Complex Response of Grassland Soil Moisture to Extreme Precipitation Patterns

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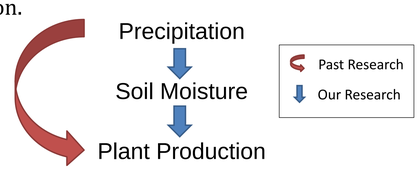
Introduction

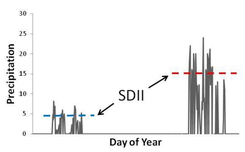
Recent research from Zhang (2013) explore how increases in extreme weather events such as higher annual temperatures, greater storm intensities, and longer periods between rainfall events are occurring in our environment. This research also found that as storm intensity increases plant production responds by decreasing. The objective of this work was to explore how soil moisture, as an intermediate between hydrologic inputs and biomass outputs, is affected by extreme weather events and how soil moisture can then be used to predict plant production.



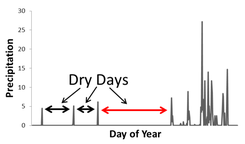
Extreme Precipitation Indices

Simple daily intensity index (SDII) is an average of the amount of precipitation that fell on each day it rained during the year.

$$SDII = \frac{annual\ precipitation}{\#\ of\ days\ with\ rain}$$



Maximum **consecutive dry days** (CDD) is the yearly measurement equal to the maximum amount of days between two storms.

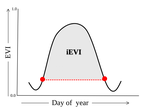


Data Collection

Sites were chosen from the USDA SCAN and Fluxnet networks to find the highest quality data set that was homogeneous, not influenced by irrigation and experienced little snow fall. Sites also had to have a record of a minimum of four years from which to pull data. Mesic and semiarid classification was based solely on average yearly rainfall.

Mesic > 500 mm yearly rainfall

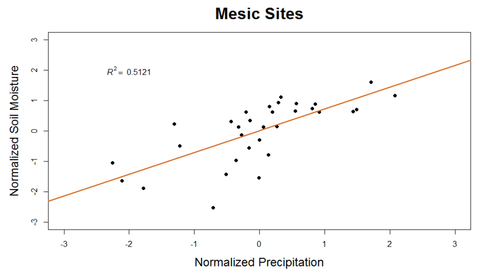
Semiarid < 500 mm yearly rainfall

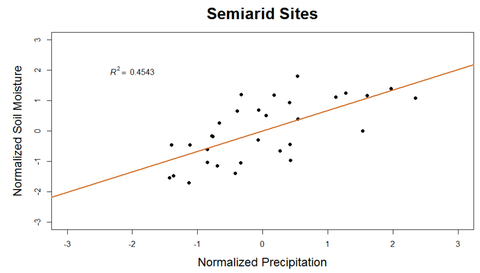


iEVI served as a proxy for plant production. It is calculated by first smoothing enhanced vegetation index data and then integrating the smoothed data over the year time period.

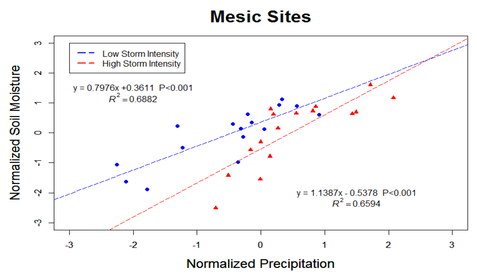
Data

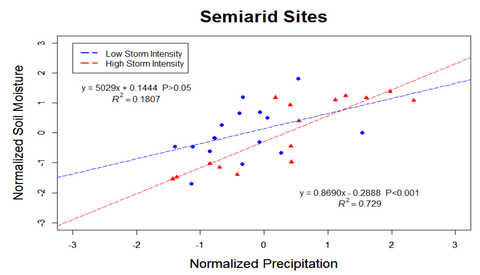
Annual Soil Moisture – Annual Precipitation Relationship



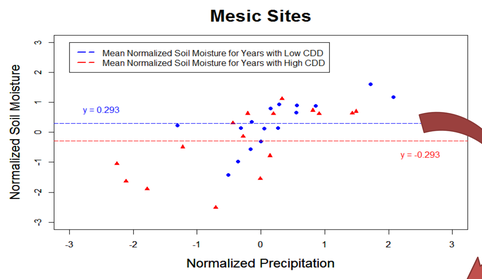


Impact of Storm Intensity on Annual Soil Moisture

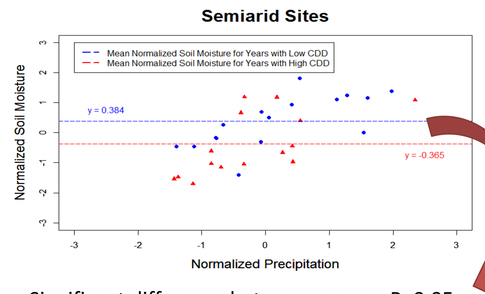




Average Annual Soil Moisture Characterized by CDD

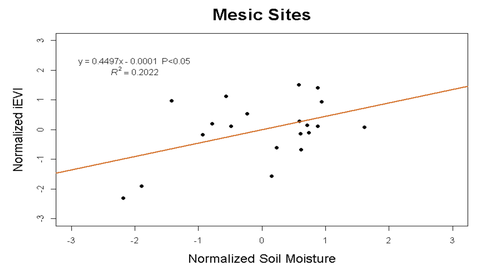


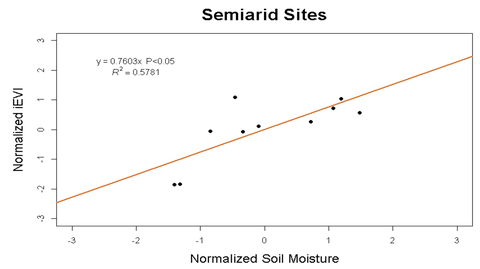
No significant difference between means, P>0.05



Significant difference between means, P<0.05

Annual Soil Moisture – iEVI Relationship





Results

Storm Intensity

Mesic

- Higher correlation between soil moisture and precipitation when data is split between high and low storm intensities than ungrouped data

Semiarid

- Correlation between soil moisture and precipitation does not improve when data is classified into high and low storm intensity

Consecutive Dry Days

Mesic

- No significant difference between the means of annual average soil moisture where years are classified with long or short lengths of consecutive dry days

Semiarid

- Significant difference of the annual mean soil moisture between years with long or short consecutive dry days

Soil Moisture and Plant Production

Semiarid sites have a higher correlation between annual average soil moisture and iEVI than mesic sites.

Conclusions

The ability to predict soil moisture from precipitation increases when extreme precipitation events are considered.

Storm Intensity

Storm intensity impacts mesic site soil moisture possibly due to inability of soils that experience high levels of precipitation to incorporate rainfall from heavy storms. In contrast, soils at semiarid sites appear to be able to incorporate rainwater regardless of how quickly the precipitation falls.

Consecutive Dry Days

The **length of consecutive dry days effect on semiarid soil moisture** may be explained because semiarid sites experience an average CDD value of 98 days. Mesic sites only experience an average CDD value of 28 days. Therefore, CDD in mesic sites may be simply too short to truly impact the annual soil moisture.

Acknowledgements & References

Special thanks to the Arizona NASA Space Grant and the USDA – Agricultural Research Service for funding this research.

Reference

- Zhang, Y., et al. (2013), Extreme precipitation patterns and reductions of terrestrial ecosystem production across biomes, J. Geophys. Res. Biogeosci., 118, doi: 10.1029/2012JG002136.