Soil Moisture Patterns in Thawing Soil at Green Lakes Valley, Colorado

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Research Experiences for Community College Students

Motivation

By contributing to a basis of understanding for the behavior of liquid water within seasonally frozen soil, moisture saturation data contributes to our ability to better predict and understand how and to what extent the moisture content of seasonally frozen ground impacts various hydrological processes which rely on soil moisture, including ground and surface water regeneration and nutrient cycles of alpine plant ecosystems.

Background

- Frozen soil inhibits the ability of liquid water to move through the soil
- Increased liquid water content could indicate times when liquid water is able to infiltrate the soil and contribute to hydrological processes (1)
- Alpine ecosystems are especially vulnerable to changing climate conditions due to their their altitude-dependent adaptations (2)

Data Set

- Soil temperature and soil moisture data were collected from five sampling sites in the Green Lakes Valley (GLV) watershed at depths of 11-15 cm
- Soil moisture is represented as the ratio of liquid water volume to total soil moisture volume
- Data was collected over 8 years between 2010-2017

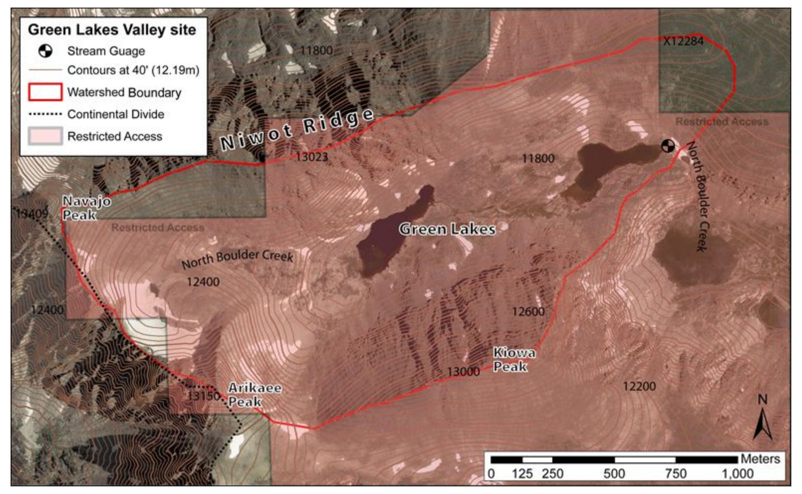

Figure 1: Map of Green Lakes Valley (GLV) Watershed (3)

Methods

- An online course on the basics of Python was used to gain the skill needed to process the given data, supplemented with coding tutorials provided by project mentor
- Temperature and moisture data was imported into Python
- Graphical images were generated from data collected during 2011, chosen for the quality and consistency of that data as compared with other years
- Soil moisture and temperature data from thawing period (defined as -5ºC to 0ºC) was visualized
- The soil moisture and temperature were plotted in relation to each other

