The Impact of Rising Atmospheric Temperatures on River pH

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THE GLOBE PROGRAM
Global Learning and Observations to Benefit the Environment

Abstract

The objective of this experiment was to determine how air temperature affects water pH, which is important to see the effects of global warming to aquatic environments. Monitoring water pH provides context as to how ecosystems are affected. We proposed that if air temperature increased, the pH of river water would have decreased because increasing the temperature will cause more water to evaporate, and increased concentration of H^+ ions in the water will decrease the pH. Water samples were collected from the same site over the course of 10 days, with three 60 mL samples per day. The appropriately ranged pH paper was used to measure water pH, and air temperature was recorded with a thermometer. Upon conclusion of its collection, all of the documented data was uploaded to Globe. We then analyzed it, determining whether there was statistical significance. Since there was, from this experiment, we concluded that water pH significantly changes based on the outside air temperature, supporting our hypothesis. These findings highlight potential risks to aquatic ecosystems as global temperatures rise.

Research Question

Asking Questions

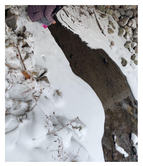
Areas like rivers, and their offshoots, such as streams, are crucial parts of our environment, providing water and homes for different species like plants, animals, and people. Water pH, a crucial factor of river and all water, shows how acidic or basic water is, and affects the health of all living organisms that depend on the water source. However, the pH of water is not a standalone factor, independent of everything around it. Rather, it can be affected by many other conditions, one of which is air temperature. Due to temperature fluctuations throughout the year, and the steady increase globally due to climate change, river conditions, and therefore the interdependent species, could be affected severely. Therefore, the question was posed: how does the air temperature around us actually have an effect on the pH of local waters?

Introduction

Content Knowledge

Due to its importance and significance in a warming world, studies have already been conducted on this relationship. For example, a study conducted by various researchers on the Nairobi River explored the relationship between meteorological activities and surface water quality on environmental health. They explored many parameters, including rainfall, temperature, water pH, and others. Within their research they discovered, "The regression analysis for pH yielded a remarkably high multiple R2 value of 1.00, indicating a very strong relationship with Rain and Temperature." As the paper progressed, the researchers also observed a statistically significant, moderate positive correlation between pH and Temperature, with an R2 value of 0.49.

In addition, another study conducted by researchers in the Jiaozhou Bay from spring to summer indicated similar results. Their study set out to find the impact of environmental factors on both sea surface pH and aragonite saturation state. While doing this, they observed the relationship between temperature and both aforementioned factors. They found that an increase in temperature leads a body of water to release more carbon dioxide in order to maintain equilibrium with the environment. This in turn increased the surface pH of the tested waters, showing an indirect, but positive, relationship between air temperature and water pH.



Field Photos

(requires release forms)

Research Methods

Planning Investigations

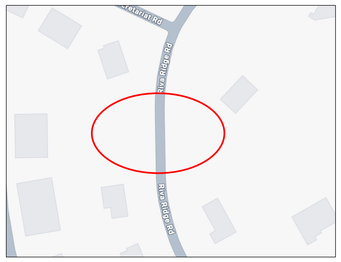
Describes the planning process

- Go to the desired site: must have a water source
- Record the outside air temperature at the site with the thermometer
- Take 3 separate 60ml samples of the water
- Use pH paper to test the pH of each of the samples
- Compare the color of the pH strip to the pH chart
- Record data in the data table
- Repeat steps #1-5 for 10 different days
- Upload data to Globe

Carrying Out Investigations

Describes what happened

- The GLOBE protocols we used were Air Temperature, where we use a thermometer to measure and record the outside air temperature; and water pH, where we use pH paper and dip in it the water to determine the water pH.
- We went underneath the bridge to the Ottawa River stream, and used 3 plastic containers to collect approximately 60 mL of water, and there we also tested the pH, recorded the data, and then threw the water back.
- When we collected the data, we recorded the date, outside air temperature, and water pH of each sample. Later, we averaged the pH samples and created SEMS, STD, and 2 SEMS, to show the variation of the data rather than just the average..
- We collected 3 samples of the data for 10 days, one of us collected the water while the other recorded the temperature, and both of us determined color of the pH paper.



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.

