Greening of North American Deserts: Predicting Grass Responses using AI Technologies

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Introduction
Climate change is resulting in regional increases in the frequency of extreme climate events, including multi-year wet or dry periods. Recent observations from the Chihuahuan Desert show a remarkable perennial grass response in desensitized shrublands that has been sustained (2010-present) following a wet period (2004-2008) that differs from the prior 15-year record with little or no grasses (1988-2003). This greening of the desert suggests a shift to an alternate state where production responses cannot be predicted from historic relationships between rainfall and primary production.

Objectives
Our objective was to develop an artificial intelligence (AI) system that could: 1. Identify discrete changes in patterns in rainfall, such as multi-year wet, dry or recovery periods based on rainfall amount by year; 2. Develop relationships between production, rainfall, and other explanatory variables for each period; 3. Apply this learned behavior to other locations or sites.

Jornada Data Catalog
Production (response)
- year month ecosystem (lat lon enclosure species)
- year month day at lon spec SVC Temp

Soil water content (SWC)
- year month at lon depth SVC

Soil texture
- lat lon sand soil silt clay

Elevation
- lat lon elevation

Contextual information (e.g. photo library)
- Northern Colarado (60 yrs): Relationship between production and precipitation in an 8-sta site study (Lauenroth and Sala, 1989)
- Southern New Mexico (15 yrs): Relationship between production and precipitation differ in wet and dry years (Peters et al., 2012)

Bibliography of data from papers
- Quantitative data from previous literature

Jornada Example
1. The user selects annual perennial grass production in three Mesquite locations (HORT, RABB, and WELL).
2. The user selects water-year precipitation at the three locations.
4a. There is a difference in linear relationship between normalized grass production and precipitation for the two periods. However, 2004-2008 precipitation appears more similar to the dry period than the wet period.
4b. There is not a difference in linear relationship between normalized grass production and precipitation between the 2000-2003 dry period and the 2004-2008 wet period.
5. There is no difference in mean annual precipitation between 2000-2003 and 2004-2008 precipitation at the three locations.
6. Adding soil texture data in the models can help explain the variance in grass production since the soil depth profiles for the three Mesquite locations differ.
7. There are data at four other locations where the AI System can be applied:

Summary
The AI system is currently being developed to help disentangle grass production in several locations at the Jornada site. Ultimately, it will help users explain patterns in their ecological system of choice.

Next Steps
The AI System is currently under development. Although it is initially being configured for relating primary production to precipitation at the Jornada site, it is being designed as a general framework to allow users to:
- Upload their own data and provide their location coordinates
- Pursue their own ecological research questions

Referenees