivity in the water because lower alkalinity occurs when there are more traces of metal in an environment, and more metal in water should lead to a higher reading of conductivity in the water (AtlasScientific, 2024).

Research Methods

The materials used for this experiment were jars for collecting river water, a thermometer to measure the temperature of the water, pH strips for the pH, an electrical conductivity tester, and an alkalinity tester. The alkalinity tester was manufactured by LaMotte and it was model WAT-DR. The electrical conductivity tester was manufactured by Oakton Instruments and was a Waterproof ECtestr Low, with a range from 0-1900 µS. The pH paper was Hydrion (O67) Urine & Saliva pH Paper 5.5-8.0. The GLOBE protocols used were alkalinity, electrical conductivity, and pH.

First, an empty water bottle was labeled and put in a plastic bag. After going to the Ottawa river, the appropriately labeled bottle was filled with the river water, and a thermometer was instantly inserted into the bottle to see the original temperature. Then the Ottawa river water was put into the bag. The bottle sat overnight in the cold until it could be taken to a lab. At the lab, it was tested for pH, electrical conductivity, and alkalinity, using the tests aforementioned. The water from the bottle was poured into a beaker in order to be tested efficiently.

First, the pH tester strip was dipped into the water sample three times, and the mean of the data for each sample was kept. The pH tester ranges from 5.5 to 8.0 and the case has colors on the side of the container starting from 5.5, to 5.8 and every even tenth place digit up to 8.0. After dipping the strip into the water, it was let alone for about 30-60 seconds and then compared against the side of the container. It was determined what color the strip was in relation to the colors on the side, and the consensus was recorded. Then, electrical conductivity was also measured three times for each sample, keeping the mean of the results. Likewise, each sample was tested with the alkalinity titration fluid and indicator tablets 3 times, and the average was recorded. N = 3.



GLOBE Badges

Be a **Collaborator**

All team members are listed including students from the same school or schools from around the world, along with clearly defined roles, how these roles support one another, and descriptions of each student's contribution. The descriptions clearly indicate the advantages of the collaboration. If the students collaborated with students from another school, describe how working with other schools improved the research.

Be a **Data Scientist**

The report includes in-depth analysis of students' own data as well as other data sources. Students discuss limitations of these data, make inferences about past, present, or future events, or use data to answer questions or solve problems in the represented system. Consider data from other schools or data available from other databases.

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The report uses student-generated sources of evidence to describe an engineering problem, looks at solutions through engineering, or optimizes a design to address a real-world problem, and describes the potential impact of the engineering principles on the environment.

Make an Impact

The report clearly describes how a local issue led to the research questions or makes connections between local and global impacts. The students need to clearly describe or show how the research contributed to a positive impact on their community through making recommendations or taking action based on findings.

Be a **STEM Professional**

The report clearly describes collaboration with a STEM professional that enhanced the research methods, contributed to improved precision, and supported more sophisticated analyses and interpretations of results.

Be a **STEM Storyteller**

The report describes or shows how the students shared the story of their research in a creative way. This could be via a dramatic interpretation, a blog, Instagram post, artistic rendering, or any other way to creatively share what the students learned.

Results

These results suggest that there is no correlation between alkalinity levels and water pollution. There were outliers, including one in alkalinity on the first day of testing and one in conductivity on the last day. The outlier could have been due to any number of factors, including but not limited to: runoff, temperature, and pressure on the water. To start, the alkalinity on the first day could have acted as a buffer to any possible acidic substances the rain washed into the river. This would mean any damaging substances swept up by the sediment on the first day would affect the lake less because of its high alkalinity. The latter two days had a higher, basic pH and a low alkalinity. The mix of these numbers tends to mean an easily fluctuating environment. At any time given time, the pollution levels in the river could be low or high, and just alkalinity can not be relied on to figure that out.

The hypothesis- if the alkalinity levels in a river are higher than normal, then there is a higher percentage of pollution in the water because the pH levels will be lower and the electrical conductivity will be higher- was not supported. The pH levels increased while the conductivity levels remained mostly constant. These results were most likely obtained because the pollution of water does not just depend on alkalinity, but also how people treat their garbage. They can either recycle items and dispose of them responsibly or dispose of any materials in any way, which can include dumping them in rivers; one of the main causes of pollution (National Resources Defense Council, 2023). This particular river has been cared for by the residents of the village, and measures have been taken to reduce the pollution in it. Alkalinity levels wouldn't be sufficient enough to see pollution levels in this particular river.

However, if this experiment were conducted at other rivers, the results would have alluded to more of a correlation between water pollution and alkalinity. There also may have been errors in testing the alkalinity of the samples, too much titration B added to any of the water samples would mess up the results. Also, if there were more testing days, more accurate measurements could have been found, as well as additional rivers or water sources being tested. The hypothesis also said that lower pH would correlate with high alkalinity and more pollution, but higher pH also occurs in alkaline conditions (as alkaline is a synonym for basic), meaning it is possible the research data, in regards to pH, was uncertain if a lower or higher pH could prove the hypothesis. In the end, the hypothesis was not supported. It is not clear whether a higher alkalinity leads to more water pollution.

Figure #1

Ottawa River Water Data

Ottawa River	11-13-24	11-26-2024	12-05-2024
Temp of H2O (ºC)	15	3.1	1.1
Conductivity (µS/cm)	1210	1210	1517
Alkalinity (mg/L)	400	161	207
pH	6.53	7.26	7.30

Fig. 1. the various tests on the Ottawa River with information about the temperature of water, the conductivity, alkalinity, and pH provided in the lab.

Discussion

Since this experiment didn't prove the hypothesis, it cannot be stated that with increased alkalinity, there are more pollutants in the water. However, more research can be done to figure out what really causes an increase in water pollution. In the future, more rivers and other bodies of water can be tested with a longer period of testing days to further if indeed high alkalinity and conductivity does in fact relate with higher levels of water pollution. In addition, samples from the water can be examined to see the percentage of pure water compared to other substances in it to see if the connection is valid. A wise choice would also be to check other properties of water like dissolved oxygen or salinity to see if either of those also play a part in discovering what is in our water (Pollution and Water Quality, 2000). Further study of this question would help our water and planet be healthier for all plants and animals to live in.

Conclusions

Obviously, pollution is a huge problem in the world, and water pollution makes up a good portion of it. Metals are one of the causations of unhealthy river water, and more metal presence in a body of water can be affiliated with higher alkalinity. This experiment hoped to prove that higher alkalinity would also lead to higher conductivity with lower pH. The amount of water pollution was measured by seeing if the conductivity would increase with more alkalinity. The hypothesis was not supported, as the conductivity didn't change in correlation with the alkalinity, and the pH got higher as well. Other data sources did indeed mention that more alkalinity could lead to toxicity and algae blooms (The Alkalinization of Eastern Rivers and Streams, 2013). The last testing day most likely had the outlier in conductivity due to the significant decrease in temperature. This project is important so people can understand the factors that can cause a body of water to be more polluted, and by discovering the causes, solutions can be put in place. Water pollution is indeed still an issue on the planet, so by conducting experiments like these, findings can be made to solve the problem.

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