Soil Analysis Research Papers Summer 2014

Chapter 1: EFFECT OF ROAD SALT ON SOIL PH NEAR PARKING LOTS
Luisa A. Gil

1. Objective
Acid rain has been affecting Long Island for the past several decades. Scientists have conducted experiments to assess the harmful repercussions of acidity in the soil yet the magnitude of the increase in acid rain has not been unequivocally established (Cowling, 1982 and Cogbill *et al.,* 1984 and Schindler, 1988). Acids and bases are measured by what is known as the pH scale: solutions with a pH of less than 7 are acidic; those with a pH greater than 7 are basic; those with a pH of 7 are neutral (Hedin and Likens, 1996). During the winter here on Long Island, road salt is regularly used. Salt lowers the freezing temperature of water and thus melts street-clogging snow and ice. The salt neutralizes the acidity in the soil and raises the pH. My objective was to analyze the pH patterns of de-icing salt in soil near two parking lots, with and without a concrete curb. The soil samples collected at the second site were gathered to test if the calcium found in the concrete curb of the first site could alter the pH.

2. Background
2.1 Acid Rain
Acidic rain is a complex mixture of nitrous, nitric, sulfurous and sulfuric acids which all combine to lower the pH of soil (R. Donnelly, 2008). Acid rain reacts with minerals in the soil causing a decrease in pH. The H+ ions replace base cations in the soil such as magnesium, sodium, potassium, and calcium which serve as nutrients to the soil.

2.2 Road Salt
Sodium chloride and calcium chloride are the most commonly used deicers due to their effectiveness, availability, and low cost. When it runs off directly, or is splashed into the adjacent area of the parking lot it can neutralize the effect acid rain has on the soil (Zehetner *et al.,* 2009 Gil 3 and Ramakrishna *et al.,* 2005). When salt accumulates in the soil structure, it raises the soil pH and reduces water infiltration and soil aeration (Jull, 2009).

2.3 Location
To see the effect road salt has on soil, I collected samples from soil adjacent to the Earth and Space Sciences (ESS) building in a perpendicular path. These samples were taken along the near vertical path, perpendicular to the ESS parking lot. A 9 feet un-certainty may have caused inaccurate GPS location. The parking lot is completely surrounded by a concrete curb that could also affect the pH, therefore I also collected samples from the South parking lot on Stony Brook University Cam-pus that does not have a curb. The location of samples was taken along the near vertical path, perpendicular to the South parking lot.

3. Method

Four holes were used to collect 16 samples on July 8th and July 29th at the ESS and South parking lot locations respectively. Samples were collected at 0m, 1.5m, 3m, and 4.5m away from the parking lot with depths of 0-2cm, 4-6cm, 8-10cm, and 20 cm in each hole (Figure 1).

Figure 1: Holes where samples were collected at ESS area (left), and South parking lot area (right).

My peer dug the holes with a shovel, and I used a spoon, sandwich bags, marker, measuring tape and ruler to gather the soil. I took the samples back to the lab, and laid out the samples to dry overnight, labeling the piece of paper it was on with the same label on the plastic sandwich bags. The day after, a 2mm sieve is used to separate the coarser and finer material. To measure the pH of the fine soil samples, I cleaned out a test tube and cap for each sample with deionized water and placed 10mL of soil into the test tube. I added 10mL of 0.01 M Calcium Chloride $CaCl_2$(aq) into a separate test tube in order to fulfill a 1:1 ratio of soil and Calcium Chloride. Then I combined the two solutions together by shaking the test tube with the soil and liquid for approximately 20 seconds until both components have blended well. Next, I placed the test tube into a sonic bath and let it sit for 5 minutes under a cold setting. After 5 minutes, I took the test tube out of the bath and let it settle for 1 hour. After the test tube has settled, I calibrated the LabQuest 2 pH meter using a 4.01 pH and 7.01pH buffer. Once the probe is rinsed with deionized water and carefully dried, the probe was placed in each sample and the pH is recorded. I repeated this procedure for the second location

4. Results

4.1 ESS Parking Lot

Table 1: pH of soil samples collected at ESS parking lot on July 8th.

ESS Parking Lot pH

	Distance from Parking Lot			
Depth (cm)	**0 Meters**	**1.5 Meters**	**3 Meters**	**4.5 Meters**
0-2	5.1	4.25	3.26	3.64
4-6	5.5	4.41	3.37	3.5
8-10	5.7	4.49	3.86	3.55
20	5.9	4.5	3.99	3.74

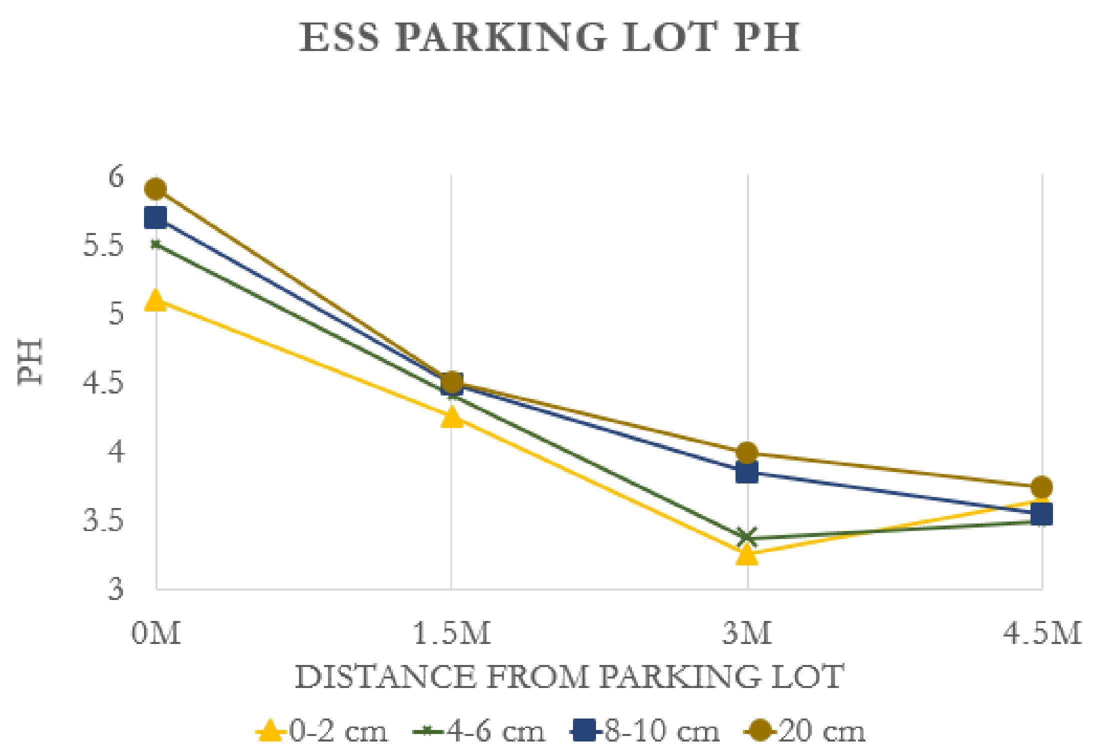

Figure 2: pH of soil samples collected at ESS parking lot on July 8th.

The area closest to the parking lot showed a higher pH of 5.10 than further away (Table 1). The data I collected does vary, but generally shows a trend in the soil pH near the ESS parking lot. The soil pH decreases as you increase the distance from the parking lot. The salt in the winter and dust have affected the soil where it most heavily reaches; about 0-1.5 meters before remaining fairly constant. PH also decreases as depth increases. The change could be more evident if we went back to the site for future research. We could take samples from deeper depth to compare change.

4.2 South Parking Lot

Table 2: pH of soil samples collected at the South parking lot on July 29th

South Parking Lot pH

	Distance from Parking Lot			
Depth (cm)	**0 Meters**	**1.5 Meters**	**3 Meters**	**4.5 Meters**
0-2	5.7	5.25	5.25	4.98
4-6	6.03	5.1	5.00	4.52
8-10	6.29	5.18	5.20	4.96
20	6.11	5.18	4.80	4.65

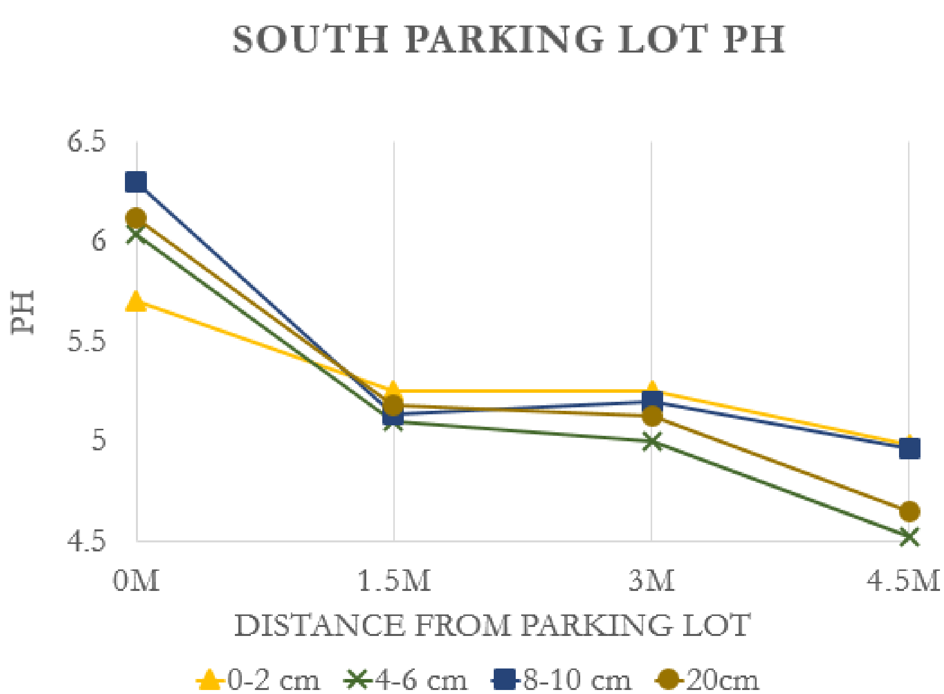

Figure 6: pH of soil samples collected at South parking lot on July 29th.

