Effects of Climate on Nutrient Pollution in the Chesapeake Bay Watershed

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ES 245 Hydrology & Limnology

Abstract

As the nation's largest estuary, the Chesapeake Bay is ecologically and economically significant. It is being impacted by nutrient pollution, which can lead to the harmful algal blooms that deplete the water of dissolved oxygen and make the habitat unsuitable for aquatic life. These impacts have degraded benthic communities and disrupted natural processes that regulate nutrients. Warmer stream temperatures can cause more nutrients to be released from the sediments of rivers that flow into the bay, which worsens the problem. Data from the Susquehanna and Potomac Rivers was used in this study to analyze the relationship between water temperature, precipitation, and nitrogen nutrient content. Trends in the rivers during the past year were compared. The most significant trend observed was the increase of nitrate and nitrite content in both rivers during the winter months. This may have implications for harmful algal blooms in Chesapeake Bay.

Conowingo Dam.

Potomac River near Washington, D.C.

Introduction

It is important to understand nutrient pollution in the bay because excessive nutrients lead to the growth and decay of algal blooms that deplete the water of dissolved oxygen (Langland, Moyer, & Blomquist, 2007). This phenomenon is called eutrophication, and it causes oxygen-poor water conditions that are unsuitable for aquatic life. (Kemp, et al., 2005). Plans to decrease nutrient pollution in the Chesapeake Bay have been implemented, yielding mixed results. (Ator, Blomquist, Webber, & Chanat, 2020). The relationships between climate, water temperature, and nitrogen content were analyzed in order to better understand the causes and fluctuations of eutrophication in the Chesapeake Bay.

Methods

Data on water temperature and combined nitrate and nitrite content was obtained from USGS monitoring sites in the Susquehanna and Potomac Rivers. Precipitation data was obtained from USGS atmospheric monitoring sites near the location of the stream sites. The data collected was from April 2020-April 2021. Trends in the rivers during the past year were compared. In addition, nitrogen data for as many years as available was obtained and compared to precipitation data.

Results

Susquehanna River

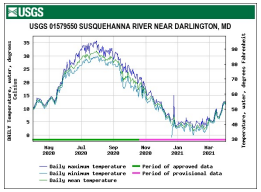

Figure A. Water Temperature.

Potomac River

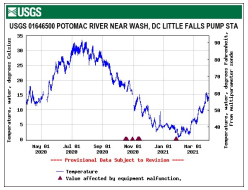

Figure B. Water Temperature.

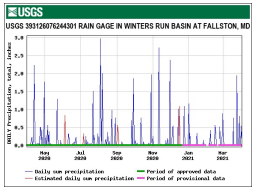

Figure C. Precipitation.

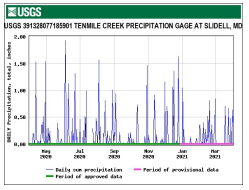

Figure D. Precipitation.

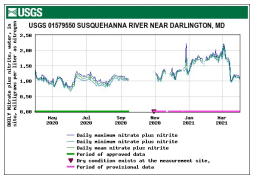

Figure E. Nitrate and Nitrite Content.

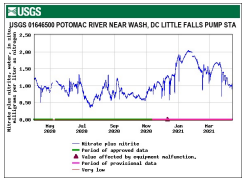

Figure F. Nitrate and Nitrite Content.

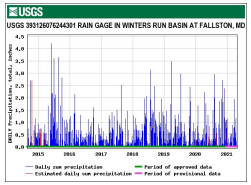

Figure G. Long-term Precipitation.

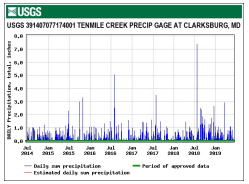

Figure H. Long-term Precipitation.

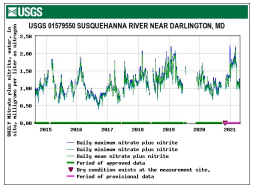

Figure I. Long-term Nitrate and Nitrite Content.

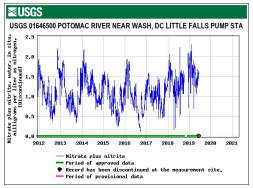

Figure J. Long-term Nitrate and Nitrite Content.

- Nitrogen concentrations were highest in winter, despite the lower water temperatures.
- Nitrogen content tended to decrease during months with higher rainfall in the Potomac.

Conclusion

The most significant trend observed was the increase of nitrate and nitrite content in both rivers during the winter months. This was shown in both the year-long and long-term data (Figures E, F, I, and J). Another study found an increase in nitrate in streams during the winter. One possible explanation given by the researchers is the decrease of consumption of nitrate by algae during the winter due to the decrease in sunlight (Lee, Lorenz, Petersen, & Greene, 2012). Water temperature at both sites increased during the summer and decreased during the winter in correlation with the air temperature (Figures A and B). In the Potomac River, precipitation and nitrogen content appeared to have an inverse relationship during the past year (Figures D and F). In addition, the Potomac River received more precipitation overall. There was no obvious trend for the correlation between precipitation and nitrogen in the Susquehanna River during the past year (Figures C and E). Overall, the Potomac River site appeared to have more variation in nitrate and nitrite levels than the Susquehanna River site (Figures E and F). One key difference between the sites is the location. The Susquehanna River site is located just south of the Conowingo Dam, and it is impacted by fertilizers in agricultural runoff from Pennsylvania. Sediment and nutrient loading at the dam is a significant issue (Palinkas, Testa, Cornwell, Li, & Sanford, 2019). The Potomac River site is less impacted by agriculture because it is in Washington, D.C. Further research could consider the effects of streamflow on nutrient loading in the Conowingo Dam.

References

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