How does Water Turbidity In a Certain Location Fluctuate Over Time Given Environmental Factors?

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Abstract

This project targets the understanding of human and environmental effects on water turbidity in various locations. We looked at multiple different factors in order to create our hypothesis. With the hypothesis "If rainfall and human activity increase, then turbidity will also increase due to the introduction of suspended particles into the water," we dove into how different factors develop an unstable and unhealthy predicament for water clarity. We found no anomaly in our project as our findings consistently matched up with our hypothesis. We hope that further discovery could lead to changes around water activity to keep turbidity low.

Research Question

How does Water Turbidity In a Certain Location Fluctuate Over Time Given Environmental Factors?

Introduction

his research focuses on the question: How does water turbidity in a certain location fluctuate over time given environmental factors? The study examines turbidity measurements collected on different days and explores how changes in weather, human activity, and natural conditions influence water clearness. This investigation has brought up several questions. What environmental conditions contribute most to fluctuations in turbidity? Does increased rainfall correspond with higher turbidity levels? To what extent does human activity, such as pollution, impact water clarity? Based on these considerations, our hypothesis is: If rainfall and human activity increase, then turbidity will also increase due to the introduction of suspended particles into the water. Water quality is an important issue for both ecological health and public safety for those drinking it, and turbidity is a significant factor in assessing it. Elevated turbidity can disrupt aquatic ecosystems, limit light penetration, and indicate potential contamination. The clarity of water is not constant; it shifts due to various influences, including seasonal weather patterns, erosion, and industrial or urban runoff. This project explores these changes to better understand their causes. The Ottawa River serves as an essential freshwater resource, supporting ecosystems, recreation, and possibly local water supplies. However, external influences can impact its quality, making it necessary to examine how and why turbidity levels vary.Turbidity is a measurement of water's clarity, determined by the concentration of suspended particles such as sediment, organic matter, and pollutants. According to the U.S. Environmental Protection Agency, turbidity in drinking water should not be over 1 FTU (Formazin Turbidity Units), in order to ensure safe, uncontaminated drinking water. Natural and human-induced factors, including precipitation, deforestation, and land use changes play a role in turbidity level shifts. Understanding the patterns behind turbidity fluctuations is crucial for monitoring water health and identifying potential risks. If rainfall and human activity contribute to increased turbidity, it could uncover patterns in areas of high impact. In conclusion, the goal of this experiment is to figure out how water turbidity in a certain location fluctuates over time given different environmental factors. Looking at existing research alongside data collected, it is to be determined whether or not environmental conditions are directly linked to changes in water turbidity over time.

Research Methods

This experiment collected data through the protocol of water sampling. For this method, there is the option to use either a transparency tube or a Secchi disk to measure water turbidity. With a transparency tube available, that is the route we took. Data was collected spread out across four dates to mark data in different conditions; November 8, November 26, December 2, and December 6. Water samples were collected in the transparency tube at each date, out of a bucket. The water in this bucket was collected from the same location on the Ottawa River by Dr. KG. We filled up the tube to see when the disk at the bottom wasn't visible indicating the turbidity of the water, and recorded these data points on a google doc. We didn't use many materials for our protocol. It required: a transparency tube, water from the Ottawa River, the bucket to hold the water, and the laptop to collect the data. This experiment is easily repeatable and could be improved by collecting more data points across a longer period of time.

References

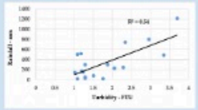
Chen, X., Chen, W., Bai, Y., & Wen, X. (2021, August 14). *Changes in turbidity and human activities along Haihe River basin during lockdown of COVID-19 using satellite data - environmental science and Pollution Research*. SpringerLink. https://link.springer.com/article/10.1007/s11356-021-15928-6

Hao, Q. N. (2017, August). *(PDF) spatiotemporal variation of turbidity based on Landsat 8 Oli in Cam Ranh Bay and Thuy Trieu Lagoon, Vietnam*. Research Gate. https://www.researchgate.net/publication/318993756_Spatiotemporal_Variation_of_Turbidity_Based_on_Landsat_8_OLI_in_Cam_Ranh_Bay_and_Thuy_Trieu_Lagoon_Vietnam

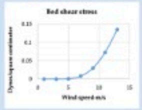
Swanton, oh weather historystar_ratehome. Weather Underground. (n.d.). https://www.wunderground.com/history/monthly/us/oh/swanton/KTOL/date/2024-11

Presentation of Data & Results

Our collected data was flawed given that the turbidity tube used was not long enough to mark specific data points. On each day of turbidity measurement, it was recorded that the transparency of the water was >100, which was marked as the highest unit on the tube. However, through extensive research, previous experiments have proved useful for testing our hypothesis.



This chart, derived from a 2017 study in a bay and lagoon in Vietnam, shows the direct correlation of rainfall and increased turbidity. As rainfall increases, the turbidity generally increases, reaching a peak of about 3.7 FTU on the day with highest rainfall (1200 mm). (See Fig. 1)



This graph shows how higher wind speeds create more bed shear stress in the water. This stress is what allows for suspended particles from the bank and floor to enter the water, therefore increasing the turbidity. Therefore, high wind speeds, which are often coupled with rainfall, increase turbidity. (See Fig. 2)

This graph depicts a study on the Haihe River during the Covid-19 lockdown. At the peak of the lockdown, March 2020, meaning the least human activity by the river, the NDTI was the lowest, meaning that turbidity was the lowest as well. (See Fig. 3)

These results suggest the clear impact of rainfall and human activities on the turbidity of different bodies of water. With water turbidity reaching a peak of 3.7 FTU due to high rainfall, the rain directly affects turbidity as it, combined with high wind speeds, loosens up sediment and stresses bed shears. As for human activity affecting turbidity, high agricultural and urban activity creates a higher turbidity in nearby bodies of water. This is due to loosened up soil and runoff. If this experiment was to be done again, a longer turbidity tube would be used, in order to develop accurate data sets of our own in the Ottawa River. For the moment, our data of transparent Ottawa River water makes sense, as rainfall was low around times of measurement, and there is no agricultural activity around our part of the river.

Discussion

Turbidity is an important factor in environmental health, along with the health of humans who drink the water. Fish and other organisms living in the water can be affected with high volumes of sediment in the water. Higher turbidity impacts aquatic plants, as it blocks necessary sunlight from penetrating the water and giving these plants benefits. Understanding how to keep turbidity low can improve the health of various ecosystems. To start, lowering human activity along rivers and bodies of water would have an immediate effect. Along with this, building more dams would help control sediment flow from rain and runoff.

Conclusion

In conclusion, we found our hypothesis "if rainfall and human activity increase, the turbidity will also increase due to the introduction of suspended particles into the water" accurate. Our data proves our hypothesis by including necessary graphs of certain times of low human activity, wind speed graphs, and rainfall relations to water turbidity. A more in-depth analysis of the graph of a river in March of 2020 provides us with enough information to support our claim. In the graph pictured above, the river had the lowest turbidity during the lowest times of human activity. This was shown at this time during the COVID-19 lockdown. While our experiment data doesn't exactly replicate online graphs and examples like these, we can assume that with a longer turbidity tube our data would be more similar. For example, with more rainfall and human activity, we could expect a higher turbidity value, and with less rainfall and human activity, we could expect a lower turbidity value.

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