The pH at the South parking lot is higher (6.29), but follows a similar trend to that of the first site (Figure 1). Therefore we can see that the curb does not drastically affect the pH of nearby soil. The samples did contain some asphalt when we collected them. Asphalt generally causes low soil fertility which leads to poor agricultural productivity, but doesn't significantly affect pH (Ifenna, 2013). This may explain why the area had a small amount of organic matter until we reached about 4.5m.

5. Discussion

As shown in my results, salt like sodium chloride, will give its Na+ to the soil and replaces any H+ in the soil caused by acid rain. Although this does increase the pH, and lower the acidity, it also prevents any nutrients in the soil to be absorbed by plants. At high concentrations in the soil, sodium (Na+) will compete with essential nutrients for uptake by plants. Roots will also ab-sorb toxic levels of chloride (Cl+) from deicing salts, which accumulates in buds, leaves and twigs, causing desiccation (Jull, 2009).

6. Conclusion

The soil has a higher pH near the parking lot because salt used in the winter and car dust replace the H+ found in the soil which raises the pH. A place with more car activity will have a higher pH when the car dust settles near the soil (Amodia, 2013). The South parking lot samples showed that the ESS samples were accurate since the curbed area produced similar numbers to that of the uncurbed area. Further research that can be done on this topic is collecting samples from other areas near salted pavements. Samples can be collected near high traffic areas and low traffic areas and be compared to see if car dust significantly affects soil pH. In a future experiment, I could go back to the same location and go deeper into the forest to see if the soil pH continues to drop.

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Chapter 2: Soil Acidity of the SAC Parking Lot and ESS Building at Stony Brook University
Carlos A. Cobo

Introduction

Over the course of approximately 200 years, acid rain has increased the acidity of soil, which can severely damage the ecology of the vicinity when that area receives precipitation. Certain damages include the damaging of leaves, exposure to toxic chemicals, and the limitations of nutrients previously available to the vegetation (EPA, 2012). An experiment was conducted in 1922 on the North Shore of Long Island, New York, where the lowest recorded pH value was a pH of 4.5 (Wherry 1923). Another experiment was conducted in 1985 based off of Wherry's 1922 experiment; the lowest recorded pH value of that research had a pH of 3.77 (Greller, 1985). Acidity in soil has started to become a major issue in environmental science, with the pH levels has become a major issue in environmental science,

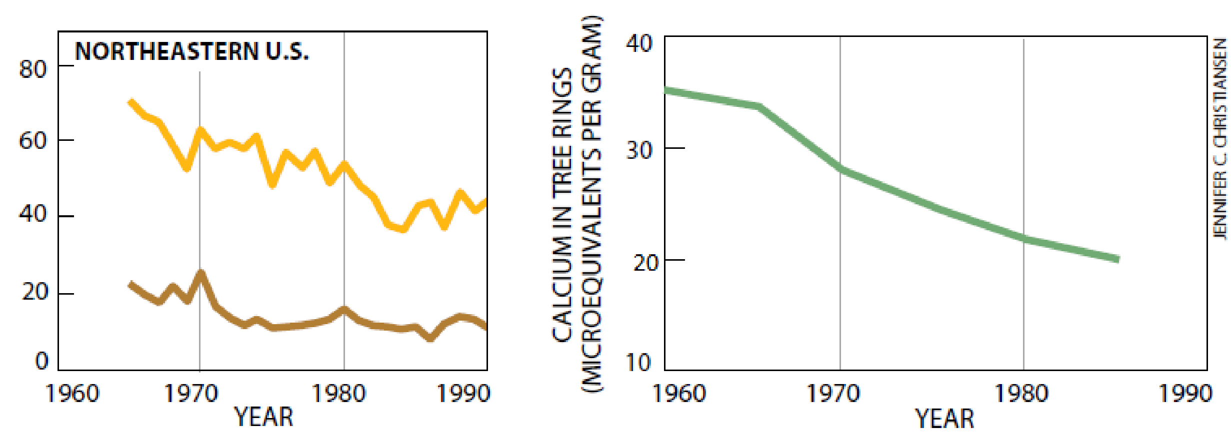

Figure 1: The graphs above depict a decrease in base cations and Calcium in an interval of 30 years. This graph was edited from the original source.

with the pH levels drastically dropping. Normally, when acid rain makes its way into the soil, base cations found in soil particles help neutralize the soil. Base cations are elements such as K+, Ca2+, Al3+, and H+. According to the graphs in Figure 1, base cations and Calcium decreased over the course of 30 years (Hedin & Likens, 1996). This correlates with the increase in acidity, as shown from Wherry (1922) and Greller's studies (1985). Their studies show that the acidity of the soil on Long Island has increased due to the loss of base cations. If this trend continues, then the soil with an incredibly low pH can severely damage the vegetation in the future.

The purpose of this research experiment is to determine what effect the Sodium in road salt and Calcium in the concrete have on soil. Also, the purpose is to see how grand these effects are on the soil pH. Sodium is found in road salts, which are placed on roads before and during snowstorms. The road salts may sometimes drop onto the soil, which helps neutralization. The concrete building was chosen because Calcium is a base cation, which found in lime, a composition found in concrete. I hypothesized that as the distance increases away from the parking lot and the building, the soil will become more acidic due to the decreasing amount of base cations. Soil samples were taken at the SAC parking lot and the Earth and Space Science Building at Stony Brook University, which is located in Stony Brook, New York.

Method

We first collected soil samples next to the curb of the SAC parking lot. We dug a hole 0m from the curb (18T 0657706 4530976) then continued digging holes away from the parking lot at a 1.5m mark , a 3m mark , and finally, a 4.5m mark with a coordinate uncertainty of 20ft. We collected the samples at 0-2cm, 4-6cm, 8-10cm, and 20cmdepths. We placed each soil sample on a white sheet of paper and took a picture of it to see the variation of physical characteristics (ex. Color) between samples as we dug deeper. We then placed the samples into plastic bags and labeled the bags with a marker to indicate the sample according to its distance from the SAC parking lot and depth. Upon returning to the lab, we placed each soil sample on separate pieces of paper and let them set for a day to dry. After a day, each soil sample was separated between its course and fine sediments using a 2mm sieve and measured for its mass. The fine sediments were then placed on the side to work on the pH testing. When testing each soil sample, we placed the sample into a test tube and filled it up to 10mL, and filling in a .01M solution of Calcium Chloride (CaCl2) into a separate test tube at 10mL. After that, we combined the two test tubes of both the sample and solution and shook the test tube for twenty seconds to blend the two components. We then placed the test tube into a Sonogen Sonic Bath for five minutes under the cool setting then let it settle for one hour. After the one hour, we calibrated the pH meter using two buffers with pH values of 4.01 and 7.01. When the machine was calibrated, we tested each soil sample using a pH probe, and recorded the pH.

Data

I collected samples from a nearby concrete building in order to determine whether the Calcium in the concrete would have an effect on the soil. The GPS contained an inaccuracy of 20ft (6m) at the ESS building location which could contribute to some inaccuracy, but note that this inaccuracy is by at least 800m. The distance and depth intervals were kept at constant to make comparisons more precise. Sixteen samples were collected and tested. Table 1 displays the pH values of the area next to the SAC Parking Lot, while Table 2 displays the pH values of the area near the concrete building. The data from area near the SAC Parking Lot is shown to have a lower pH level than the area near the concrete building, as shown on Table 2.

Analysis

As shown in Figure 2, the pH values took a drastic drop from the 0m hole towards the 4.5m hole, beginning at a pH of 6.19 and ending above a pH of 3.53. While the Sodium in road salts raise the pH of the soil closest to the parking lot, the soil is far too acidic the farther away the soil is from the lot. This also explains for the sudden plummet from the 0m hole towards the 1.5m hole. Following that is a drop in pH values, with 3.53 being the lowest recorded pH level at 4.5m away from the parking lot at 0-2cm depth. At the 4.5m hole, the 20cm depth seems to have a higher pH to the rest. Overall, there was an indirect relationship between the distance and the change in pH.