Results

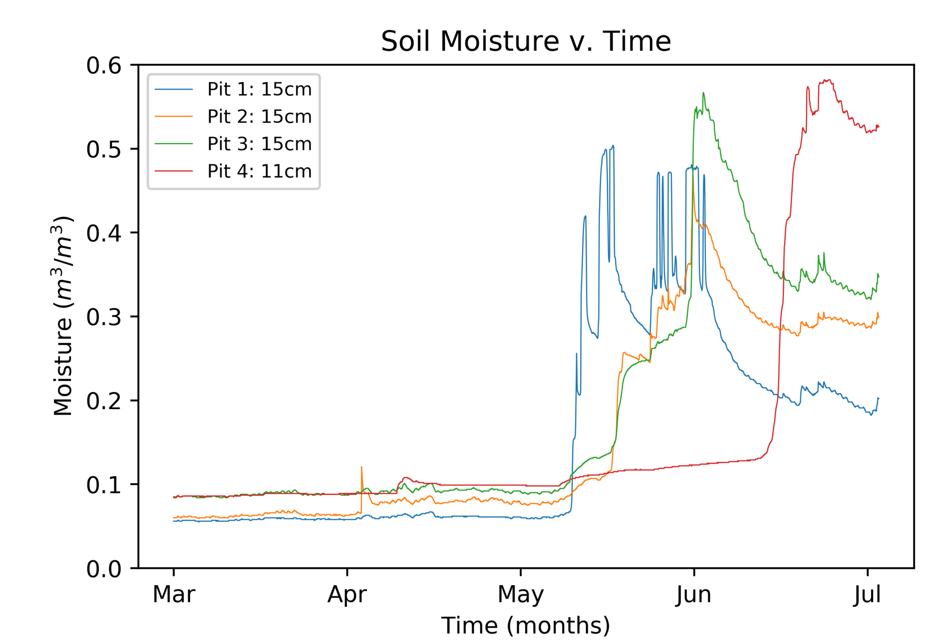

Figure 2: Soil moisture during spring thaw

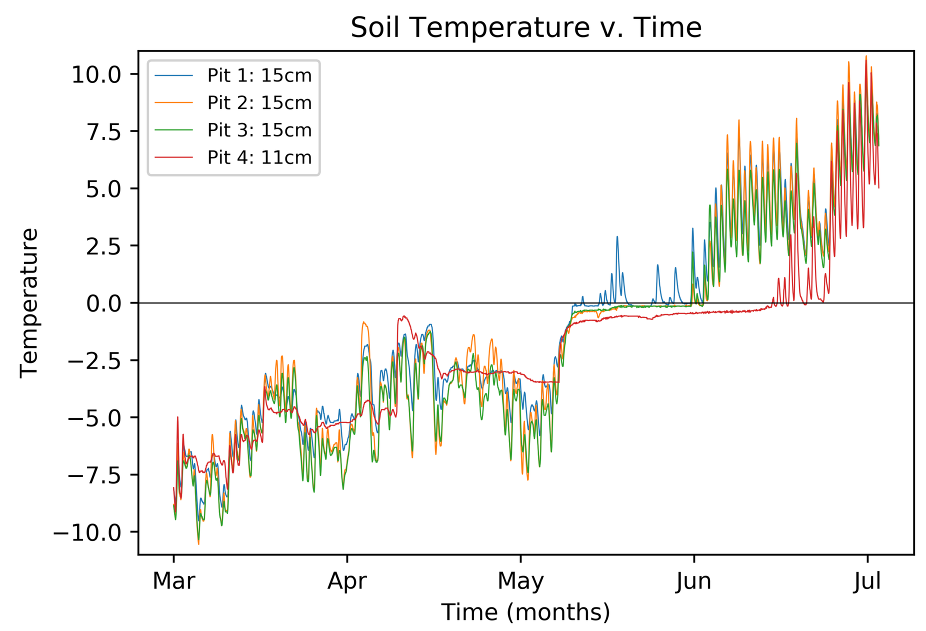

Figure 3: Soil temperature during spring thaw

- Each soil pit (SP) experiences a rapid and sudden increase in moisture during late spring thaw after remaining relatively constant during early spring months, followed by an irregular but gradual decrease during early to mid summer
- SP 1 thaws sooner and maintains relatively high moisture levels for a longer period than other soil pits
- SP 4 is the last to thaw, occurring approximately 5 weeks after the initiation of thawing in SP 1
- Peak moisture levels indicate high degrees of saturation e.g. 0.55-0.6 for SP3, SP4
- SP 2 3 & 4 exhibit similar rates of moisture gain and decline, although overall moisture content is varied

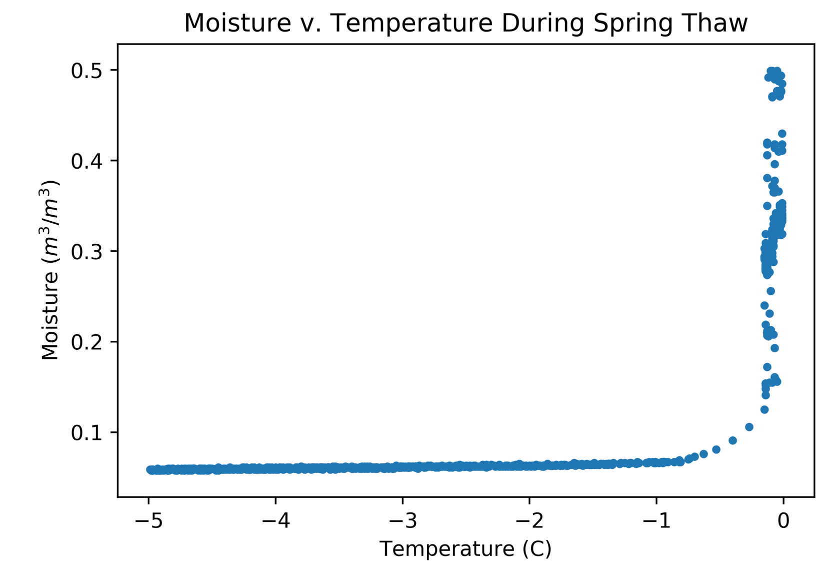

Figure 4: Relating soil moisture and temperature during spring thaw in SP 1

- The relationship between soil moisture and soil temperature appears to be non-linear as the soil thaws
- Moisture begins to rapidly accumulate between -1ºC and 0ºC

Discussion

- When liquid water content in soil increases, so does the potential for hydrological connectivity within the region.
- Peak moisture levels indicate the point at which the soil is highly saturated. When soil is saturated water infiltration becomes less likely, encouraging water to flow over soil and potentially contribute to surface water regeneration
- Time periods when soil moisture is significantly higher than pre-thaw levels may indicate times when water can infiltrate the soil and contribute to ecological processes

Further Research

- Cataloging the elevation of each soil pit could provide clues as to why there is so much variation in the timing of thaw initiation
- Soil composition may influence moisture saturation thresholds, and should be compared between soil sites

References

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