An Analysis of Fifteen Years of GLOBE Hydrologic and Atmospheric Data Collected in Southeastern Michigan

Mohammed Ali Al-Sabeh, Noor El Fadl, Maryan Farhat, Hala Komaiha
Crestwood High School, Dearborn Heights, MI

Abstract

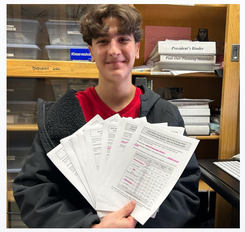
In this project, student researchers analyzed the relationship between air temperature and key **water quality** parameters over a fifteen-year period in Southeastern Michigan. This study focused on how fluctuations in **air temperature** correlate with water temperature, **dissolved oxygen levels, nitrate levels,** and **pH levels**, providing insight into potential environmental trends. Data collection took place annually in early May from 2009 to 2024, ensuring consistency in seasonal conditions. By examining long-term patterns, the researchers aimed to determine whether rising air temperatures influence **aquatic ecosystems** and water quality parameters. The research involved field data collection using standardized measurement techniques to minimize human error and ensure data reliability. Temperature and water quality readings were taken at the middle branch of the **Rouge River**. Dissolved oxygen levels were measured to assess aquatic health, while nitrate levels provided insight into nutrient pollution. pH levels were recorded to track changes in water acidity or alkalinity, which can impact aquatic life. The findings of this study contribute to understanding the broader implications of **climate change** on freshwater systems. By identifying trends in air and water temperature relationships, as well as shifts in water chemistry, this research provides valuable data for **environmental monitoring** and conservation efforts. Future studies can expand on this work by incorporating additional variables, such as precipitation patterns and land use changes, to further explore the interactions between climate and **freshwater ecosystems.**

Discussion

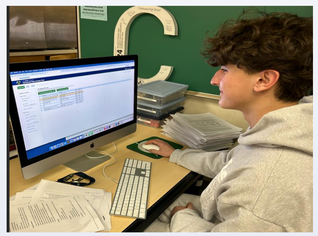
To reduce uncertainty, the study could be expanded to account for factors such as geographical variation, inconsistent sampling methods, and potential seasonal or temporal changes. For example, limiting the study to a single season may overlook fluctuations in water quality caused by human activity, storms, or biological factors like species composition changes throughout the year. Variations in sampling frequency, time of day, or equipment calibration can also introduce errors. Additionally, unmeasured pollutants, such as heavy metals or pharmaceuticals, could influence water chemistry, leading to potential inaccuracies. Nutrient loading from sources like agricultural runoff or wastewater discharge could vary seasonally, and the impacts of climate change might alter temperature patterns, precipitation, and other environmental factors, further increasing the level of uncertainty. By expanding the study over multiple seasons and ensuring consistent methodologies, these variables could be better accounted for, leading to a clearer and more reliable understanding of the relationships between environmental factors. In the future, researchers could measure water quality parameters during various times of the day, allowing for a more comprehensive understanding of the impact hydrological factors have on aquatic systems. Moreover, this research could be expanded to the other two branches of the Rouge River Watershed to strengthen previous research. Also, by working with the local Dearborn Heights Stewards Commission and its student commissioners, researchers could highlight issues regarding water quality to expand environmental protection efforts.

Methodology

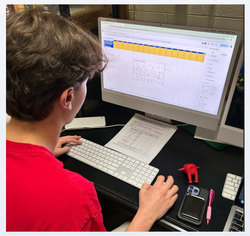
Over 15 years, student researchers gathered hydrologic and atmospheric data from the Rouge River's middle branch to track trends.



Researcher organizes data in chronological order.

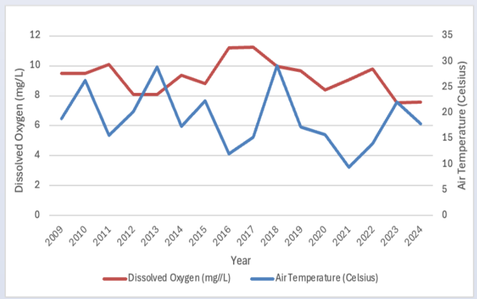


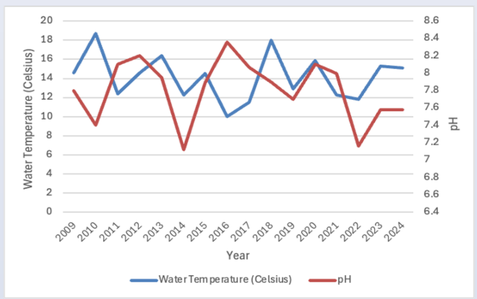
After analysis, researchers input data into the GLOBE database.

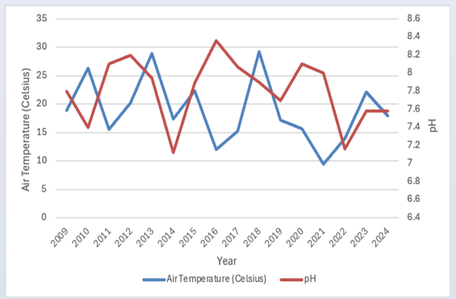


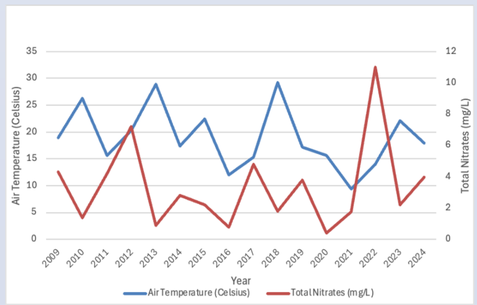
Researchers input data into a spreadsheet for analysis.