Table 1: SAC Parking Lot Soil pH.
Note: The 4.5m 20cm soil sample was spilled before it was sieved.

SAC Parking Lot Soil pH Data		
Distance (m)	Depth (cm)	pH
0	0-2	6.19
	4-6	6.29
	8-10	6.16
	20	6.07
1.5	0-2	4.8
	4-6	4.7
	8-10	4.55
	20	4.52
3	0-2	3.75
	4-6	3.77
	8-10	3.75
	20	3.76
4.5	0-2	3.53
	4-6	3.6
	8-10	3.56
	20	3.75

Table 2: ESS Concrete Building Soil pH

ESS Building Soil pH Data		
Distance (m)	Depth (cm)	pH
0	0-2	5.62
	4-6	5.31
	8-10	5.04
	20	5.05
1.5	0-2	5.26
	4-6	5.39
	8-10	5.19
	20	5.42
3	0-2	4.96
	4-6	5.05
	8-10	4.69
	20	4.77
4.5	0-2	5.5
	4-6	4.94
	8-10	4.86
	20	4.95

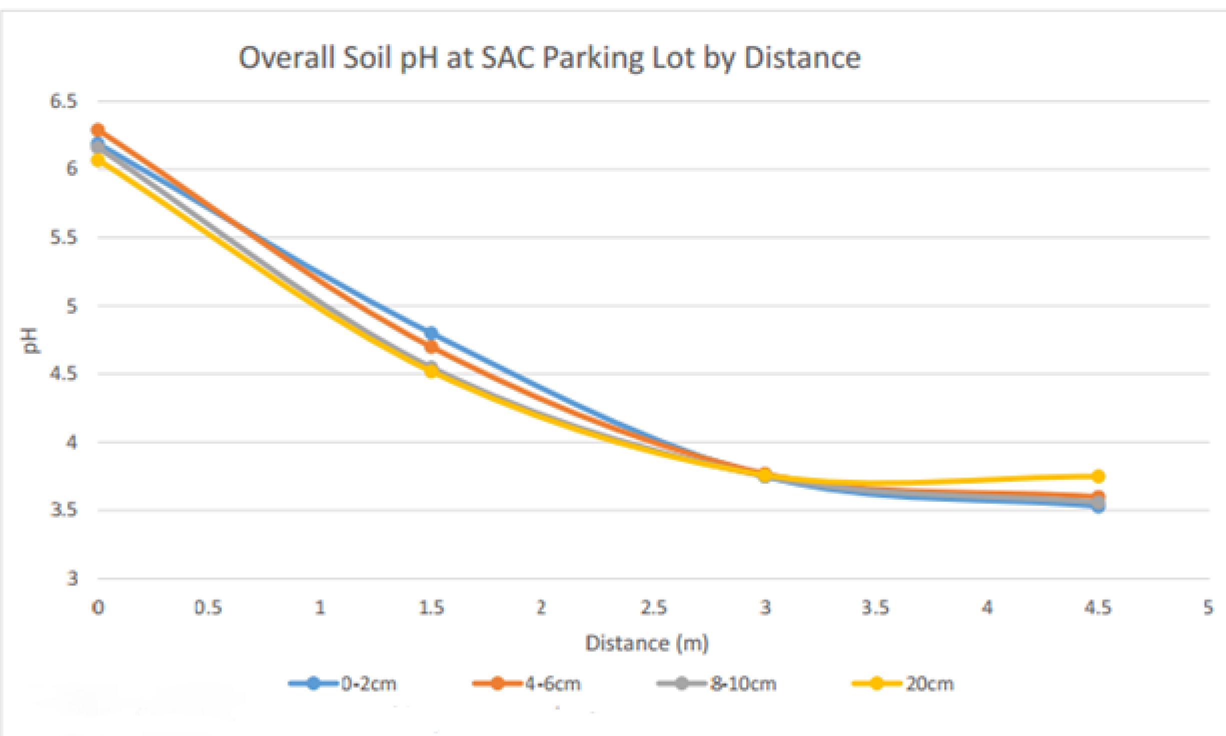

Figure 2: Soil pH at the SAC parking Lot based on Distance

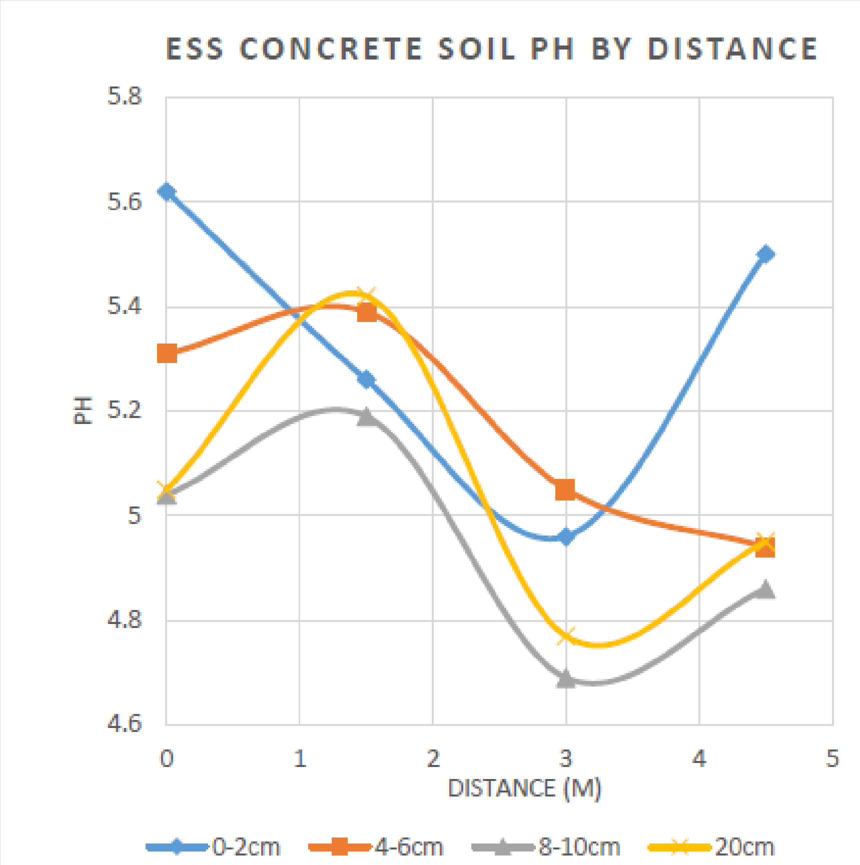

Figure 4: Notice how the nontoxic blue dye begins to trickle in less amounts when reaching the lighter soil.

Source: http://soilandwater.bee.cornell.edu/Research/pfweb/educators/intro/macroflow.htm#2

Figure 3: Concrete Building Soil pH

In Figure 3, the initial pH at the 0- 2cm interval of all the holes start off at a lower pH level than the SAC Parking Lot, which is salted, although the 0m hole has a significantly higher pH than the rest of the holes. One interesting fact to point out is that the 0-2cm depth starts off with a 5.62 pH at the 0m, and then drops down to as low as 4.96 at the 3m hole. Suddenly, the pH value rises to 5.50 when reaching the 4.5m hole, almost the pH value when at the 0m hole. This particular area was between the concrete building and a paved path. Therefore, this path would be salted, which could explain for the sudden high pH at 4.5m 0-2cm. However, this is not the case for the rest of the depths, as all the values end no higher than a pH of 5. Macropores, or cavities within the soil are created by biological activity, geological forces, or other interferences which can contribute to infiltration. The reason as to why the 0-2cm depth contains a higher pH than the rest of the depths can relate to the infiltration of the soil. Figure 4 displays a nontoxic blue dye that has been dumped onto the top soil. Notice how almost all the blue dye infiltrated through the top layer, but is halted at some degree when reaching the lower layer, with lighter grass. One thing I noticed when digging the holes is that there was a change in soil color. Figure 5 shows a lighter patch of soil, like shown in Figure 4, where the infiltration was shown. This could be a similar scenario to the holes in the concrete site, as certain pH levels shown in Figure 3 fluctuate in the depths below 0-2cm. As

Figure 5: A representation of the 3m hole. Notice the small area towards the left with a lighter patch of soil.

said before, macropores are cavities in the soil; certain channels dug by biological activity could transport certain rain through the soil while the rest will settle in areas where the rain can no longer trickle down.

Discussion

When comparing the two sites, it can be concluded that the area next to the SAC Parking Lot is far more acidic than the area next to the ESS Concrete Building. This is mainly because the 0m hole next to the parking lot contained a pH of 6 and the 4.5m hole had an average pH of 3.61, as oppose to the average pH of the area next to the ESS concrete building which was 5.0. In 1985, a study was conducted by Andrew M. Greller on the North Shore of Long Island, New York, where his research concluded that only certain plants were able to tolerate the increase in acidity from the soil from Edgar T. Wherry's research in the same area in 1922. This could be a potential danger towards the area next to the SAC Parking Lot because while certain plants survive, the diversity of vegetation in that area can slowly diminish as the acidity rises.

