# The Affects of Moisture in a Tropical Environment as Expressed in Soil Properties

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**Abstract**

**This project tested the impact precipitation has on a variety of soil properties in a tropical environment. Three habitats were selected for study: Primary Rainforest, Secondary Rainforest, and agricultural sites; all found on the island of Dominica in the West Indies. Soil samples were taken and tested from each of these sites and a tarp was placed on the ground to prevent rain from reaching that area of soil. After fourteen days, the tarp was removed and additional soil samples were taken and tested from the area under the tarp as well as an uncovered area immediately adjacent to the tarp. The results of the tests indicated an increase in soil pH in Primary Rainforests for soils covered by the tarp as well as a change in the amount of Available Iron. Tests in the agricultural site indicate an increase in pH for soils covered by the tarp and those left uncovered. Also, Active Aluminum in agricultural soils decreased in soils covered by the tarp and soils left uncovered.**

**Introduction**

Rainforests, as the name suggests, are environments highly dependent on rainfall to support life. In Dominica, an island in the West Indies, rainfall is heavy and seasonal. The rain cycle in a tropical rainforest is one that is self-perpetuating. Rain falls to the ground where it is absorbed by trees and plants. The moisture is absorbed through the soil by the plant roots, which transport it vertically through the xylem and phloem. As the water travels through the plant, the plant stomata release it in the form of humidity. The constant humidity of the environment returns the water to the clouds, where it will start the cycle all over again. Without the plant biota, the rains will be reduced. This basic concept has been one of importance in South America where the governments of some countries have been encouraging the practice of "slash and burn" agriculture and clearing land for pasture. As the tall trees were cut down and the plant life cleared for the purpose of farming, the rains were greatly reduced. With this reduced amount of rain, what was the affect on the soil? This study compares soils that have been exposed to the natural amount of water to soils that have been covered with plastic tarps, effectively eliminating all of the moisture that falls to the soil from rain.

I hypothesize that as the rainy season begins, soil samples obtained from area not covered by a plastic tarp will not exhibit any significant changes in pH or micronutrient availability.

However, samples obtained from areas covered by the plastic tarp will exhibit higher pH than the uncovered counterpart.

**Methods**

Three types of habitats were selected for study: a primary rainforest, a secondary rainforest, and an agricultural area. Initially, two soil samples were collected from each site during the late dry season. Within each site, two clear plastic tarps were placed on the ground, approximately 10 meters from each other. These tarps were staked into the ground to safeguard the tarps from gusts of wind and foraging animals.

Each of these samples was tested for pH, Percent Water (PW), Available Ferric Iron, Active Aluminum, Sulfate, Available Calcium, Nitrite Nitrogen, and Ammonia Nitrogen. The soil tarps were left in the field for fourteen days. After that time had elapsed, soil samples were again collected from each site; this time, however, four samples were taken from each site. A sample was taken from under the tarp and another sample taken from an area adjacent (<1 m) to the tarp. These soil samples were then analyzed using the same tests as mentioned earlier. (Milford, 1997)

**Data**

| Site * | Time ** | Location *** | Soil pH | Available Iron | Sulfate | Active Aluminum | Available Calcium | Nitrite Nitrogen | Ammonia Nitrogen | Percent Water |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 0 | 5.3 | 15 | 0 | Very High | 0 | 3 | low | 152 |
| 1 | 1 | 0 | 5.3 | 10 | 0 | Very High | 0 | 3 | low | 198 |
| 2 | 1 | 0 | 6.1 | 5 | 0 | Medium | 0 | 1 | low | 52 |
| 2 | 1 | 0 | 6 | 5 | 0 | Medium | 0 | 3 | low | 64 |
| 3 | 1 | 0 | 6.5 | 15 | 0 | High | 0 | 3 | low | 62 |
| 3 | 1 | 0 | 6.6 | 15 | 0 | Medium | 0 | 3 | low | 84 |
| 1 | 2 | 1 | 5.9 | 15 | 0 | Very High | 0 | 5 | low | 175 |
| 1 | 2 | 1 | 5.7 | 15 | 0 | Very High | 0 | 5 | low | 171 |
| 1 | 2 | 2 | 5.3 | <5 | 0 | Very High | 0 | 0 | low | 122 |
| 1 | 2 | 2 | 5.2 | 5 | 0 | Very High | 0 | 3 | low | 130 |
| 2 | 2 | 1 | 7 | <5 | 0 | low | 0 | <1 | very low | 69 |
| 2 | 2 | 1 | 6.7 | <5 | 0 | medium | 0 | 3 | low | 70.3 |
| 2 | 2 | 2 | 6.8 | <5 | 0 | low | 0 | <1 | very low | 73.4 |
| 2 | 2 | 2 | 6.9 | <5 | 0 | low | 0 | 1 | low | 85.3 |
| 3 | 2 | 1 | 6.4 | 15 | 0 | medium | 0 | 1 | low | 64.2 |
| 3 | 2 | 1 | 6.5 | 15 | 0 | high | 0 | 1 | low | 60.4 |
| 3 | 2 | 2 | 6.6 | 15 | 0 | low | 0 | 1 | low | 50.1 |
| 3 | 2 | 2 | 6.5 | 15 | 0 | Very low | 0 | 1 | low | 58.9 |

