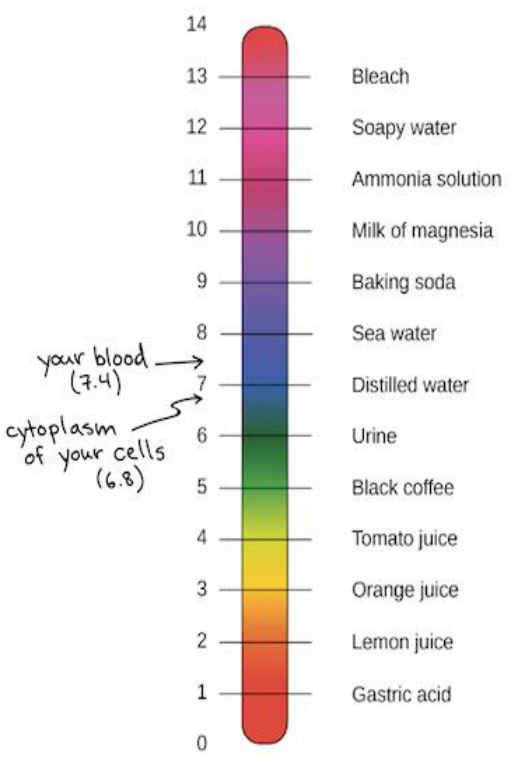
pH: A Common Denominator Across Earth Systems

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.

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.



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Both are a type of corrosion. Ideally, everything should be around neutral.

Some questions that arise 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?

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

The questions to be researched ask: 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 this water to change or reverse the outcome of the soil?

The Experimental Design

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.

To determine if the stated hypothesis supported the data, the following design was implemented. 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 for scientific study.

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.

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Analysis and Results

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.

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 the soil 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.

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Limitations and 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. Soil with a lot of clay might have performed differently that the type we were able to find. 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.

Conclusion:

In conclusion, the data did partially support the hypothesis. Different protocols were affected by different filtration 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

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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.

Next steps could also include the possibility of restoring water that previously had been considered unusable If designing a filter that can safely remove toxins, pharmaceuticals, and heavy metals is possible, then perhaps the deeply polluted water can also be cleaned, making it possible for waster water to be redeemed.

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Badges Earned:

1. Student Researcher (We submitted)
2. Collaborator
3. Impact
4. Data Scientist
5. Engineer

Collaborator

2. We are from different schools who met at an earlier Midwest Symposium and became friends. We worked together in gathering data, researching the implications of results, and even in gathering the soil and water we needed. We made our own field trips to each river and collected samples several times. London tested most of the water while I tested the soil for impacts.
3. **Impact:** We addressed local issues of polluted water impacting plant materials, not just growing food but in providing healthy environments for aquatic animals to live. The global issue of polluted water as well as our local waters can be impacted by our research. Our suggestions for further steps include modifying filtration systems to remove toxins and restore soil and water pH. We even connected this to NASA as a possibility of terra forming in the future.
4. **Data Scientist**: We collected a lot of data from our own research, discussed it's limitations, and made suggestions for improvements. Inferences to past events which caused these issues were referenced.
5. **Engineer**: We used filtration designs already in use to test for their efficiency but found they would need modifications or some sort of additive to make them work for this larger sized project. However, the fact that they did work to some extent, provides evidence that it is possible. In

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the past the literature suggests that it is impossible to restore polluted water or soil. Instead, it has been buried or vaults and covered over with more soil.

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