I found that though Calcium is a base cation, the concrete which contains Calcium didn't have a large impact on the nearby soil. As shown in Figure 2 and Table 1, the drop in pH going away from the parking lot was drastic, beginning at 6.19 and ending at 3.75. The drop in pH in the area by the concrete building was not as significant as the area by the SAC Parking Lot. The pH began at a value of 5.62 and ended at a value of 4.95, not nearly as differentiated as the first site. This, of course, can contribute to the presence of Calcium in the concrete, as oppose to the first site where there was no Calcium present but the change in pH was quite large.

For my future studies, I plan to return to the sites I conducted my experiment on, and test the pH to see the change in acidity from this summer to the following time I plan to research. I would like to see if the acidity has changed next to the concrete building to see if the concrete has truly made an effect on the area next to it. I also plan on going more in depth with infiltration, considering the fact that the pH values at the ESS Concrete Building fluctuated.

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http://soilandwater.bee.cornell.edu/Research/pfweb/educators/intro/macroflow.htm#2

Chapter 3: HOW VEGETATION WOULD SURVIVE IN SOIL AFFECTED BY ACID RAIN ON STONY BROOK CAMPUS

Bianca Paul

Introduction

The Industrial age has advanced the way we as humans live. But it had many detrimental effects to the environment, one of them being an increase in acid rain. Acid rain is caused when gasses such as sulfur dioxide, nitrogen oxides, and carbon dioxide which are byproducts of fuel combustion, mix with atmospheric water to form sulfuric, nitric, and carbonic acid. They then precipitate as acid rain. When it comes into contact with soil, the hydrogen ions replace the base cations. (Scientific American, Hedin and Likens 1996) These base cations are major nutrients for plants. Increases in aluminum ions are also present. Aluminum ions are very toxic to plants and can limit root growth. (Chojnacki 2013)

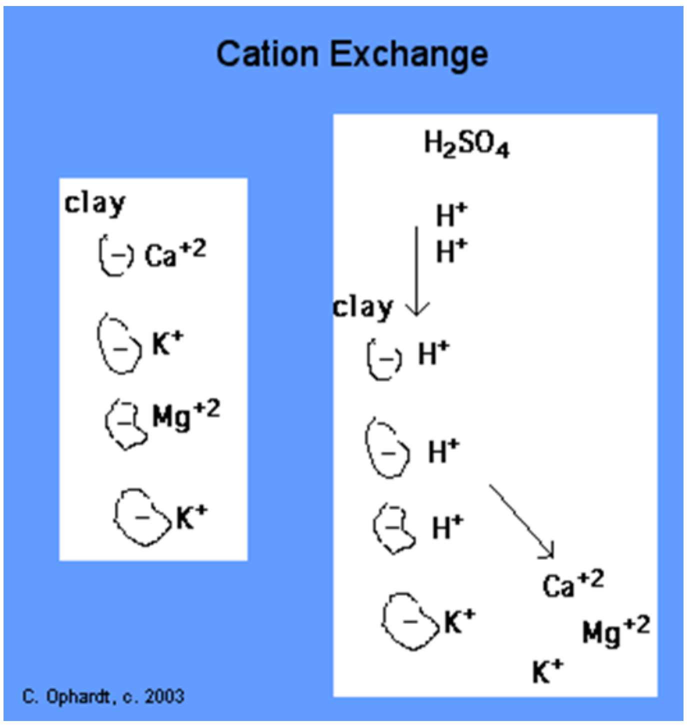

Figure 1: A picture demonstrating how the hydrogen ions from the acid rain replaces the base cations in the soil particles.

The Geo Prep research students went out to the Environmental Space and Science parking lot, the Student Activity Center parking lot, and two paths between the two parking lots in a wooded area. For each area we dug 4 holes and measured out the distance from zero. The intervals were 0 meters, 1.5 meters, 3 meters, and 4.5 meters. We then dug up to 21 centimeters for each hole. Then we measured the depth and took samples at 0-2 cm, 4-6 cm, 8-10 cm, and 20 cm. Overall, we collected 64 samples. But for this report, I used only the 4.5 meter samples.

In a previous study by Keith Chojnacki, he collected soil samples at Stony Brook University and Locust Valley. He also noted the vegetation that grew around in these areas and determined whether or not the soil was suited for these plants. The purpose of my experiment is to strengthen my experience with acid rain and its effect on soil, and to see if the vegetation that Chojnacki found on Stony Brook campus would thrive with the pH findings that I received from the soil samples I collected.

Methodology

Equipment needed for collecting samples:
Shovel
Plastic bags
Sharpie
White paper
Ruler
GPS
Ruler
Spoon
Measuring tape
Notebook and something to write with Equipment needed for lab
Paper
Test tubes
Spoon
2 mm Sieve
Calcium chloride 0.01 molarity
Deionized water
Test tube rack
Sonogen Sonic Bath
KimTech wipes
pH lab quest meter
7.01 and 4.01 pH buffer
Scale
Cup
Notebook and something to write with

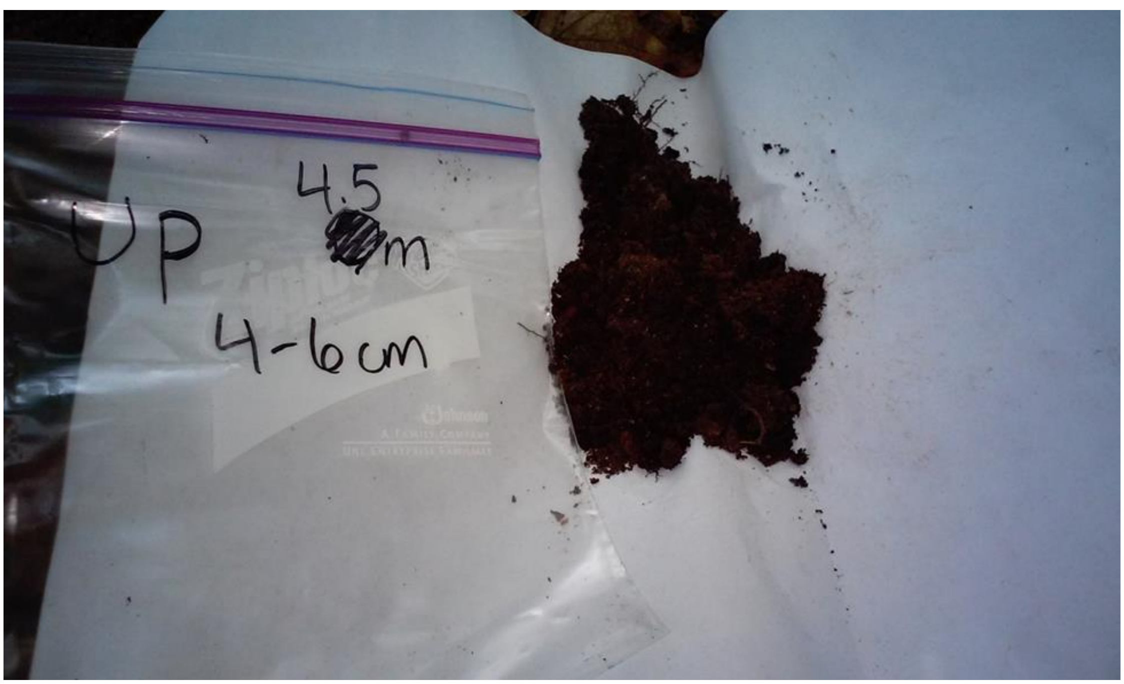

Figure 2: An example of what we did when we collected samples.

Figure 3: The holes dug from the paved path.

Before collecting samples, the plastic bags for the samples were labeled. We then went to the designated area. First we used a shovel to dig a hole that way 21 cm in depth. Then we got the ruler to measure the depth. If it was 21 cm, then we'd begin taking our samples. We took our samples at the depths of 0 to 2 cm, 4 to 6 cm, 8 to 10 cm, and 20 cm. For each sample, we put it on white paper to view the soil and we'd write the description in our notebooks. We then put the plastic bags next to the sample with the label and took a picture and then put the sample in the designated baggie. After we were done collecting samples from the hole, we took a picture and measured the distance from that hole to next one and start over again until we covered all holes.

When we came back to the lab, we set the soil samples on paper ad waiting 24 hours to dry out. The next day, we then got the samples and put it through a 2 mm sieve. Afterwards, we weighed the coarse grains and smooth grains for the mass and recorded it in our notebook. Soon after, we took the fine sediments and put 10 mL of it in a test tube with 10 mL of calcium chloride 0.01 solution. We made sure to clean out everything with deionized water first. Then we shook up the test tubes then put them in the Sonogen sonic bath for 5 minutes. After 5 minutes, we let the samples rest on the rack for an hour. After that hour we first calibrated the pH lab quest meter with the buffers and then measured the pH of the samples. Make sure to clean the pH probe with deionized water and wipe it off with KimTech wipes so you do not contaminate other samples. Make sure to also record everything in your notebook. I used only 4.5 meter samples and did not use anything else for my research.

