Analyzing water retention in soil between north-south slopes on the National Bison Range

Shirley LeClair-Bernal
Haskell Indian Nations University
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ABSTRACT

This research analyzes the difference between water retention in soil on north-south facing slopes upon two separate mountains located in Moiese, Montana. On the National Bison Range, data collection took place at both Red Sheep Mountain and Red Mans Ridge between 4,500-4,880 ft elevation. A total of 96 soil samples were taken and analyzed for water retention. Averages were compared through a T-Test showing the results were not significant (p=0.791). The averages showed no difference in the outcomes of the water retained by the soil from both north and south facing slopes. Future studies can further extend this analysis by doing more than two mountain tops on the National Bison Range.

Keywords: north-south slopes, soil, water retention

INTRODUCTION

Located in western Montana, the National Bison Range (NBR) was under the Glacial Lake Missoula, which reached depth to 4,200 ft. While above water was the highest point of elevation at about 4,885 ft on the NBR is known as High Point on Red Sheep Mountain. Along with Red Mans Ridge is above water as well having an elevation at about 4,570 ft. These high elevation points have different environmental impacts on the soil. Soils configure the landscape and the vegetation within it. Aspects influencing the microbial community within the soil include; topography, soil texture, soil type, and precipitation. Soil creates the microbe community within an area of land thus, influencing the vegetation that grows on it. The cycle of vegetation growth is also dependent on which side of the slope it is facing, in this case, north or south. To ensure growth and distribution of vegetation is the importance of soil moisture.

The spatial distribution of soil water retention relies on the distributions of soil properties, which are commonly understood to depend on Jenny's (1941) five soil forming factors: regional climate, potential biota, topography, parent material and time (Geroy, Gribb, Marshall & Benner et al., 2011). At the local scale, soil moisture can strongly be controlled by vegetation patterns (Madsen, Chandler & Belnap, 2008). While the instantaneous impacts of aspect on snowmelt, evapotranspiration, and other local energy balance problems are well studied, the longer timescale influences on landscape properties and feedbacks with hydrological processes are less understood (Broxton, Troch & Lyon, 2009). Given that aspect influences the surface energy balance, it is reasonable to expect that soils and associated ecosystems will develop differently; a trend often noted in the soil literature (Losche, McCracken & Davey, 1970). The processes of water flowing through the soil is not focused on, nor put into climate change reports.

Soil moisture is one of the primary physical factors that control microbial activity (Harris, 1981). Short- and long-term temporal variations in soil moisture are strongly correlated with heterotrophic respiration rates (Carbone et al., 2011; Yuste et al., 2007). The purpose of this project is to find a difference in water retention in soil between Red Sheep Mountain and Red Man's Ridge at their north-south slopes. Both mountains held species of grass, *Pinus ponderosa* (ponderosa pine) and *Pseudotsuga menziesii* (douglas fir) at their north slopes. While found on the south slopes a variety of arrow-leaf and cheat-grass for both mountaintops.

METHODS

Each site was 25 meters apart from each other; both mountains received 3 sites with a total of 6 sites. Collection of samples took place at 50 meters going north-south from the center point of the mountains and within a plot diameter of 15 meters. Samples were taken no more than 5 cm deep, litter was brushed away, and they were naturally studied (not sieved). Once taken from the site, we performed weight measurements on the dry soil using a fish scale Berkley FS-50 measuring tool. We proceeded to place the samples one at a time on top of a filter into a funnel and poured 100 mL of water throughout the sample. Water was allowed to percolate through the soil for 2 minutes. The released water was taken for data and the wet soil was then weighed.

RESULTS & DISCUSSION

Using a T-Test comparing the averages, these samples showed no significant difference showing a p-value of 0.228 for the difference between Red Sheep Mountain and Red Man's Ridge in water retention in soil found at the north-south slope (see figure 1). Found in figure 2, there is no difference between the water retention between the north-south slopes overall. We can see that the averages between the two mountains that Red Mans had about 65% of soil retention and at Red Sheep there is 82% of soil retention.