* Site 1 is Primary Rainforest
Site 2 is an Agricultural Area
Site 3 is Secondary Rainforest

**Time 1 indicates initial sampling
Time 2 indicates sampling after 14 days

***Location 0 represents the initial samples
Location 1 represents sampling under the tarp
Location 2 represents sampling adjacent to the tarp

**Results**

Figure 1: Change in pH in a Primary Rainforest

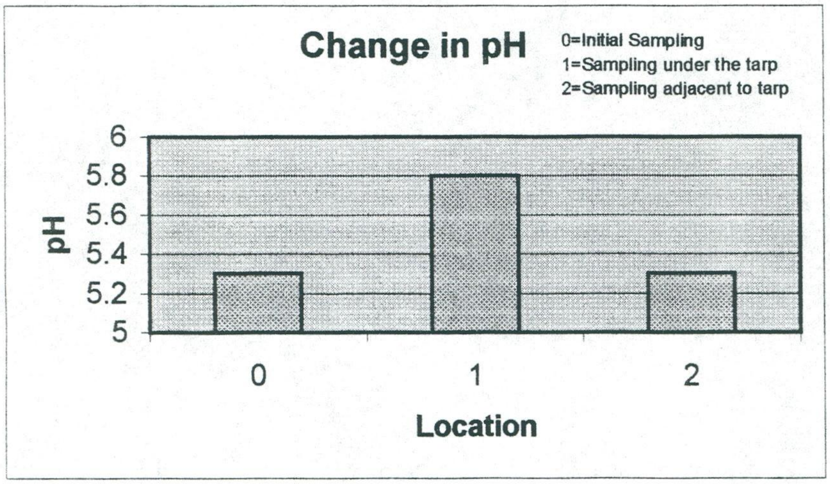



Figure 2: Changes in Available Iron in a Primary Rainforest

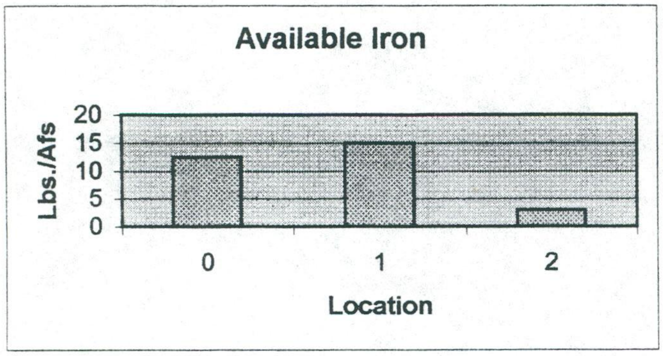



Figure 3: Changes in pH in an Agricultural Site

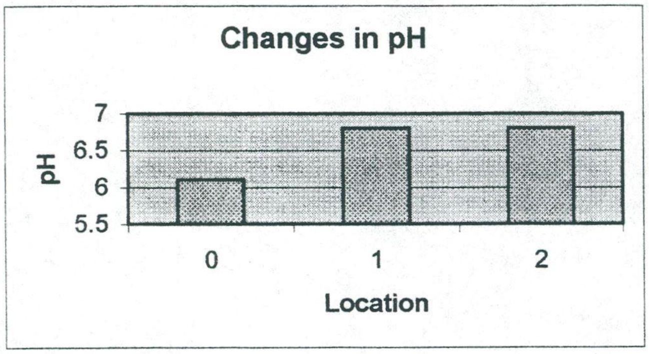
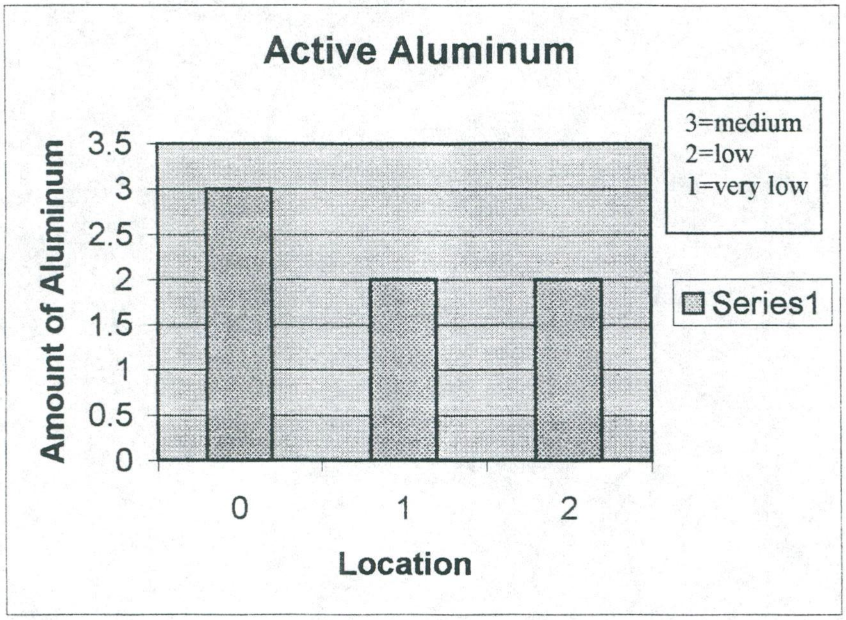