Data and Discussion:

Table 1: The pH of the soils that the GeoPrep students and I received.

P.P.	0.0- 2.0	3.11
	4.0- 6.0	3.25
	8.0- 10.0	3.55
	20	3.54
U.P.	0.0- 2.0	3.21
	4.0- 6.0	3.17
	8.0- 10.0	3.71
	20	3.84
E.S.S.	0.0- 2.0	3.64
	4.0- 6.0	3.15
	8.0- 10.0	3.55
	20	3.74
SAC	0.0- 2.0	3.53
	4.0- 6.0	3.6
	8.0- 10.0	3.56
	20	3.75

Table 2: The pH of the plants that Chojnacki found in Clara Woods on Stony Brook Campus.

Vegetation Species	pH
Viburnum acerifolium	4.5 to 7.5
Smilax	6.1 to 7.8
Quercus alba	<6.8 to 7.2
Quercus albidum	4.5 to 6
Chamaphila maculate*	1 to 14
Prunus serotina	>7.2
Vaccinium	4.5 to 5.5
Aralia nudicaulis	5 to 6
Cornus florida	5.2 to 6
Acer rubrum	4.5 to 5
Parthenocissus quinquefolia	5 to 8
Maianthemum canadense	4.5 to 5.5
Vitis app.	4.3 to 8.6
Sassafras albidum	6 to 7
Note: Anything starred with an asterisk is able to live in a very wide spectrum	

The table shows that as you increase the depth of the holes, there is an increase in pH. This is due to the topsoil being more exposed to the acid rain than the soil under it. The soil that gets in contact with the acid rain first, will take up the hydrogen ions. By the time the rain reaches even deeper, there aren't that many hydrogen ions in the rain. (Wherry 1923; Scientific American, Hedin and Likens 1996) The table also shows that the soil is very acidic in that area. The plants that would be able to thrive in such an environment hypothetically speaking is: Quercus alba and Chamaphila maculate. Every other plant that would grow in such an environment would be very stressed or dying.

Future Research Work

I have plans to go out to the same site I took soil samples from and identify the vegetation there. Once I analyze the vegetation, I would like to see if it's true that there would only be Quercus alba and Chamaphila maculate growing there.

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Chapter 4: THE ACIDITY OF SOIL NEAR PAVED PATHS ON THE STONY BROOK CAMPUS

Steeve A.D.

Background

This study was conducted to find how the distance from a select paved path affects pH and soil acidity. The areas in which data was collected are all located in the Stony Brook area. The first site was located at 18T 0657730 4530989. It was in a wooded area between the SAC and ESS parking lots. The second site was located at 18T 0657898 4530968 with a + 30ft uncertainty. Site two was near a sidewalk on Circle Road. Circle Road is a bus route. Several past experiments done by various researchers relate to my experiment. Researcher Jamie Amodia did similar studies for Stony Brook University. The data for Amodia's research was collected from two different locations in Suffolk County. Her research found that there is a correlation between distance from the road and soil pH.

Materials

The materials I used while in the field include a shovel, bug spray, backpack, ZipLock bags, tape measure, Brunton, camera, Sharpie, pen, notebook, spoon, GPS and 9 sheets of white paper. During my analysis of the soil samples I used a LabQuest for data collection and D.I. water, ph probes, Kimwipes, 4.01 & 7.01 buffers, a beaker, 8 capped test tubes, a test tube rack, 0.01M $CaCl_2$, small bottles with lids and a pipette.

Procedures

The samples used in my research were collected from two areas; one near a paved path behind the Math and Science building and one near a road next to the ESS building. Holes measured at about 20cm in depth were dug at varying distances from each pathway. They were collected at distances of 0m, 1.5m, 3.0m and 4.5m from each path. Samples were collected at 0-2cm, 4-6cm, 8-10cm and 20cm in depth. Each sample was examined on a white sheet of paper then placed in a ZipLock bag.

I left the soil samples to dry overnight on a labeled sheet of paper. This process is displayed in Figure 1. A 2mm grain sieve was used and all organic matter and pebbles were separated from fine grained particles. Both coarse and fine grain samples were weighed separately. I placed 8 DI rinsed test tubes on the rack. Each contained 10 ml of sediment and 10ml of 0.01 $CaCl_2$. The tubes were shaken before being placed in the ultrasonic bath for 5 minutes. A pH meter was rinsed with DI water and calibrated with 4.01 & 7.01 buffers. It was then used to test the acidity of each sample 1 hour after the samples were removed from the ultrasonic bath. The probe was rinsed with

Figure 1: This figure shows the samples lying out to dry.

DI water and blotted between each sample. After being allowed to sit overnight they were tested again.

Data:

First Site: Wooded Area

Table 1: This chart shows the pH and mass of the samples found at the first site (wooded area).

DISTANCE	COARSE MASS	FINE MASS	DAY 1 pH
0m	15.47	65.64	3.83
1.5m	7.11	40.27	3.23
3.0m	23.36	75	3.12
4.5m	40.2	20.1	3.1

DISTANCE	COARSE MASS	FINE MASS	DAY 1 pH
0m	1.18	118.37	3.09
1.5m	0.68	79.37	3.15
3.0m	5.88	309.49	2.93
4.5m	7.5	374.4	3.25

DISTANCE	COARSE MASS	FINE MASS	DAY 1 pH
0m	3.8	163.4	3.86
1.5m	7.3	99.8	3.3
3.0m	13.2	344.7	3.07
4.5m	7.9	419.09	3.55

DISTANCE	COARSE MASS	FINE MASS	DAY 1 pH
0m	8.5	209	3.18
1.5m	3.7	117.7	3.25
3.0m	11.06	256.02	3.52
4.5m	7.24	392.95	3.2

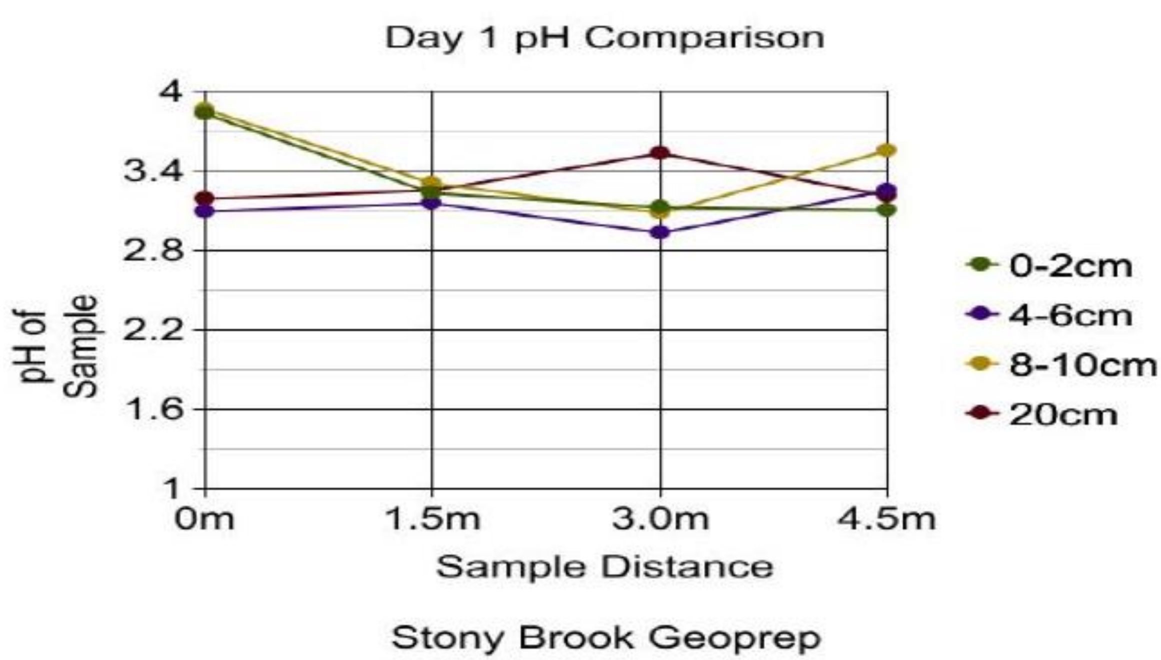

Figure 2: This graph displays the average relation between pH and distance from the first paved path (wooded area).

Second Site: Circle Path

Table 2: This chart shows the pH and mass of the samples found at the first site (wooded area).