Results

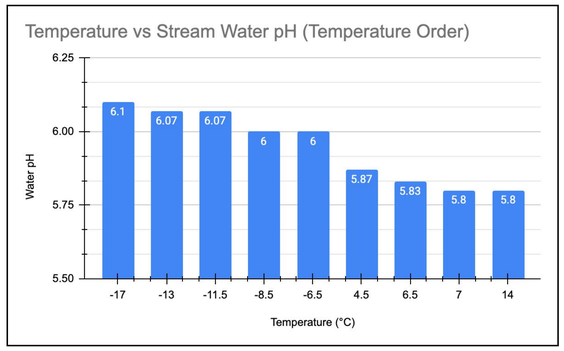
Analyzing Data

From our data, we can see that overall, as the temperature of the air increases, the water pH decreases. This data trend supports the research that was previously discussed in our background research paper. In figure two, we can see that at the warmer temperatures (4.5-17 degrees celsius) there is no statistical difference. In addition, we can see the colder temperatures (-17 - -6.5) have a statistical difference in the data between -17 & -11.5 and the data between -8.5 & -6.5, but are overall very similar. However, there is a significant difference between the pHs of the warmer temperature set and colder temperature set.

Figure #1

Date	1/24	1/23	1/28	1/27	1/22	11/18	11/16	11/17	11/14	11/15
Outside air temp	-17°C	-13° C	-11.5° C	-8.5° C	-6.5° C	4.5° C	6.5°C	7°C	14°C	17°C
pH test sample #1	6.1	6.1	6	6	6	5.8	5.9	5.8	5.8	5.8
pH test sample #2	6.1	6	6.1	6	6	5.9	5.8	5.8	5.8	5.7
pH test sample #3	6.1	6.1	6	6	6	5.9	5.8	5.8	5.8	5.8
Average pH	6.1	6.07	6.03	6	6	5.87	5.83	5.8	5.8	5.77
STD	0	0.06	0.06	0	0	0.06	0.06	0	0	0.06
SEMS	0	0.03	0.03	0	0	0.03	0.03	0	0	0.03
2 SEMS	0	0.06	0.06	0	0	0.06	0.06	0	0	0.06

Figure #2



Discussion

Interpreting Data

The results from our experiment shows that air temperature has a significant effect on river water pH. A statistically significant difference was found between the pH values measured at warmer temperatures compared to colder temperatures, with warmer outdoor temperatures resulting in higher pH values, and vice versa for colder outdoor temperatures. Similarly, this can be seen in previous research around the world. Studies conducted at the Nairobi River showed a strong relationship between higher temperatures and higher pH.

These results directly support our hypothesis that air temperature affects river water pH. Our results were consistent with what was expected based on our background research. A scientific analysis for this relationship is that water, upon an increase in temperature, separates into components, one of which is H+. The increase in H+ concentration decreases the pH of the water. Overall, the experiment effectively tested our hypothesis that air temperature affects river water pH. The observed trend supported the hypothesis, and the results were consistent with expectations.

Although the experiment aligns with previous studies and our hypothesis was supported, to improve the validity and reliability of this experiment, there are still improvements that could be made. The use of pH paper has limited accuracy as it relies on visual color comparison, which can be subjective. Environmental factors such as rainfall or biological activity may have influenced water pH independently of air temperature. To improve the experiment, a digital probe to collect pH or collecting data for a longer period of time would help reduce uncertainty.

Overall, the experiment effectively tested our hypothesis that air temperature affects river water pH. The observed trend supported the hypothesis, and the results were consistent with expectations.

Conclusions

Drawing Conclusions & Next Steps

Our hypothesis was accepted, as there was a significant statistical difference between the pH of water at the warmer temperature set and colder temperature set. Within this experiment, we had many successes. We kept variables constant by going to the site at approximately the same time each day, and using the same type of pH paper to measure and record our data. We also made sure to assess our data for statistical significance through the calculation of standard deviations and standard error of the mean. If we were to investigate further, it would be beneficial to include more temperature ranges. However, this would require a longer data collection period, such as over the course of the year. In addition, if we were to improve upon this experiment, we would test multiple sites in order to determine if the observed phenomenon was site-specific, or a generalized conclusion.

This research is significant, especially in today's world. With global temperatures consistently on the rise, it's important to study the impacts this will have on our planet. Many organisms rely on aquatic habitats to maintain their lives. However, the changing pH in response to the global temperature rise may limit the aquatic life sustainable by rivers, lakes, and even oceans. Therefore, we must prematurely assess the consequences in order to better prepare for this eventuality.

Bibliography

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