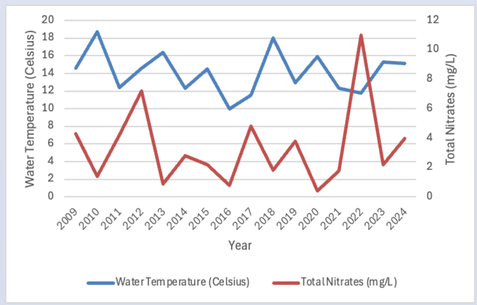
Results

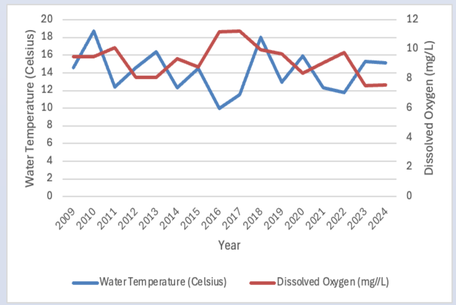












Research Questions

1. Is there a chronological relationship between atmospheric variables, such as air temperature, and hydrologic variables, such as water temperature, dissolved oxygen, pH, and nitrates?

2. Is there a chronological relationship between water temperature and dissolved oxygen, pH, and/or nitrates?

3. Has there been a significant change in the levels of atmospheric and hydrologic variables between 2009 and 2024?

Null Hypothesis

1. There is no chronological relationship between atmospheric variables, such as air temperature, and hydrologic variables, such as water temperature, dissolved oxygen, pH, and nitrates.

2. There is no chronological relationship between water temperature and dissolved oxygen, pH, and/or nitrates.

3. There has been no significant change in the levels of atmospheric and hydrologic variables between 2009 and 2024.

Conclusion

At the end of the fifteen-year study period, the researchers concluded that air temperature and water temperature can significantly impact select water quality parameters, such as dissolved oxygen, total nitrates, and pH. A strong, indirect relationship was observed between almost all these parameters in correlation to air and water temperature - apart from pH vs. water temperature and air temperature vs. water temperature. The difference between air temperature in comparison to dissolved oxygen levels, total nitrate concentration, and pH levels were notable, with a yearly increase in air temperature corresponding to a decrease in these water quality parameters and vice versa. Moreover, similar inverse trends were seen with water temperature to dissolved oxygen levels and total nitrate concentration, with each yearly increase in water temperature corresponding to a decrease in DO levels and total nitrate concentration. In contrast, air temperature and water temperature demonstrated a directly proportional relationship. On the other hand, little to no correlation was found between water temperature and pH levels, suggesting that while these conditions can influence aquatic systems, their impact is not significant. The information from this research has significant implications for climate change. Spanning a period of fifteen years, this study presents the opportunity for further analysis and expansion to include other branches of the Rouge River Watershed, thereby fostering a broader understanding of the impact of climate change across various geographic locations.

Acknowledgements

Thank you to Friends of the Rouge for the constant support over the years. Thank you also to Mr. Bydlowski of the GLOBE AREN for providing many of the equipment necessary to properly perform this research, as well as Dr. Czajkowski at NASA GLOBE Mission Earth at the University of Toledo. Finally, thank you to Mrs. Diana Johns, the GLOBE and Science Club advisor, as without her guidance, it would not have been possible to complete this research.

Citations

Improved dissolved oxygen status following removal of exotic weed mats in important fish habitat lagoons of the tropical Burdekin River floodplain, Australia. (2005). *Marine Pollution Bulletin, 51*(1–4), 138–148. https://www.sciencedirect.com/science/article/abs/pii/S0025326X0400400X

Is monitoring science? (2007). In *Front Ecol Environ* (Vol. 5, Issue 5, pp. 253–260). The Ecological Society of America. https://www.fs.usda.gov/nrs/pubs/gtr/2007/nrs_2007_lovett_001.pdf

Lehmann, K., Bell, T., Bowes, M., Amos, G., Gaze, W., Wellington, E., & Singer, A. (2016). *Trace levels of sewage effluent are sufficient to increase class 1 integron prevalence in freshwater biofilms without changing the core community*. https://www.semanticscholar.org/paper/Trace-levels-of-sewage-effluent-are-sufficient-to-1-Lehmann-Bell/96bd53ea81c04b8279545 1d178572d67fecd37d1

Ozaki, N., Fukushima, T., Harasawa, H., Kojiri, T., Kawashima, K., & Ono, M. (2003). Statistical analyses on the effects of air temperature fluctuations on river water qualities. *Hydrological Processes, 17*(14), 2837–2853. https://doi.org/10.1002/hyp.1437

Reyes-Silva, J., Bangura, E., Helm, B., Benisch, J., & Krebs, P. (2020). The role of sewer network structure on the occurrence and magnitude of combined sewer overflows (CSOs). *Water, 12*(10), 2675. https://doi.org/10.3390/w12102675