Therefore, at Red Sheep the water retention in the soil is much higher and holds the water more accurately rather than at Red Mans Ridge. This would be the case possibly due to the differences in soil properties, which indicate that north aspect slopes have the capacity to store considerably more water (Geroy et al., 2011). This aspect difference in water retention is further accentuated by deeper soils on north aspect slopes (Smith, 2010; Tesfa et al., 2009). Reasons for lower water holding capability on the south slopes is due to the south aspect soils receive considerably more insolation than the north aspect soils, while both aspects share nearly all other physical variables that dictate soil development including parent material, precipitation, elevation, slope position (Geroy et al., 2011). Differences in insolation have also, apparently, distinguished the two hillsides with respect to vegetation density, soil carbon content and soil depth, all greater on the north aspect slope (Smith, 2010).

While looking at the geography of the two mountains we can say that both of them held more steeper north slopes than on the south slope. The profound differences observed with aspect have been observed elsewhere (Yetemen et al., 2009) and theoretically predicted (Rodriguez-Iturbe, 2000; Rodriguez-Iturbe et al., 2001), but otherwise is not a popular study that has been investigated further. Which would make an even more interesting future study to collect data on the slopes venturing all the way down in elevation.

Soil weight was a variable that was analyzed as well to see any differences, showing in the bar chart in figure 3 identifies the very slight difference. This variable further studied could regulate the differences between soil properties on either side of slopes. This could be put into effect due to the differences of colors found between the samplings. The north slope had more soft, dark soil and the south slope had more light brown rough soil. These differences are presumably driven by differences in insolation; the south aspect soils receive considerably more insolation than the north aspect soils (Geroy et al., 2011).

In these environments, soil water retention will determine how much water is discharged to the adjacent streams and underlying groundwater and determine soil water availability during the growing season and overall water availability. More scientific devices should become more available to further study the water flow through soils. The ability to measure and calculate different mountain ranges deep within the soil is significant to climate change.