Figure 4: Changes in Active Aluminum in an Agricultural Site




**Discussion**

Initial soil samples taken from the Primary Rainforest exhibited a pH of 5.3 (Figure 1). Secondary sampling showed that samples taken from the sites covered by the tarp had an increase in pH to an average pH of 5.8 (Figure 1). Soil samples from areas adjacent to the tarp showed relatively no change in pH, exhibiting an average pH of 5.25 (Figure 1). A possible reason for the increase in pH of the covered areas is that as rain was removed from the environment, water ceased to trickle through the soil. Typically, when water trickles through the soil, basic cations adsorb to the water molecule and are leached through the soil. With no water trickling through the soil, it is possible that basic cation constituents of the soil were retained, yielding a higher pH.

Soil samples taken from the Primary Rainforest also showed changes in the amount of Available Iron. Initial samples yielded and average of 12.5 pounds of iron per Acre Furrow Slice (lbs./AFS). Secondary sampling indicated an increase in the amount of Available Iron, 15 lbs./AFS in areas under the tarp (Figure 2). Samples taken from areas adjacent to the tarp showed a sharp reduction in the amount of Available Iron, less than 5 lbs./AFS (Figure 2). A possible cause for this difference in Available Iron is again leaching. Ferric iron is also a cation and subject to leaching in the soil. As water was removed from the soil, the iron was retained in greater abundance. Similarly, with the advent of the rainy season, the increase in the amount of water trickling through the soil may have caused an increase in the leaching of iron cations.

Initial soil samples taken from an agricultural plot exhibited a pH of 6.1. Secondary soil samples exhibited a significantly higher pH in both areas covered by the soil tarp, pH=6.85, and areas adjacent to the tarp, pH=6.85 (Figure 3). This increase in pH in secondary soil sampling is correlated with the decrease in Active Aluminum in secondary soil sampling in agricultural areas. Initial soil samples in agricultural yielded a medium concentration of Active Aluminum; secondary sampling however, yielded medium and low amounts of Active Aluminum (Figure 4). This correlation between pH and Active Aluminum was to be expected because of the role of Aluminum in soils. Aluminum is the primary cation involved in determining the acidity of soils. It is also the primary element involved in buffering acidic soils (soils ranging in pH from 3.8-6.5) against changes in pH. As the soil pH gets closer to neutral, less Aluminum will be involved in determining the pH.

The interpretation of this data is of course subject to error. The soil test kits used do not yield numerical answers in most cases and use colormetric comparisons rather than analyses by machinery or chemical titration. The soil sampling kit's "Universal Extracting Solution" is also a reason for error. Extraction solutions specific to an element should be used in order to obtain a more precise reading. In general, the soil sampling kit is less precise than a soil laboratory. While moderate differences in some aspects of the soil tests were noticed using the field kit, minor differences might be noticed if a soil laboratory analyzed the soils.

The number of soil samples collected is also a reason for error. Were more sites selected, a broader database could be established that could produce more accurate results. The technique used for determining the Percent Water is reason for error, however. The Percent Water data do not affect any of the other variables. In future studies, testing for the Percent Water might be improved by using a different type of tarp. In this experiment, a clear tarp was staked to the ground. This method effectively prevented water from entering the soil, however, it also prohibited water from leaving the system in the form of humidity. During plant respiration, the water released by the plants was retained by the tarp. Some of the water escaped through the side of the tarp, but the remaining water condensed underneath the tarp and fell to the ground. To prevent this, a tarp could be mounted above the ground, so that rain would be prevented from entering the soil and plant respiration would continue to remove water from the soil. This type of error reduced the precision of the Percent Water measurements, as a true secondary sample was unavailable.

**Conclusion**

In a Primary Rainforest, as rain was removed from the environment, the soil exhibited an increase in pH. Also in the Primary Rainforest, as rain was removed from the environment, the Available Iron in the soil increased, while Available Iron in soils exposed to rain exhibited a sharp decrease in the amount of Available Iron.

In agricultural sites, the advent of the rainy season caused an increase in pH of soils covered from the rain and soils exposed to the rain. Also in agricultural sites, the amount of Active Aluminum decreased in soils exposed to rain and soils protected from the rain by the tarp.

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**Literature Cited**

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