pH: A Common Denominator Across Earth Systems

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Abstract

The purpose of this experiment is to determine if soil pH is affected when watered by polluted water. Is it possible to filter that water and return the soil to its original pH?

We think that pH is affected when polluted water is used to hydrate soil, making it unusable, but this pH can be reversed by applying filtration that can remove the soil toxins and return its pH to its original state.

To determine if the hypothesis supported the data, the following design was implemented. Samples were collected from three urban rivers. These samples were tested for basic water quality parameters and the results recorded for study and analysis. Tests conducted were: dissolved oxygen, water temperature, pH, nitrates, phosphates, copper, lead, turbidity and atmospheric data. Pertinent data that GLOBE collects was then uploaded through the Observer app.

All water samples were then filtered through four brands of filtration systems: Brita, Pur Basic, Pur Plus, and Zero Water. For each river, ten trials were run for each system tested. Each sample was tested for pH changes.

The data did partially support the hypothesis. Different protocols were affected by different systems. Brita apparently was the most effective in restoring and improving the impacted soil plots. Further research on a much larger scale is necessary to fully support this hypothesis but enough evidence exists that suggest it is a worthwhile study.

Research Questions

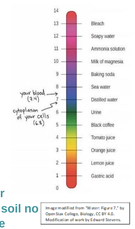
- Does watering soil with a known polluted water source change the original pH of the soil, rendering it unusable for growing plants?
- Can you filter the water to change or reverse the outcome?
- Does the pH in one area would affect the pH of another area?
- Does the pH in water affect the pH in the soil it hydrates?
- Can this pH can be reversed by applying filtration that can remove the soil toxins and return its pH to its original state?

Introduction

pH can be hard to understand. We hear about it all the time in the news, local farmers, medicine. But what really is it and why is it so important? First, it should be understood that EVRYTHING has a pH number and this measurement can be basically described in one word: balance. pH measures acids and bases and organizes everything we know into one group or the other. Your own body maintains a precise pH level and changing it can affect different areas of your health if it is not balanced.

pH is measured using whole numbers from 0 to 14. Everything is measured against water, which is given the number 7 and is considered neutral. If something has a number LOWER than 7, it is considered to be acidic. If the number is higher than 7, it is considered basic. Milk is given a basic number while battery acid is given the lowest number on record: 1. Too acidic, things start breaking down and eroding away. Too basic, and things just pile up, coating something. Both are a type of corrosion. Ideally, everything should be around neutral.

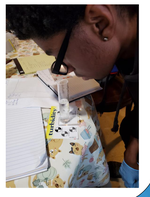
Some questions that arose: are whether the pH in one area would affect the pH of another. For example, does the pH in water affect the pH in the soil it hydrates? Most water that has been polluted has a lower pH from the Chemicals and toxins dumped into the water. Could this acidic pH polluted water change the original pH of soil, making it unusable for what was originally growing there? If so, could this pH be reversed, if the polluted water was filtered to remove most of the toxins? Could formerly ruined soil be restored?



These are exciting questions for our community because we are a unique setting in that there is an international port leading to the Atlantic and a large urban area which also is surrounded by agriculture: farmlands, cattle lands and the like. Much of our soil is polluted either from chemicals in the water from factories or from farmland. This has taken its toll on drinking water and on soil no longer useful for farming. Waste and other invasive materials also come from the international freighters coming through the ports.

The purpose of this experiment was to determine if soil pH was affected when it was watered by a known polluted water source. Was it possible to filter that water and return the soil to its original pH, making it useful again?

The questions researched asked: Does watering soil with a known polluted water source change the original pH of the soil, rendering it unusable for growing plant materials? Can you filter this water to change or reverse the outcome of the soil?



Research Methods

The research team's developed hypothesis states that pH is affected when polluted water is consistently used to hydrate soil, making it unusable for growth of plant materials but it can be reversed by applying filtration methods that can remove the soil toxins and return soil pH to its original pH.

Samples were collected from three urban rivers known to be polluted. These are the Ottawa, the Rouge River, and the Huron River. These samples were tested for water quality parameters and the results recorded for study and analysis. **Tests conducted were: dissolved oxygen, water temperature, pH, nitrates, phosphates, copper, and lead. Turbidity and atmospheric data were also collected and uploaded to NASA GLOBE via the Observer app.**

All water samples were collected and then filtered through four brands of filtration systems: Brita, Pur Basic, Pur Plus, and Zero Water. For each river, ten trials were run for each system tested. Each sample was also tested for pH changes. The unfiltered water was also tested for all parameters to establish a baseline. The filtrated results were tested and compared with the original over a two-week period of daily application of water. The control group was watered with spring water while the rest received the polluted water and purified water. A total of 160 soil plots were tested.

Data was collected and analyzed to determine if the hypothesis was supported or disproved. The stated hypothesis was that pH is affected when polluted water is consistently used to hydrate soil, making it unusable for growth of plant materials BUT it can be reversed by applying filtration methods that can remove the soil toxins and return the pH to its original state.