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FIGURES & TABLES

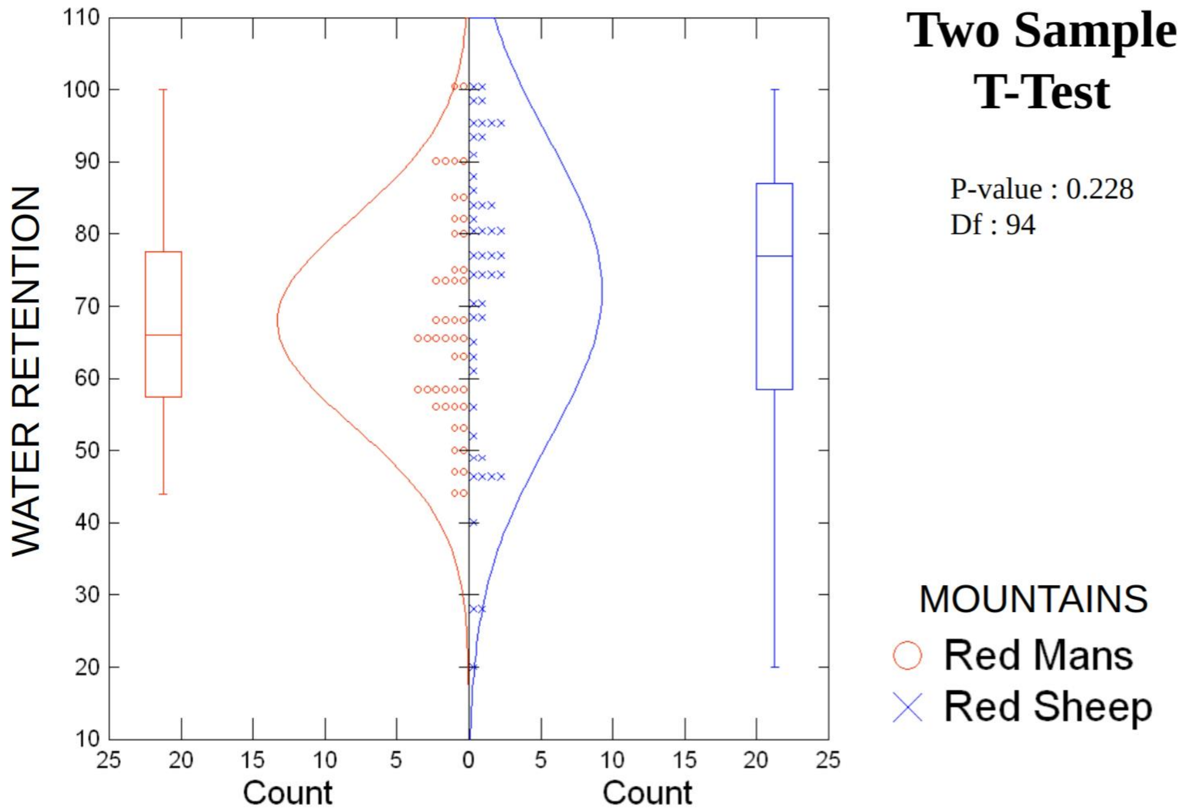

Figure 1: Two Sample T-Test identifying the average of water retention in the soil at both Red Sheep Mountain (Blue) has an average of about 77% and Red Mans Ridge (Red) has an average of about 68%. The distribution of the samples are showing that Red Sheep Mountain has about 15 samples that have the 77% average of water retention in the soil. Whereas, Red Mans Ridge samples come to a count of only 10 had 68% water retention in the soil.

