The Impact of Forest Fires on Soil pH, Surface Temperatures and Snow Surface Temperatures

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Abstract

The importance of managing wildfires and their effects upon the soil and the health of environments are key in forest management around the world. The significance of these impacts is the effect of forest fires on soil characteristics such as pH and the temperature readings of the soil surface and the snow surface temperatures. The two sites tested near Murphy Dome compared a burn area and a non-burn area of arctic boreal forests within a 200m distance of each other. The impacts of the Shovel Creek fire near Murphy Dome that occurred in 2019 indicated through data collected in the fall of 2021 that there was a decrease in soil surface temperature, no significant change in snow surface temperature, and an increase in the soil's pH levels.

Research Question

What is the impact of forest fires such as the Shovel Creek Fire on soil pH, snow temperatures, and surface temperatures? This research is important because with warmer global temperatures correlating with increasing likelihood of wildfires it is crucial to see what impacts these fires will have on the areas they take place in.

Introduction

The impact of forest fires can be massive, but they can also have affects on the environments that they leave behind. The addition of large amounts of charcoal into a once heavily forested area can have many impacts on the soil. These impacts can help foresters and farmers better understand the impacts of charcoal on soil management and what to look for when examining soil characteristics. For example, the addition of ash and charcoal from the burn can influence the soil and can help give information which can be used in agriculture and forest management when trying to raise pH, "For instance, soil pH tends to increase after fire due to the release of basic cations by combustion and the addition of ash" (Huerta et al. 2020). This is relevant to the community of Fairbanks and surrounding areas because of the tendency of spruce-dominated forest areas to be replaced by deciduous forests which takes up more carbon (Johnstone et al. 2021).

Photo on the left is the burned data collection site and the photo on the right is the unburned data collection site.

Research Methods

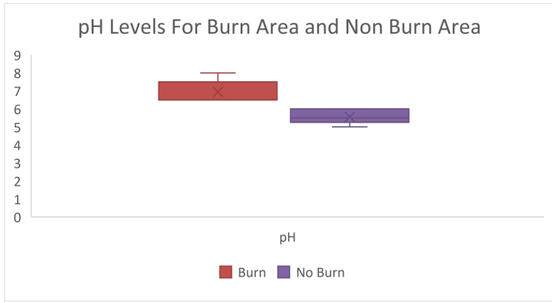
The area of study was selected upon the top of Murphy Dome alongside Murphy Dome Road west of Fairbanks Alaska. Data was acquired from the burn area to the north and the unburned forest to the south of the road. The burn area was on a lower slope than the burn area and had a slightly lower elevation. The area of study is forested on the unburned area with a sparsely forested burned area as the second area of study. The site is rural and has snow cover across the research areas. The unburned area is rich in coniferous trees and some shrubs.
The process of data acquisition included sampling two adjacent burned and unburned 30x 30 m plots using GLOBE surface temperature protocol. Nine sample locations in each site were randomly assigned from north to south while walking five paces between the locations. After snow surface temperature was measured using a Fluke Infrared thermometer, the soil surface was exposed, and soil surface temperature was taken. A spade was then used to dig up soil samples which were collected for a measurement of pH in soil labs. Data from each of the nine sample locations were averaged to find the mean for each parameter for every 30X30 m plot. Data was organized into graphs for pH levels for burn and non-burn areas as well as a graph of snow surface and soil surface temperatures for each site. GLOBE equipment used was a spade, Fluke Infrared Thermometer, and a thermal glove for the thermometer. GLOBE protocols used were pH and snow protocols, as well as Soil protocols. Arctic and Earth SIGNS provided our equipment.

Murphy Dome Road & Sampling Locations.

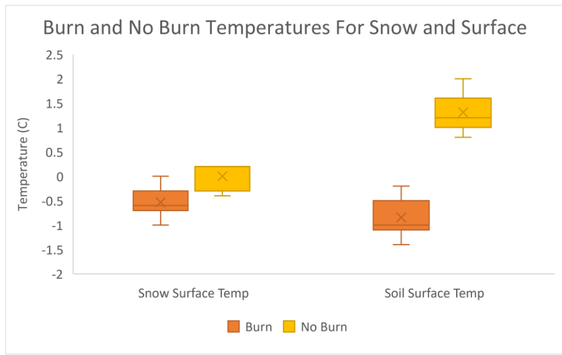
GLOBE Teacher: Christina Buffington

Results

The results of our data show that the unburned area and the burn area had differences in pH and soil surface temperature but not a significant difference of snow surface temperature averages between the two sites. We can see that the mean soil pH level in the burn area was higher than in the no burn area, and that there was not a significant difference between the snow surface temperature of the two sites. However we can see that the mean soil surface temperature for the no burn area is higher than the mean soil surface temperature of the burn area.



pH levels. Mean pH for the burn area was 6.9 and mean pH for the no burn area was 5.6



Temperature levels (Celsius). Mean snow surface temperature for the burn area was -0.5 C and the mean soil surface temperature was -0.8 C. Mean snow surface temperature for the no burn area was 0 C and the mean soil surface temperature was 1.3 C.

Discussion

From the data we can infer that the differences in data can be attributed to the forest fire and the introduction of ash and large amounts of carbon material into the soil of the burn plot. This is because the release of positive basic cations from the soil created an increase in pH level. The heat and burning caused by the forest fire also impacted soil characteristics. The burning of the topsoil also left the soil exposed which caused the soil to have less insulation against the elements. This potentially created the difference in soil surface temperature. The snow surface temperatures had little to no difference and further testing and data would be needed to conclude if there are any more discrepancies caused by the Shovel Creek fire. Different sampling sites located throughout the Shovel Creek fire burn area and non-burn areas surrounding it are needed in order to collect this data. Different elevation sites could also be included in further research as well as measuring surface temperature at different times of the year.

Conclusions

From our data collection we can infer that the effects of the Shovel Creek Forest fire on Murphy Dome were the soil being impacted by an increase in the soil pH levels and a decrease in snow levels in the burn area due to charcoal absorbing more heat. This most likely contributed to the decrease in soil surface temperature as soil was in direct contact with the surface. The snow surface temperatures are well within the range of the data and the impacts of the fire on the temperature are inconclusive. We suggest that the next steps in research are to measure the ash layer and charcoal levels within it (which tends to be darker and thus able to absorb radiation and trap heat) in order to find the amount of organic material present on the soil surface. Research could also pursue how long it takes soil pH in burn areas to return back to normal. We also may want to conduct research monitoring the soil to find out if ash layers and charcoal concentration change as soil thaws over time. What we learned from working as a team is that it takes a lot of coordination and time to collect larger amounts of data, process it, graph it, and then interpret the results.

Bibliography

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GLOBE Surface Protocol Surface Temperature Protocol (globe.gov)