# Effects of changing rainfall patterns of soil moisture storage and plant canopy dynamics

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## Abstract

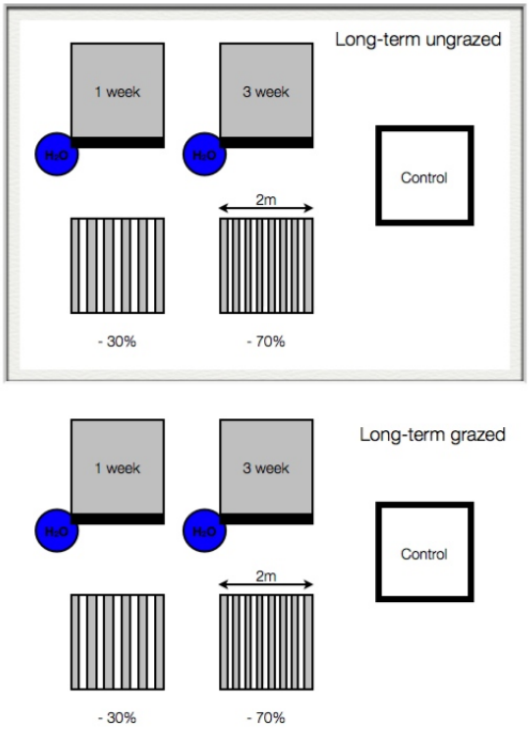
Climate change will greatly effect ecosystems where water, temperature, and available light are already at marginal levels for survival. The Wasatch Plateau in Utah, USA is a vibrant ecosystem flourishing at 3,000 m that depends summer monsoonal rains to maintain productivity. Current global climate models suggest that future rains will be less frequent and may be reduced in intensity. We carried out a series of precipitation experiments that showed how changing rainfall patterns either increase or decrease productivity. Future measurements will benefit for enhanced radio telemetry to distribute sensors.

## Keyword

Climate change, wireless network, NDVI, precipitation, soil moisture

## 1. Introduction

Global climate change will have unique impacts on ecosystems, especially with respect to plant available water. These effects will be most prominent in areas where growing season, water holding capacity, and growing degree days may be limited such as at 3000 m on the Wasatch Plateau. Here, temperatures constrain the growing season to just a few months a year, while a thin soil crust mixed with cobbles and stones limit rooting depths and soil quality. Scientists predict that in the future, global climate change will reduce the frequency of the summer monsoonal rain and lessen the size of each event. This could have serious consequences for the overall biomass created in this ecosystem, as well as the plant diversity and development across the season. Sheep also pose a challenge to plant growth and development as the US Government sells permits to allow sheep herders to graze sheep on these small plants halfway through the growing season.




## 2. Method

To study these effects, low cost rain shelters were constructed that would change the amount of rainfall in individual plots to 70% and 30% of total rainfall (-30 and -70, respectively), and the frequency of rain to one week and three weeks (1-week and 3-week, respectively). A fifth plot remained open for a