DISTANCE	COARSE MASS	FINE MASS	DAY 1 pH
0m	17.67	96.04	6.08
1.5m	2.88	115.05	4.7
3.0m	3.7	58.89	4.53
4.5m	2.06	52.39	4.81
DISTANCE	COARSE MASS	FINE MASS	DAY 1 pH
0m	16.86	62.57	6.08
1.5m	4.72	41.2	5.17
3.0m	9.76	35.61	4.94
4.5m	6.29	36.99	4.83
DISTANCE	COARSE MASS	FINE MASS	DAY 1 pH
0m	9.65	72.62	6.1
1.5m	3.31	46.22	5.31
3.0m	3.5	28.56	4.94
4.5m	1.7	4.94	4.97
DISTANCE	COARSE MASS	FINE MASS	DAY 1 pH
0m	6.22	60.63	6.2
1.5m	3.13	67.15	5.27
3.0m	7.37	74.73	5.17
4.5m	13.77	102.27	4.98

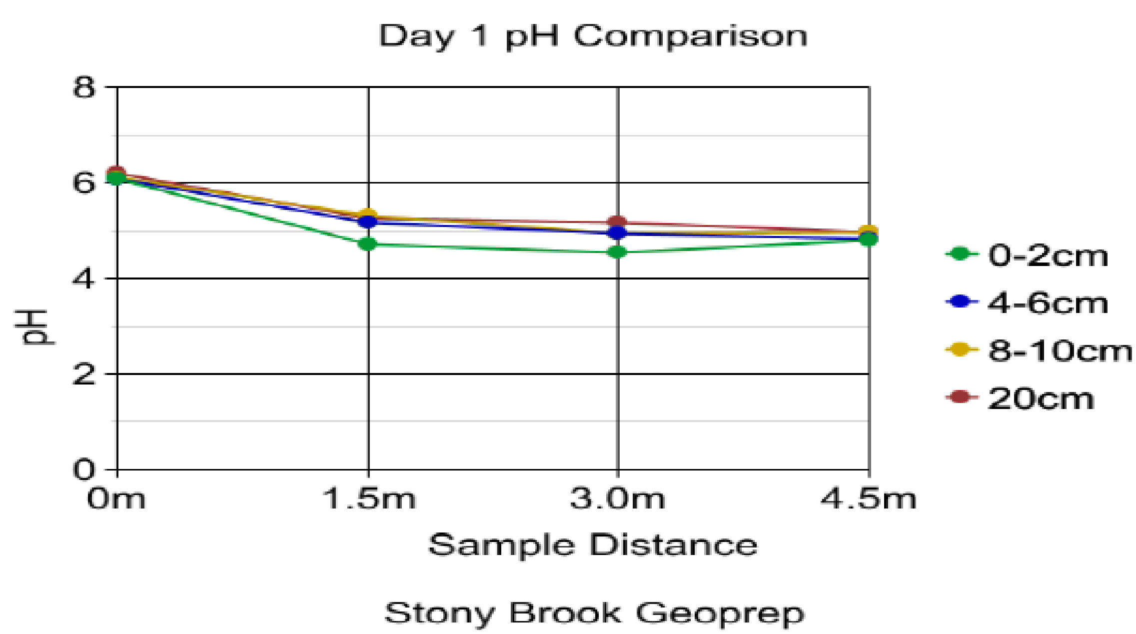

Figure 3: This graph displays the average relationship between pH and distance from the first paved path (wooded area).

Results

I found that there is a strong relationship between the distance each hole is from the path and the pH of the soil. As you travel farther from the path, the pH decreases. There was a contrast between the pH of the path in wooded area and the pH of soil by the road path. The soil found in the wooded area had a higher acidity and a less apparent pattern. This data is displayed in Table 1 and Figure 2. Several factors may have resulted in this difference. The soil by the wooded path was recently affected by the actual laying of the path. The strong pattern found in the second sites data is shown in Table 2 and Figure 3.

There is also a relationship between depth and pH shown. This relationship is less noticeable in the data collected from the 1st site. The lower levels of site one seemed to follow little to no pattern. One can assume this is a result of human interference.

Discussion

I investigated the relationship between distance from a paved path and the acidity of a soil sample. I found that there is a definite relationship. My findings are important because they cover things that affect our environment. This data can be used in further research studies within this topic.

Several previous studies served as motivation for my study. The findings of other studies mostly support my findings which strengthens my study results. Previous studies aided in my decision to test in two areas. They also helped me decide which questions to ask.

My study had a few limitations. The generalizability of my results is questionable. I encountered a few problems whilst collecting samples. Some areas were difficult to dig in caused me to shift my holes. My areas of collection are also relatively close.

According to Briana Santa Ana's research the application of Magnesium Chloride (MgCl) has a major effect on soils acidity and pH. Her studies tested electrical conductivity. I may implement some of her techniques in future studies. Ana's studies also covered the effects MgCl has on vegetation. I hope to go more in depth when I complete further studies.

"Roads in northern hardwood forests affect adjacent plant communities and soil chemistry in proportion to the maintained roadside area" is a journal article written by Deborah A Neher, David Asmussen and Sarah Taylor Lovell. This journal article will also aid in the continuation of my research. Neher, Asmussen and Lovell included the impact on vegetation as well.

A lot of questions pertaining to this topic remain unanswered. My study may bring some of these typically unanswered questions to light. This study can also branch off into different research topics. Future researchers can collect data from several points on campus instead of two. I could improve my study by expanding my sample amount. Another way I could improve my study is by being more specific when selecting depths to collect from. I hope to find out how each paved path is treated throughout the year. Further studies could be done on this topic and should include a wider range of topics relating to soil pH and locations.

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Chapter 5: The Comparison between pH and Distance from Unpaved Paths on Stony Brook University
Alexander Kling

Introduction
The purpose of this research was to determine if there is a relationship between the pH of soil and the soil's distance from an unpaved path. The reason for this interest is that it is known that human activities on paved paths and roads are known to affect the pH of soil. Such activities that affect soil pH are road salting (Green *et al.*, 2008) and the construction of concrete curbs (Brueckner, Clark, Williamson, 2013). The pH of soil on Long Island is normally acidic due to the rainfall there, with an average pH of 4.5 as of 2009 (Bauch *et al.*, 2007).

I chose two unpaved paths to gather samples from in Stony Brook University Campus on Long Island; between the ESS Parking Lot and the SAC Parking Lot and in Clara's Woods. My hypothesis was that with increasing distances from the path, the pH would stay relatively the same, due to the lack of human activity that would change pH such as salting or a concrete curb. When the road salt (NaCl) or concrete enters the soil, it breaks down into its respective components. When the Na^{+} ion from the salt or the Ca^{+2} ion from the concrete enters the soil, it replaced the H^{+} ion that is already present in the soil from the acid rain. These ions then act as base cations and raise the pH of the soil.

Methodology
Field
At the Unpaved Path between the ESS Parking Lot and SAC Parking Lot, holes were dug at four distances from the path into the woods; 0 m, 1.5 m, 3 m, and 4.5 m. At each hole, soil samples were collected at the depths of 0-2 cm, 4-6 cm, 8-10 cm, and 20 cm. Each sample was organized into labeled plastic bags. The coordinates of the site were also taken with a GPS. The process was repeated at the Unpaved Path in Clara's Woods.

Lab
All of the samples were taken from the bags and laid out on paper to dry for a day. After this, the samples were run through a sieve to separate the fine material from the coarse material and the coarse material was disposed of. For each sample, 10 mL of the fine material was mixed with 10 mL of 0.01 M calcium chloride ($CaCl_2$). This mixture was placed into a sonic bath for 5 minutes and then put on a test tube rack for an hour in order to settle. Before testing the pH of the samples, the pH probe was calibrated using buffers of pH values of 4.01 and 7.01. Once calibrated, the probe was put into the test tube so that the tip was completely submerged in the liquid. Once the reading was steady, the pH would be recorded. After that, the probe rinsed with deionized water and dried with Kim wipes. This was repeated with all of the samples from both sites.

Data

Table 1: Data taken from the ESS Unpaved Path with distance and soil pH.

Distance (Meters)	Depth (Centimeters)	pH
0	0-2	3.71
0	4-6	3.67
0	8-10	3.71
0	20	3.89
1.5	0-2	3.24
1.5	4-6	3.57
1.5	8-10	3.97
1.5	20	4.15
3	0-2	3.26
3	4-6	3.54
3	8-10	4.01
3	20	3.93
4.5	0-2	3.21
4.5	4-6	3.17
4.5	8-10	3.71
4.5	20	3.9

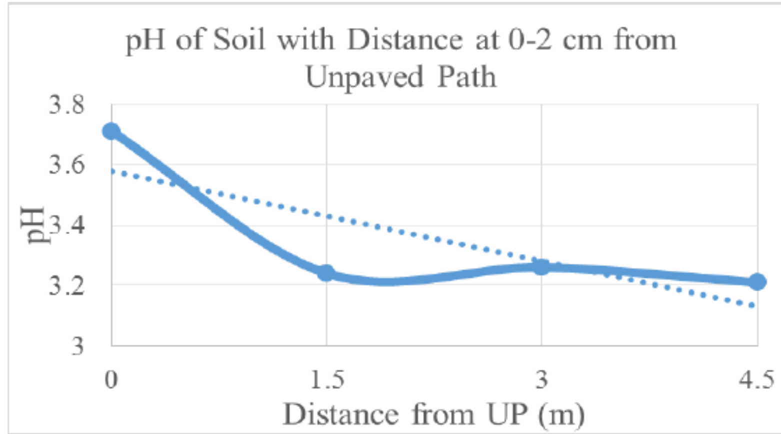

Figure1: Graph showing the relationship between pH and distance at a depth of 0-2 cm at ESS.

