The Effects of Erosion on Protozoa

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Background

Erosion is a growing environmental problem all over the world. The effects of erosion can permanently damage ecosystems and environments. Agriculture and construction have proven to be two of the primary causes of erosion (Model Post-Construction Storm water Runoff Control Ordinance, 2005). Together, these two main industries cause the weathering and destruction of soil and landforms. (Soil Erosion, 2005). Construction in particular damages the soil, making it unable to absorb water and be a productive part of an ecosystem.

Erosion is the process of wind or water wearing away at the earth beneath it. This has a negative effect because it strips the soil of its essential nutrients that are needed to continue fostering the intricate ecosystem. Soil is made up of three layers; sand, silt, and clay. These three parts, in different densities, combine to form individual soils (Soil Texture, 2001). The density of a soil determines its porosity, and the ability for microorganisms to move through it. Clay is the densest part and has a very sticky and firm texture. Next, silt is made up of medium sized particles, giving it a soft and silky texture. Lastly, sand is comprised of the small particles, making it feel coarse to the touch (Soil Texture, 2001).

Loams, or soil mixtures that contain more than 65% sand are classified as sandy loams. Loams with more than 65% clay are classified as clay loams and so on and so forth. The ideal soil texture differs from place to place and is influenced by both weather, human interaction, and organisms living there. It is hard to name one perfect soil texture considering all sorts of loams are used in different places. (Here's the dirt: People cause more erosion than natural processes. 2004).

By changing soil texture, one runs the risk of altering the intricate soil ecosystem. Microorganisms, such as protozoa, have very particular requirements for the condition of their soil habitat. By altering the soil's density and texture, it is possible to kill and/or damage the inhabitants. Construction changes the soil texture through destroying the plants on the site and drying out the soil. In order to successfully begin construction, the desired site must be cleared and dry so that there is no interference with the building. This not only changes the texture of the soil immediately surrounding the site, but also has an indirect effect on the soil in the surrounding watershed through erosion. (Protecting Water Quality from Urban Runoff. 2003).

Microorganisms live within the various types of soil. Organic matter, bacteria, fungi, protozoa, and nematodes all inhabit the soil. Each organism is essential to the intricate ecosystem. Organic matter is mostly decomposing plant remains, but also consists of live roots and other plant life (Organic Matter, 2001). The organic decay is filled with important nutrients and minerals that the other organisms digest, recirculating it through the soil. Bacteria are the primary consumers of the organic matter, assisting in the decomposition of the dead plants. By recirculating the nutrients in the dead plants, a bacterium proves to be an imperative organism (Organic Matter, 2001).

Bacteria provide food for the protozoa, another necessity in the soil. The protozoa come in three forms: ciliate, amoeba, and flagella (The Soil Biology Primer, 2005). Ciliate are the largest protozoa and use their hair to move. They eat bacteria as well as smaller protozoa. Amoebas are the second largest protozoa, and they use their pseudopod foot to move. Some amoebas live in shells, while others do not. Bacteria are the main source of food for the amoebas. Flagella are the smallest type of protozoa. They

use their whip like tail to move throughout the soil. Like the amoebas, flagella eat bacteria. Protozoa are noticeably larger than bacteria, and require an airy soil to move through. Protozoa continue the recycling of nutrients essential to the soil. Healthy soil is determined by the ability to use, produce, and recycle nutrients. Protozoa are key organisms when recycling and using energy (The Soil Biology Primer, 2005).

The changing of the soil has major effects on the microorganisms that live there. Protozoa are a very crucial part of the soil. By eating bacteria, the protozoa successfully recycle soil nutrients such as nitrogen. Nitrogen fixation is a process that bacteria, with protozoa, do. This is essential because nitrogen must be turned into ammonia in order for it to be useable by the plants. Bacteria transforms the nitrogen into ammonia and the protozoa release it into the soil. Healthy protozoa make for healthy soil. The protozoa prefer to live in moist environments, with an airy loam. Soils that are not tightly compacted make it easier for the protozoa to feed on the bacteria and fungi that also live there.

