Complex landscapes in the American Southwest: are desertified systems “novel”?  
Debra PC Peters1, Steve R Archer2, Osvaldo E Sala3, Enrique Vivoni3, Kris M Havstad1, Curtis Monger4, Jin Yao1, & Nathan Burruss5  
Jornada Basin LTER Program1, 1 USDA ARS, Las Cruces, NM; 2 U of Arizona, Tucson, AZ; 3 Arizona State U, Tempe, AZ; 4 USDA-NRCS, Lincoln, NE; 5 New Mexico State U, Las Cruces, NM

Introduction

Novel ecosystems are often defined as no-analog communities consisting of new combinations of species that assembled under new abiotic conditions. In the Anthropocene, novel systems differ from the historical state as a result of human influences where self-organization processes prevail to make these ecosystems unlikely to revert to their historical structure/function. Degraded shrub-dominated ecosystems that developed following livestock overgrazing and drought in arid and semi-arid grasslands are a potential example of novel ecosystems. Although self-organization and stability of desertified ecosystems have been well-studied, these ecosystems have not been tested as novel ecosystems.

Our objective was to test novel ecosystem concepts and hypotheses across complex landscapes at a 78,000 ha research site established in 1912 to examine the causes and consequences of desertification.

Study site: USDA ARS Jornada Experimental Range and Jornada Basin Long Term Ecological Research (LTER) site (32.5°N, 106.5°W), Las Cruces, NM, USA, is located near the northern end of the Chihuahuan Desert. Elevation ranges from 1,300 – 1,500 m. Annual precipitation averages 24 cm. Mean monthly minimum air temperature ranges from -6 °C in Dec to 17 °C in July; and Mean monthly maximum air temperature ranges from 13 °C in Dec to 35 °C in July.

Novel ecosystems

We recognize that other definitions of novel systems are possible.

Methods

We first determined if the five major ecosystem types are similar in terms of subdominant plant species composition and soil texture.

We examined three historical (1858, 1915, 1928) and one current vegetation map, focusing on the subdominant species.

Definition of a “novel” ecosystem:

• Novel: If subdominant plant species composition and soil texture at the same location are different between historical and current states, then the current ecosystem is novel.
• Not novel: If subdominant species composition and soil texture at the same location changed little over time, then the current ecosystem is not novel.

We recognize that other definitions of novel systems are possible.

Results

1. The top five subdominant species based on % biomass were different at all five ecosystem types.

<table>
<thead>
<tr>
<th>Ecosystem Type</th>
<th>Species Group</th>
<th>%</th>
<th>Species Group</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Playa grassland</td>
<td>PLMU P grass</td>
<td>10</td>
<td>EPTR Shrub</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>AMPA A forb</td>
<td>7</td>
<td>AMPA A forb</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>LEVS A grass</td>
<td>6</td>
<td>SPOR P grass</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>HYDO A forb</td>
<td>6</td>
<td>PRGL Shrub</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>SPAI P grass</td>
<td>5</td>
<td>XASP Sub-shrub</td>
<td>3</td>
</tr>
</tbody>
</table>

2. Playa grasslands have a different soil texture compared with the other ecosystem types. Tarbush shrublands have significantly low % sand than upland grasslands, creosotebush shrublands, or mesquite shrublands.

Novel system or not: by examining changes in dominant and subdominant plant species composition, and soil texture over time, we hypothesize the following systems:

A. On alluvial flats and playas where grassland remnants persisted over time, subdominant species composition and soil texture changed little. These are probably novel systems.
B. On piedmont slopes where mesquite shrublands persisted over time, subdominant species composition and soil texture changed little. These are probably not novel systems.
C. On the basin floor where mesquite shrublands replaced upland grasslands, subdominant species composition changed, but soil texture did not change. These are probably novel systems based on other processes (e.g., soil erosion).
D. On the bajada where tarbush shrublands replaced grasslands in 1915, but were replaced by creosotebush shrublands starting in 1928, the current ecosystems are likely novel based on changes in species composition and soil texture.

Conclusions

Arid landscapes are complex mosaics of historical grassland remnants, persistent shrublands, and degraded and novel shrublands. The dynamic soil-geomorphic template interacting with species characteristics is another layer of complexity that needs to be accounted for when predicting future dynamics of arid landscapes that contain novel ecosystems.