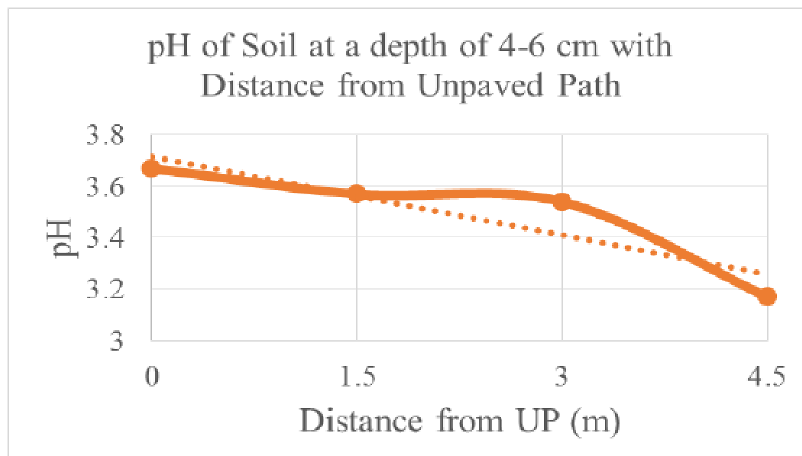

Figure 2: Graph showing the relationship between pH and distance at a depth of 4-6 cm at ESS.

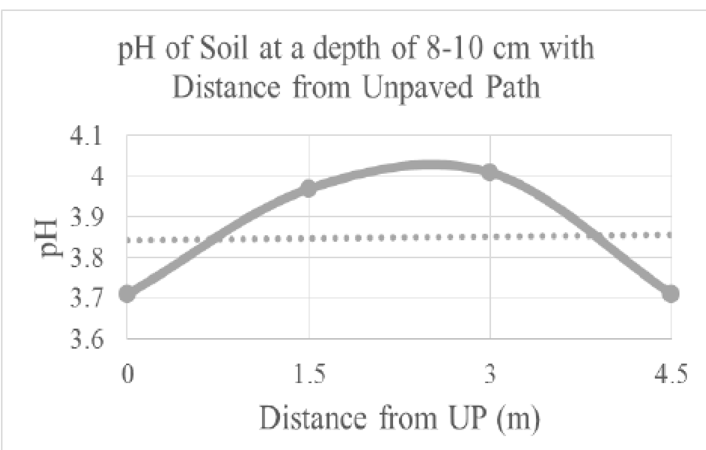

Figure 3: Graph showing the relationship between pH and distance at a depth of 8-10 cm at ESS.

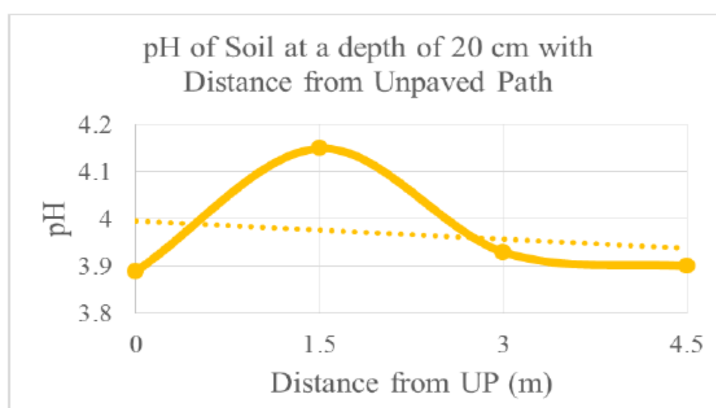

Figure 4: Graph showing the relationship between pH and distance at a depth of 20 cm at ESS.

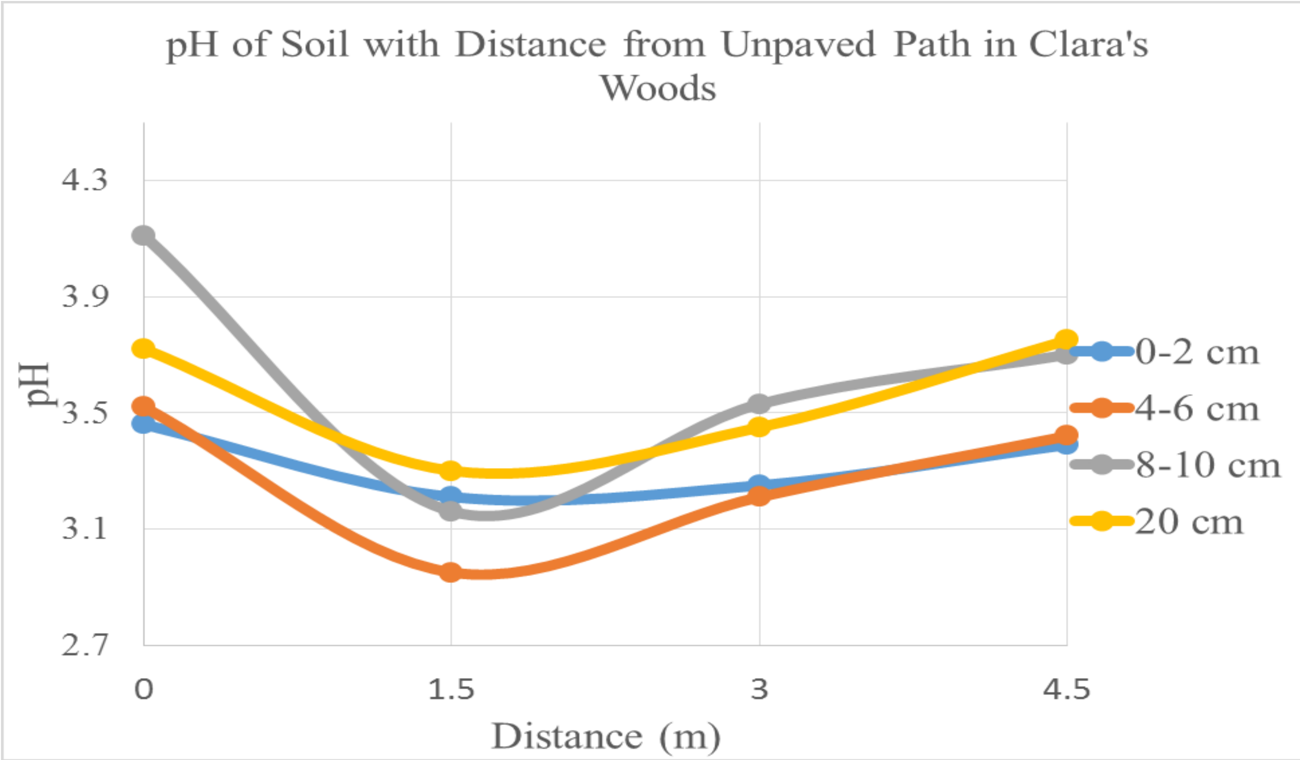

Figure 5: Combined graph of Figures 2-5.

Table 2: Data taken from Clara's Woods Unpaved Path with distance and soil pH.

Distance (Meters)	Depth (Centimeters)	pH
0	0-2	3.46
0	4-6	3.52
0	8-10	4.11
0	20	3.72
1.5	0-2	3.21
1.5	4-6	2.95
1.5	8-10	3.16
1.5	20	3.3
3	0-2	3.25
3	4-6	3.21
3	8-10	3.53
3	20	3.45
4.5	0-2	3.39
4.5	4-6	3.42
4.5	8-10	3.7
4.5	20	3.75

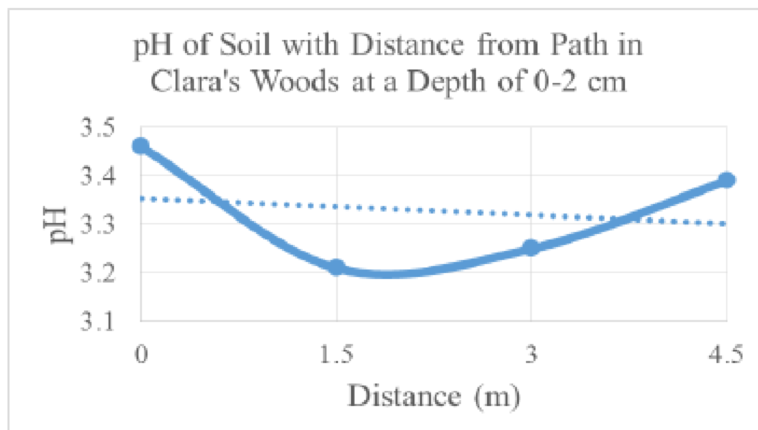

Figure 6: Graph showing the relationship between pH and distance at a depth of 0-2 cm at CW.

