Climate-soil interactions
Global change, local properties, and ecological sites

Mike Duniway
Brandon Bestelmeyer
Deb Peters
USDA-ARS Jornada Experimental Range
mduniway@nmsu.edu
Landscape as a filter

- 2 things that are going to happen with GCC
  - Temp & rain changes
  - Increased variability/change in event sizes
- Where you are on the landscape matters
  - Vegetation response broad-scale drivers mediated by local properties

http://home.earthlink.net/~mplagens/
Landscape as a filter
Static properties (Ecological Site)

Landscape Position

Mineralogy/Parent Material

Surface texture

Aspect

Soil Profile
Landscape as a filter

Dynamic properties (Ecological State)

- Plant community composition
- Bare ground & canopy cover
- Soil organic matter
- Production
- Soil structure
- Soil biota, Biological soil crusts
Landscape as a filter

- This talk is focused on **static/ecological site properties**
  - Plant community composition/ecological state is also very important

- Example from a water limited system
Water limited systems

- Changes in ecosystem function and community composition most proximally related to changes in water
- Example using Jornada LTER data to illustrate the importance of static factors for mediating response of plant community (NPP) to new climate regimes:
  - Long-term trends & relationship w/ site properties
  - Take advantage of a recent extreme event & relationship w/ site properties
Water limited systems & static properties that mediate NPP

Landscape Position

Surface Soil Texture

Soil Profile Water Holding Capacity
Long-term trends
NPP (1990-2008) at 5 sites along a bajada

Variety of landscape positions (some run-on & some run-off)
Long-term trends NPP (1990-2008) at 5 sites along a bajada

Variety of surface texture & soil profile properties
Long-term trends
NPP (1990-2008) at 5 sites along a bajada

Just Rain
$R^2 = 0.25$
Long-term trends

NPP (1990-2008) at 5 sites along a bajada

Rain + Topographic Wetness Index

$R^2 = 0.31$
Long-term trends
NPP (1990-2008) at 5 sites along a bajada
Rain + Saturated hydraulic connectivity (top 10cm)

$R^2 = 0.39$
Long-term trends
NPP (1990-2008) at 5 sites along a bajada
Rain + Available water holding capacity (top 1 m)

$R^2 = 0.42$
What about extreme events?

• Static properties mediate general NPP - PPT trends
• What about “extreme events” expected to become more common with GCC?
• Since 2005, we have had a sequence of really wet & just slightly wet years

![Graph showing relationship between predicted NPP and PPT](image)

Rain + AWHC (top 1 m)
$R^2 = 0.42$
What about extreme events?

- Expand our view
- Include 4 additional sandy sites

Positive feedback?
What about extreme events?

“Normal” years (1990 - 2005)

Just Rain

$R^2 = 0.16$

Rain + Soil

$R^2 = 0.24$
What about extreme events?

Really wet years (2006-2008)

Just Rain
\[ R^2 = 0.02 \]

Rain + Soil properties
\[ R^2 = 0.65 \]
How do we use this information?

• Variability of response to climate driven by landscape heterogeneity for both
  - general trends &
  - extreme events

• If going to compare and contrast point based data (GCC and/or long-term studies) in regional analysis, we need the soil & landscape context
How do we use this information?

- Dig a hole! Look around!
- Detailed soil & terrain data would be great
- What about using ecological sites?
  - All properties also used to differentiate ecological sites
  - Ecological sites already used as management units
  - Useful unit for synthesizing responses
  - Could be refined to account for GCC
Summary

• Need to account for local-scale properties
• Ecological sites already do this to some extent
  – Useful for communicating landscape context to others
• Dynamic properties/ecological state at beginning of extreme events effects outcome
Questions?