Erosion compacts the soil, restricting the protozoa. Erosion can be stopped by planting plants and trees to supply support for the soil and well as soaking up some of the excess water. (Soil Erosion, 2005). Plants are crucial to preventing erosion because they keep the soil firm and in place. By planting plants, more organic matter circulates into the soil. Also, the plants break the pressure of rain drops when they fall from the sky. Although this may seem like a small task, in reality it saves many microorganisms that could be decimated by the impact of a raindrop. The lack of plants allows for water to directly contact the soil and potentially hurt it (Soil Erosion, 2005).

References

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Procedure

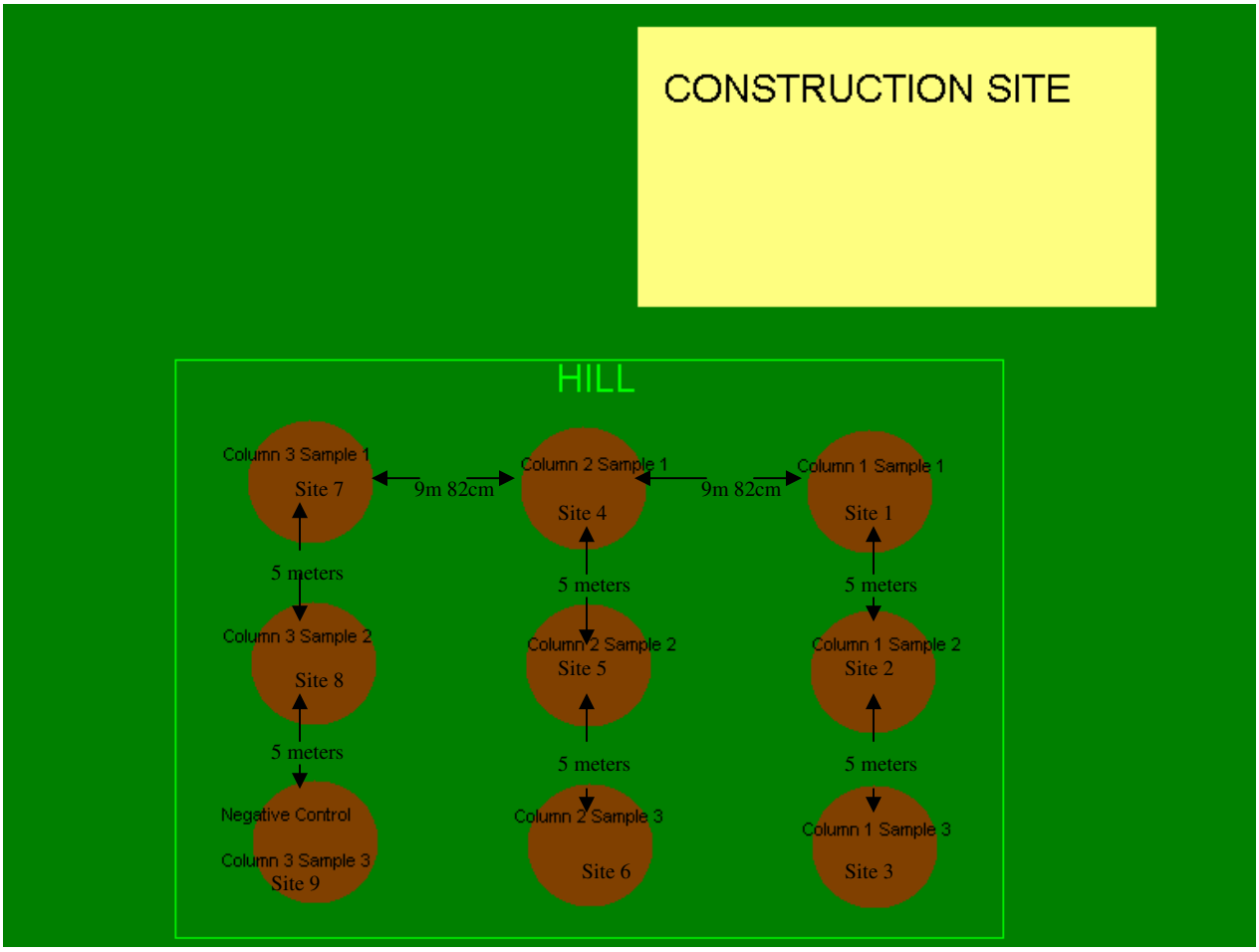
I. Problem: As soil erosion from the construction site flows down on to a hill how does the change in soil density alter the density of active protozoa in the soil?