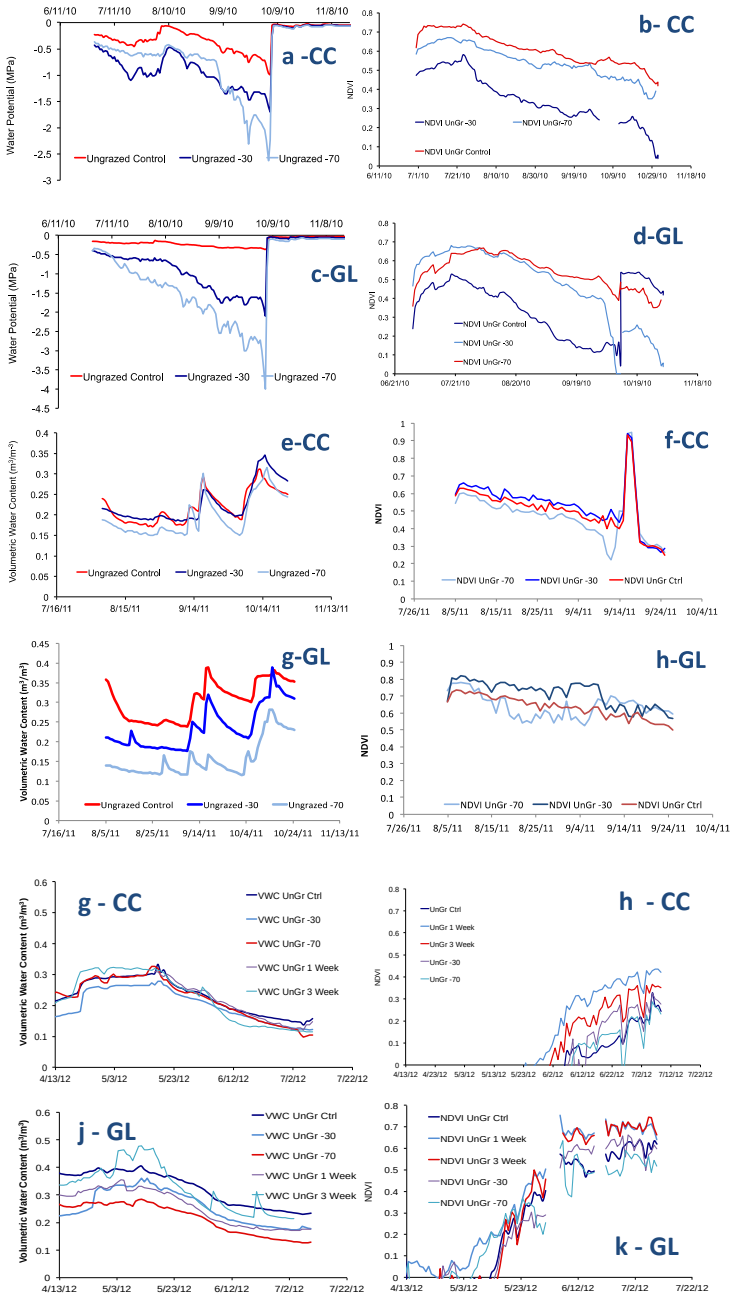
control. We applied the shelters at two paired sites (Carrying Capacity, CC, and Glacier, G) where we could compare the five treatments at a grazed and an ungrazed site located adjacent to each other (total of 10 treatments per site. Soil moisture sensors were installed at 5 cm in each plot to monitor shallow root zone water content and temperature over time. Prototype normalized difference vegetation index (NDVI) sensors measured the reflected red and near infrared (NIR) light using red and NIR light emitting diodes (LEDs) to continuously sense leaf area and plant phenology.

## 3. Results and discussion

Reduced rainfall had an understandable effect on soil moisture, reducing in somewhat in the -30 treatments and more in the -70. The effect on leaf area was somewhat more difficult to interpret. NDVI (and leaf area) were reduced in some of the drought treatments, while in others it was not as clear. Indeed, the middle year of the study was the wettest on record; so all plants had adequate water and did show much difference in NDVI. The last year was the driest, and there was a clear difference between the plots with no water, and those (1 week and 3 week) being watered at the seasonal average. Data indicate climate change-induced drought will have considerable impact on the health and longevity of the alpine plants, while less frequent, but more intense rain will provide water to maintain water at plant optimal for longer.

## 4. Conclusion

A system is currently being developed that will allow many of these types of small sensors to be integrated with a new generation of lower cost ($25), medium range (1 km line of sight) radios and connected across a landscape. Relying on a star network configuration to maintain low power use and network robustness, these radios will communicate through a gateway collection point powered by power-over-Ethernet (POE), and back to a specially designed base station that will allow continuous web access. The goal of the system is to finally bridge the gap between the over-promised and under-delivered field wireless node system and the ongoing needs of research scientist to gather data from a broad landscape.

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