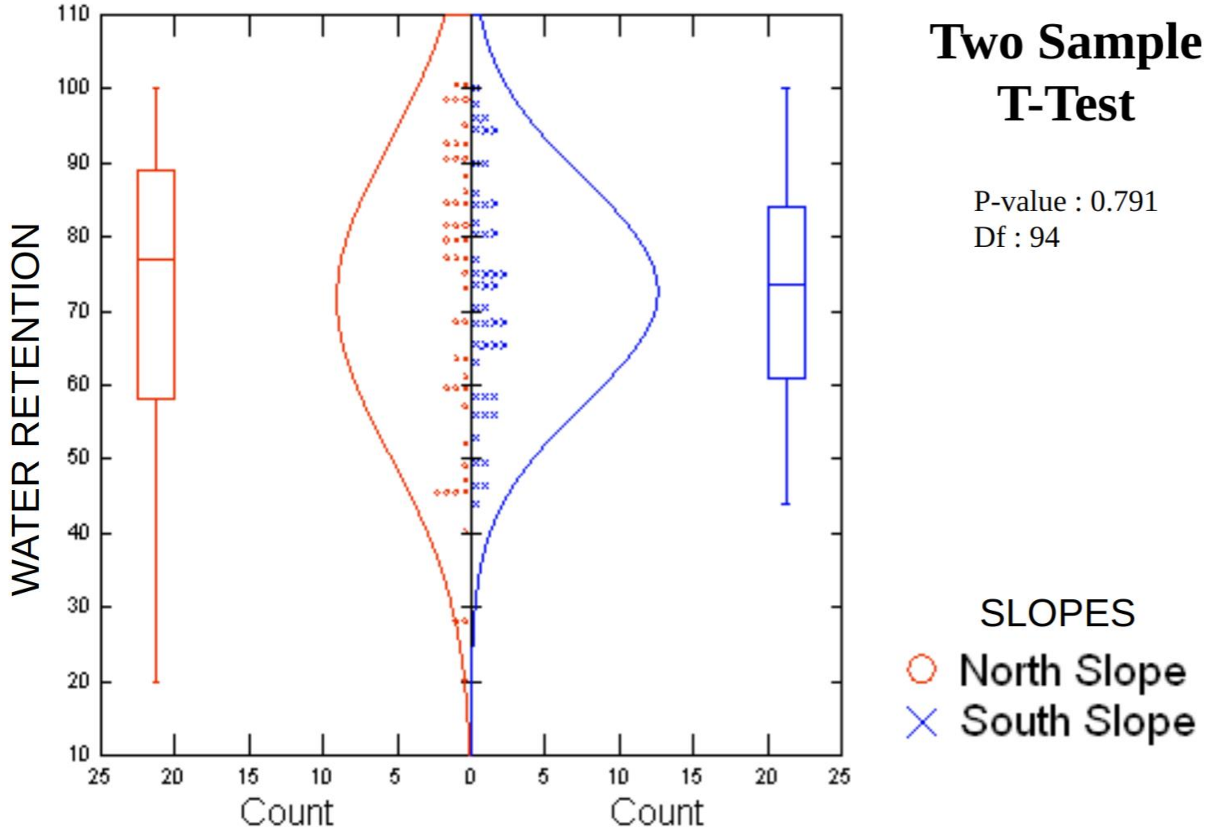

Figure 2: Two Sample T-Test identifying the averages between the slopes on the mountains. At the North Slope (Red) has an average at about 78% with about 10 samples being distributed in that area. The South Slope (Blue) has an average at about 75% with about 15 samples being mostly assigned to that average.

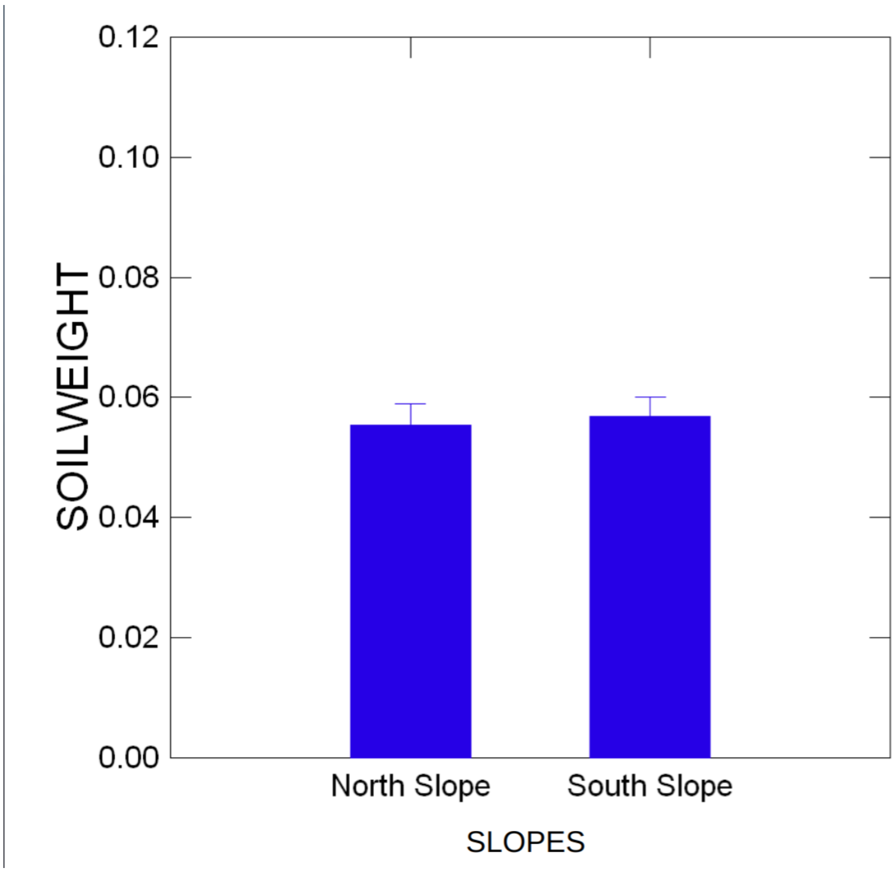

Figure 3: Bar Chart showing slopes at the x-axis and soil weight at the y-axis. The South Slope has a slight more weight average at 0.06 kilograms while North Slope is a bit lower than that.

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