II. Hypothesis: The density of active protozoa will decrease as the density of the soil increases.

III. Experiment:

a.) Independent Variable: The distance away from the construction site.
b.) Dependent Variable: the number of protozoa per grams of soil at each distance away from the construction site
c.) Dependent Variable 2: The texture of the soil at the different sites
d.) Negative Control: the sample farthest away from the construction site
e.) Controlled Variables: the side of the stream samples are taken; the place where samples are taken(we looked for similar plants, to try and keep the other things in the soil similar); the number of samples taken at each column; the distance between each sample taken; the time the soil is allowed to dry out; using sterile equipment so we do not contaminate; size of samples; extraction process (how soil was removed, brushing away leaves and sticks before taking sample); amount of water given to each to dilute; amount of sifted soil; doing each step for each soil sample at the same time; amount of time soil samples allowed to dry; the amount of time the texture texts sat for; the time Uhligs were left; the amount of diluted soil and methyl green dye put on microscope slide.
f.) Step by Step Procedure*:

1.) Go to the backwoods of RPCS. Use the GPS machine to find N 39.35, W 076.63.
2.) At Site 1 (as seen on the map below) take a soil sample.



3.) To take a soil sample use a soil cylinder and put it into the ground 10cm deep (the markings are on the side). Then twist the soil cylinder (2cm diameter) in order to loosen the soil then remove the soil core from the ground and put the soil sample into a clean plastic baggy and make sure to label the baggy to which site it came from and the number sample it is. (Make sure that each soil sample has it's own bag)

4.) Then go to the next site 5 meters down the hillside from where the last sample, Site 2 (as seen on the map)

5.) At this site repeat steps 2-3

6.) Again go to a new site that is 5 meters away from the sample just taken, going directly down the hillside, to Site 3(as seen on the map)

7.) At this site repeat steps 2-3

8.) At the first sample taken, highest spot on the hill, move right (when facing downhill) 9 m and 82 cm. Site 4 (as seen on the map). Here will begin a new column. Take a sample here (step 3)

9.) After, move to site 5 (as seen on the map) and take a sample (step 3)

10.) Go down to site 6 now (as seen on the map) and take a sample (step 3)

11.) Move to the top of the hill (10 meters up) where the first sample was taken of that column and move right (facing downhill) 9 m 82 cm. Site 7 (as seen on the map). Here begins a new column, take a sample here (step 3).

12.) Move down the hill from this location to site 8 (as seen on the map). And take a sample (step 3)
13.) Go down to site 9 (as seen on the map) and take a sample (step 3).
14.) You have now collected all soil samples you need (there should be nine). Now return inside to the lab.
15.) Label a clean petri dish column 1 sample 1
16.) Label another clean petri dish column 1 sample 2
17.) Label another clean petri dish column 1 sample 3
18.) Label another clean petri dish column 2 sample 1
19.) Label another clean petri dish column 2 sample 2
20.) Label another clean petri dish column 2 sample 3
21.) Label another clean petri dish column 3 sample 1
22.) Label another clean petri dish column 3 sample 2
23.) Label another clean petri dish column 3 sample 3
24.) From now on each step that is done to the soil samples need to be done at the same time.
25.) Air dry the soil samples for 24 hours. (to air dry, leave the soil samples in an uncapped petri dish. Make sure to put the soil sample in the petri dish that has the same label as the bag (ex: plastic bag labeled column 1 sample 3 should be put in petri dish labeled column 1 sample 3) All samples need to be dried at the same time
26.) After that put the soil sample labeled column 1 sample 1 into a cup, and over top it put $1mm^2$ nylon mesh
27.) Sift 10 grams of soil into a clean petri dish
28.) Do steps 25-26 with every soil sample taken
29.) Now saturate soil sample column 1 sample 1 with 20mL of distilled water
30.) Do step 28 with every sample
31.) Let samples sit capped for 7 hours at room temperature. All sample need to be doing this at the same time.
32.) Now make modified Uhlig ciliate sandy sediment separators (out of plastic cups and a sheet of 110/45 Nytex nylon mesh) for each of the petri dishes
33.) Place the Uhlig separator into a 100x15 mm Petri dish and scoop the dehydrated soil sample, column 1 sample 1 into its bottom
34.) Do this for each sample, using a different Uhlig separator and petri dish each time.
35.) Add 30 ml of distilled water to the bottom of each Petri dish and allow it to filter for 24 hours at room temperature. Do this to each sample at the same time.
36.) Filter the column 1 sample 1 soil sample again using qualitative filter paper and a funnel into a cup
37.) Repeat step 35 with all the other samples. Make sure to use new filter paper and funnels for each sample.
38.) Now prepare the microscope slide for viewing the second filtration of soil sample column 1 sample 1.
39.) Do this step for all the other soil samples
40.) Using a capillary tube, add 7ul (7drops) of methyl green dye to each microscope slide