GLOBE Data Used

- The GLOBE data used was primary data; we gathered it ourselves.
- Using GLOBE hydrology protocols, we collected data using the following parameters: Dissolved Oxygen, air and water temperatures, atmospheric data requested through the Clouds protocols on the ***Observer*** app, Nitrates, Phosphates, soil and water pH, GIS system data, and site description for each location sampled. Lead and copper tests were also performed.
- The data gathered and analyzed is what will either support or disproved our hypothesis.

Carrying Out Investigations

1.The GLOBE protocols used were from both the hydrosphere and the atmosphere systems. Data presented here was uploaded to the GLOBE database using the *Observer* app. We were unable to locate data useful to our research from the data already uploaded from other researchers.

2. The data collection at the various sampling sites were the best part of our research. The most challenging site was the Ottawa River because we wanted to sample in the city and it was difficult finding a site we could access. Once we located the site, getting the water necessary for testing was not as difficult because we really worked as a team to collected the samples. The most difficult part was being really, really cold due to the frigid temperatures outside. The sign posted stated there had been a lot of river clean up in this little park so we thought there would not be much pollution in this urban river but we were very mistaken. The water samples smelled terribly, the color was an off yellow and there were high levels of pollution still present in the water. Our teacher warned us not to spill any in her van! Sample collection at the other two rivers were easier, except we ran out of large tubs to store the water in and it was cold and tedious pouring that water into gallon water jugs. Both the Rouge River and the Huron river samples were clear, and did not smell. Even though it was really cold, we enjoyed gathering the water because we worked well as a team. We have decided that we will do this again but maybe in the summer when it is warmer outside.

Huron River@ Huroc Park

Ottawa River @ Harroun Park

Rouge River @ Ford Field Park

3. The data we collected was able to be used for different research projects. We knew we would need large amounts so we stored the water in extra cat litter tubs and still had to go back to the Huron River twice. We were sampling for water quality tests and to use it to water soil and check for pH. Others used it to actually water plant materials to see if they could get it to grow. We performed the basic water quality tests and ran ten trials for each type of sample. We were filtering raw water through four different types of filtration systems to see if we could restore the water to its original state of usability.

4. To gather water samples, we took a bucket on a rope and threw it into the water. Many times we wished we had a larger bucket because it took a while to fill those litter tubs up with water. Two of would throw in the buckets and hold the container while poring the water in. We also had to perform the dissolved oxygen test at the sampling site. It has to be done within ten minutes of collecting the water or it is not considered accurate. We also did atmosphere measurements while there and recorded in our log books what the site was like. We also located the GIS coordinates for each site and back home, looked up the google earth coordinates for these sites. Each of us took turns doing each activity so we would know how to repeat this in the future. We were very glad that the rest of the testing could be done inside. For the second part, each river had to be tested and then filtered through each of the filtration systems. We really did not know the amount of work we chose to do! After enough water was filtered, then each soil plot had to be waters and the soil tested for pH. Another surprise was that the soil test took one whole hour for each test! We did not want to spend 160 hours just doing the pH so we found a large number of clear jars that we could use and ran the test for each sample, several at a time. A few of our classmates helped us with that part. The time was waiting for the sample to settle so you could test the water portion of suspended soil without getting dirt on the test strip.

Results

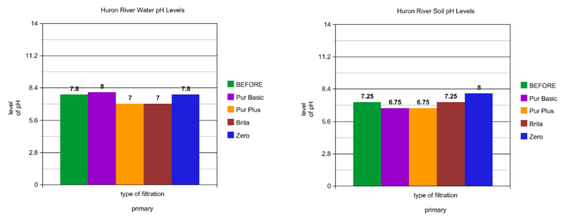
Both the Huron and Ottawa rivers had lead in the raw water and the one system that claimed to remove lead was **not** successful.

Huron River @ Huron Park
Flat Rock, MI
Collection Date: 31 January 2023
8:00 PM Local Time

	Raw water	filtration	systems	used	
Test	BEFORE	PB	PP	Brita	Zero
D.O.	4ppm				
Phosphates	6 ppm	4	2	2	1
Nitrates	14 ppm	0	5	5	5
Lead	YES		YES		
Copper	0.05 ppm	0.0	0.05	0.0	0.05
Turbidity	0 JTU				
Water pH	7.8	8	7	7	7.8
*Soil pH	7.25	6.75	6.75	7.25	8

Air Temperature: -8°C
Water Temperature: 7°C
Atmosphere: Cloudy
Wind Speed: WSW 6

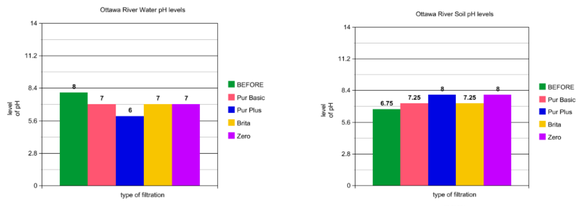
The green 'BEFORE' indicates original pH of substance before any filtration applied



Ottawa River @ Harroun Park
Toledo, OH
Collection Date: 31 January 2023
5:45 PM Local Time