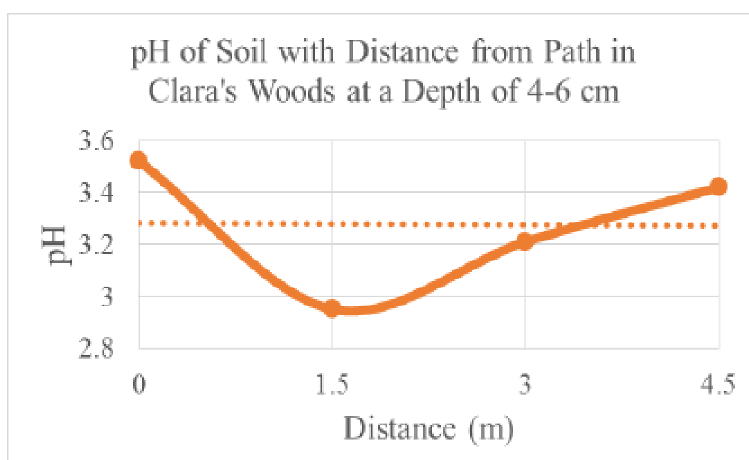

Figure 7: Graph showing the relationship between pH and distance at a depth of 4-6 cm at CW.

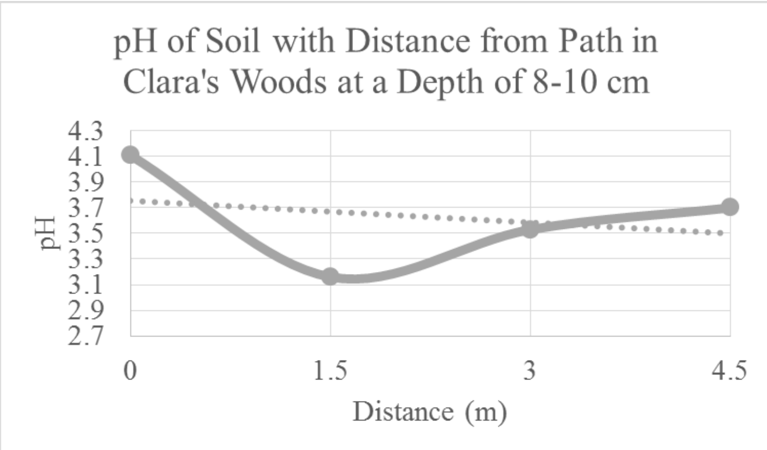

Figure 8: Graph showing the relationship between pH and distance at a depth of 8-10 cm at CW.

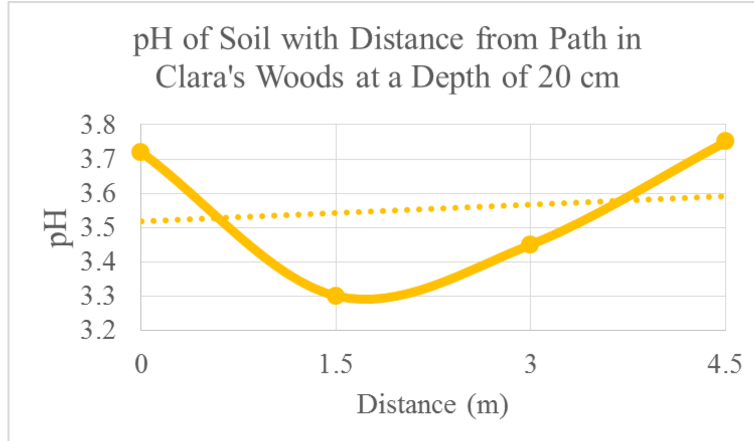

Figure 9: Graph showing the relationship between pH and distance at a depth of 20 cm at CW.

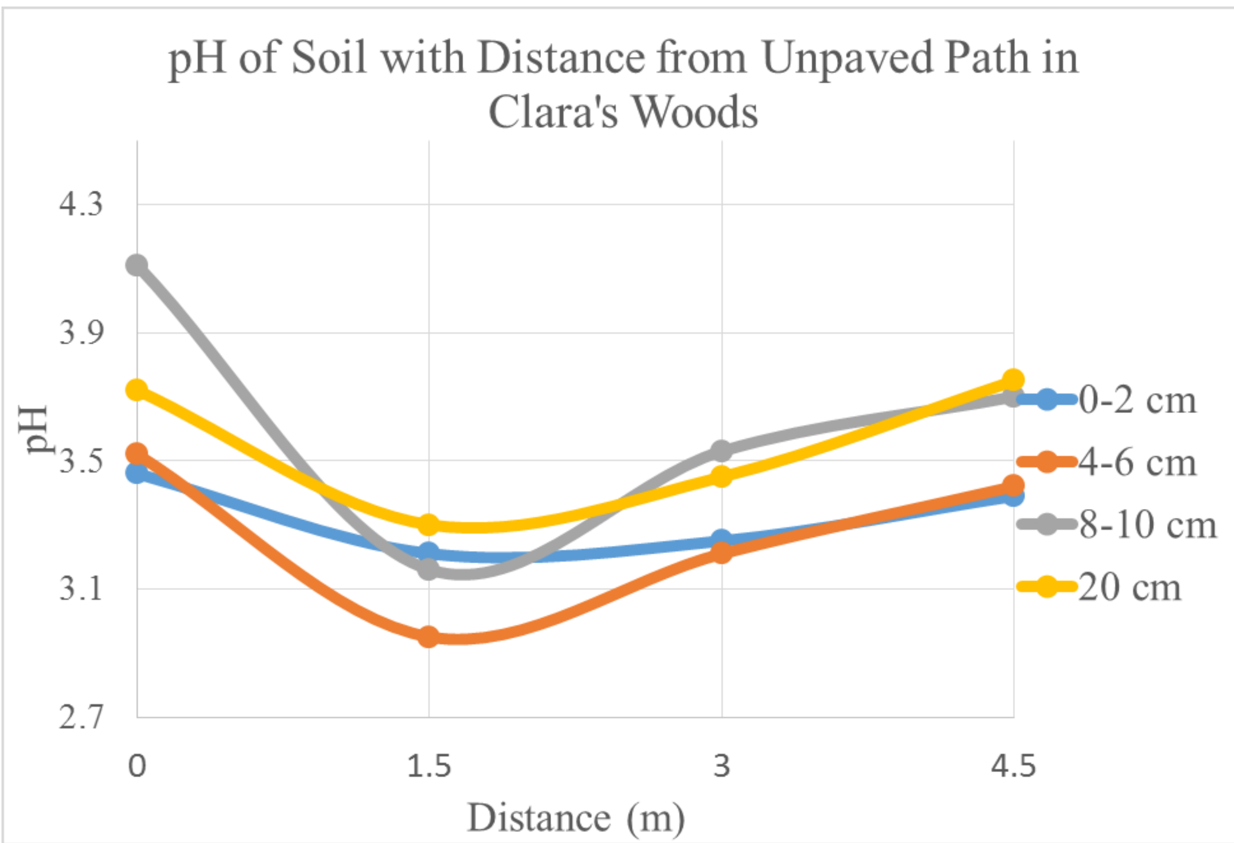

Figure 10: Combined graph of figures 5-8.

Data Analysis

The data collected from the ESS unpaved path shows a general inverse trend as distance increased from the path (Figure 5). As distance from the path increases, the pH decreases. In Figures 1 and 2, the pH of the soil clearly decreases by as much as 0.5, whereas in Figure 3 it remains generally the same and in Figure 4 it slightly decreases by about 0.05. I hypothesized that the reason for this was that people carried salt or pieces of concrete on their shoes from the two parking lots on either side of the path. To test this, I took samples at an unpaved path in Clara's Woods thinking that it would remove the variable of salt. Generally, as the distance from the path increases, the pH should stay constant. As depth increases from the surface, the pH should increase. However, salt disrupts this trend by making the soil closer to the surface as well as closer to the path have a higher pH.

The data from Clara's Woods did seem to be more consistent across the distances from the path. There was very little change in the pH of the samples at the same depth; the pH only changed by about 0.05 in Figures 6, 7, and 9. However, the 8-10 cm depth did change by about 0.4 (Figure 8). Furthermore, there was still a drop-off in pH from 0 m to 1.5 m as displayed in Figure 10.

Conclusion

The data gathered from the first unpaved path between the two parking lots showed a decrease in pH between the distances of 0 m and 1.5 m. This lead to the conclusion that salt and/or the concrete curb was still a factor here and that another location was needed to remove both variables. At the Clara's Woods site, the pH was more constant at each distance from the path; however, there was still a decrease in pH from the 0 m to 1.5 m. The reason for this may have been another variable, infiltration of the soil. This meaning, how well the acid rain infiltrates into the soil at different distances and depths. The Clara's Woods site did have sand and grains of similar size that may have affected the data by allowing more acid rain to infiltrate deeper into the soil closer to the path. One more possible factor in the soil at the 0 m distance having such a high pH could have been the presence of atmospheric dust that was kicked up by humans. Atmospheric dust is known to be basic and raise the pH of soil. (Hedin et al., 1996). For future research, I could further investigate the effects of different soil types and their porosities on the pH of soil. I could also find other unpaved paths with different sediment types in the surrounding soil and observe the differences in pH that they have. Atmospheric dust and its effect on soil pH could also be further researched to determine if that is the most likely cause of the pH differences present at both sites.

Citations

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