41.) Add 18 ul (18 drops) of the filtrate using a graduated Beral- type pipette and cover it with an 18x18 mm^2 cover slip
42.) Examine each slide at 5 different fields of view all at 40x power for protozoa. This will tell you about how many protozoa per gram of soil there is at each site. This ultimately will be the data to see if the number of protozoa correspond with the soil textures you will take later which is the data needed to prove your hypothesis correct or not.
43.) Formula to determine the estimate of population density per gram of soil. The formula is: [(# for field of view at 40X) x (total ml of water used) x 747] / (grams of sifted soil) = # of protozoa per gram of soil
44.) Record your data
45.) Go back outside to the back woods of Roland Park Country School (same one as step 2)
46.) At site 1 take a trough and scoop up dirt from the same place the soil core was taken from. Put the sample in a clean plastic baggie labeled column 1 sample 1.
47.) Repeat step 45 at each site on the map, making sure to use new clean plastic baggies for each sample and don't forget to label you bags which column and sample (will be the same labels used when taking soil cores)
48.) Go back to the lab with your new nine soil samples, to finish the second part to the experiment.
49.) In a flat bottom container with a lid fill one 1/3 with soil sample column 1 site 1. Fill the 2/3 with water, and then put 3 drops of phosphorus detergent in it. Put the cap on it
50.) Shake well and then put the jar in a place where it will not be touched or moved. Leave it there for 24 hours
51.) Do steps 48-49 for each soil sample. After 24 hours measure the percent of sand, silt, and clay in the container.
52.) To measure use a ruler to measure the height of the settled soil. Then measure the clay and silt layers separately and together to get the percent of soil in that site that is not sand.
53.) Record your data

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*This procedure is fashioned off of the one created by Kate Brockmeyer

Data & Analysis

Conclusion

For our experiment, we tested the change of protozoa in eroded areas compared to a more natural environment. We have concluded that we were incorrect in stating that the number of protozoa will decrease as the density of the soil increases. Our data shows that we were not entirely correct. We predicted that the negative control, the site furthest away from the construction (column 3, site 3), would have the most protozoan and the sandiest loam. After performing our experiment, the negative control turned out to have the least amount of protozoa (13,147.2 protozoa), but, it was the sandiest loam. The site closest to the construction, (column 1 site 1) has about 143,424 protozoan, which is one of the higher counts of protozoan out of all of the samples we took. Column three has the highest total number of protozoa, but there is an outlier of 708,903 protozoans, the largest count of all the samples. Ignoring the outlier, column 3 as a whole has the least amount of protozoa and column 1 has the most.

There are many variables, which we could not control for, that could have changed our experiment. For example, an animal could have died in the spot which we took some of the samples, causing an outburst of bacteria that would assist in the decomposition of the animal. The large number of bacteria causes an increase in protozoa in order to keep the food chain in order. There could have been an unusually large number of nematodes in the sand loams, eating the protozoa. There also may have been large amounts of nutrients in the samples taken from column 1 for unknown reasons.

We thought that the construction site would increase erosion because the construction workers had to cut down trees and ruin vegetation in order to build. Since the trees and plants were being cut down and killed we assumed it would have a negative

impact on the amount of protozoa: the loss of organic matter would result in a change of soil texture. The amount of clay and silt would become larger, making it harder for water to be absorbed. The soil texture plays a large roll in the experiment, proving the presence of erosion. In column 1 site 2, there was no sand present in the sample we took, proving erosion through the high levels of silt and clay. Overall, column 1 samples were the densest of all the samples taken. This is a perplexing fact when compared with the protozoa populations. The high number of protozoa and the large presence of silt and clay leads one to believe that there is an outside variable. These results are compelling and provoke further research in the department of protozoa and erosion.