	Raw water	filtration	systems	used	
Test	BEFORE	PB	PP	Brita	Zero
D.O.	4ppm				
Phosphates	2 ppm	6	2	6	1
Nitrates	35 ppm	35	25	23	5
Lead	YES		YES		
Copper	0.05 ppm	0.0	0.05	0.0	0.00
Turbidity	0 JTU				
Water pH	8	7	6	7	7
*Soil pH	6.75	7.25	8	7.25	8

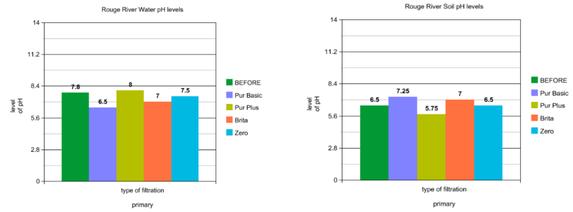
Air Temperature: -3°C
Water Temperature: 2°C
Atmosphere: 100% Cloudy; light snow
Wind Speed: WNW 7°C
Wind Chill: -8.88°C



Rouge River @ Ford Field,
Dearborn, MI
Collection Date: 31 January 2023
6:33 PM Local Time

	Raw water	filtration	systems	used	
Test	BEFORE	PB	PP	Brita	Zero
D.O.	3 ppm				
Phosphates	3 ppm	3	3	1	2
Nitrates	20 ppm	15	15	5	10
Lead	NO		NO		
Copper	0.05 ppm	0.0	0.0	0.0	0.5
Turbidity	0 JTU				
Water pH	7.8	6.5	8	7	7.5
*Soil pH	6.5	7.25	5.75	7.0	6.5

Air Temperature: -7°C
Water Temperature: 2°C
Atmosphere: 100% Cloudy; light snow
Wind Speed: SW 6°C



Discussion

- **Data was collected and analyzed to determine if the hypothesis was supported or disproved. The stated hypothesis was that pH is affected when polluted water is consistently used to hydrate soil, making it unusable for growth of plant materials BUT it can be reversed by applying filtration methods that can remove the soil toxins and return the pH to its original state.**
- **The results were staggering. A huge amount of data was collected and it was determined that many different answers might be found in the data for other questions besides the ones we generated. It was discovered that pH could possibly be modified by filtering the water that originally polluted the soil. However, not one brand of filtration system performed the best in every category that was examined. The only filtering system that claimed to remove lead did not remove it. The cost to examine every system and lead removal was too costly to permit this aspect of testing. It could be useful to further study this when a budget might allow the cost.**
- **For water pH levels, only the Pur Plus seemed unable to bring water to its desired pH level of a neutral 7. Brita was consistent across all three rivers in bringing the pH to neutral, certainly a desired position.**

Acidic polluted water about to change soil pH

Soil watered with Huron River tested

Preparing the soil pH by adding the water.

- The soil pH, however, every system seemed determined to bring it to a more basic level than its original level. The Huron River had two exceptions to this: Both Pur products rendered the soil more acidic than its original level. Brita had no change and Zero pulled it back to basic. All filtration devices were effective in reducing copper, nitrates, and phosphates found in the water. This would give a more positive impact on the soil as those toxins were removed before hydrating the soil. It would seem the lower pH levels prove this.
- The control variable, watered only with spring water did not change its pH levels either in the water or the soil.

Conclusions: Limitations /Real-World Experiences

- **The most obvious limits for this design were the shortness of time for the study and the small sample. Although 160 soil plots seemed huge to these researchers, it is understood that there are different types of soil and a lot more than we could access.**
- **Another issue was finding soil that was actually soil. We noticed many brands stated mix, not soil, and it was discovered that the growing substance was not soil at all, but ground up coconut shells. The time of year made it difficult for digging soil but a landscape company had actual soil which could be purchased.**
- **There might be other ways to alter or restore the soil, but the hope for this investigation was restoring both soil and water to balance out our earth systems.**
- **Who would be interested in this study? The answer is many. Farmers, city planners, gardeners, end consumers (families)to name a few. Hydrologists would be interested in the possibility of restoring water since water is not a renewable substance. City planners would be delighted to find ways to restore soil and water. Perhaps, if the soil could be filtered, the brown fields and nuclear waste fields might even be redeemed. NASA might even consider it for terra forming other planets.**
- **Next Steps**
- **In conclusion, the data did partially support the hypothesis. Different protocols were affected by different systems. Brita apparently was the most effective in restoring and improving the impacted soil plots.**
- **Further research on a much larger scale is necessary to fully support this hypothesis but enough evidence exists that suggest it is a worthwhile study. If the soil pH can be amended or reshaped to a particular level of pH, it might be possible to control what types of plant materials are being grown in a particular area.**
- **One example might be to grow corn in an area where none has grown because the soil is now at a pH level that supports this type of growth. Fruit trees can be grown in more acidic soils, perhaps even shaping the desert to provide for more population needs.**
- **It is certainly an area of great possibility; perhaps not just for Earth, but for the Moon or beyond.**

Bibliography

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