

# *Climate Change Impacts on the Navajo Nation, and other Native Lands*

Margaret Hiza Redsteer  
U.S. Geological Survey  
Navajo Land Use Planning



# Recognizing the Disharmony of Climate Change in an Unbalanced World





*“We need you to help us understand what the white men are up to. My Grandchildren, be good. Try and make a mark for yourselves. Learn all you can.”*

*-Tatanka Iyotanka (Sitting Bull)*

# Using Workshops and a Tribal Archive to Document Climate Change on the Koyukuk River at Huslia: A Koyukuk Athabascan Community

- Winter ice much thinner
- Snowfall extremes common
- Consistently warmer temperatures all year
- Severe wildfire intensity
- Animals and fish, and their behavior, changing
- Declining permafrost
- Prolonged drought
- Riverbank erosion has increased
- Lakes drying out
- Grasses growing more, plant distribution changes constantly
- Flooding events have changed
- Weather no longer predictable
- Prophecies of change supported





# Changes in Average Annual Temperature for Navajo Nation

<b>Location</b>	<b>Historic (60's)</b>	<b>Current (00-06)</b>
Chinle, AZ	51.6 ° F	55.5 ° F
Farmington, NM	51.6 ° F	53.9 ° F
Lees Ferry, AZ	62.2 ° F	64.0 ° F
Tuba City, AZ	55.0 ° F	58.1 ° F
Shiprock, NM	53.3 ° F	56.3 ° F
Wupatki, AZ	57.3 ° F	58.8 ° F

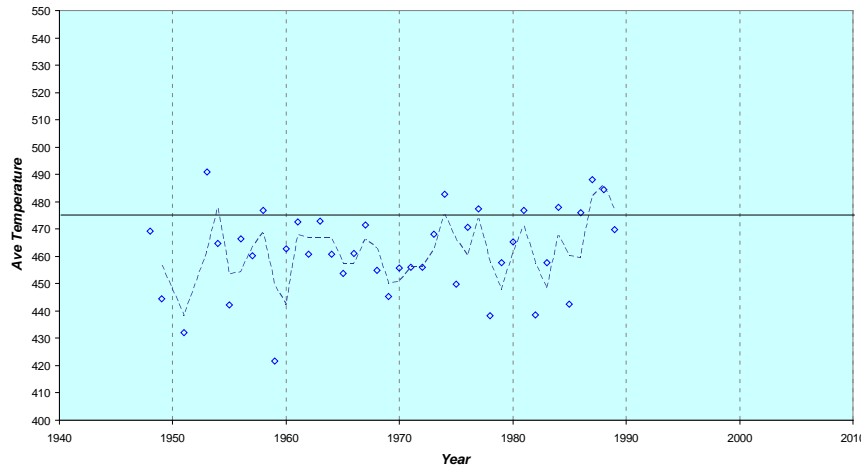
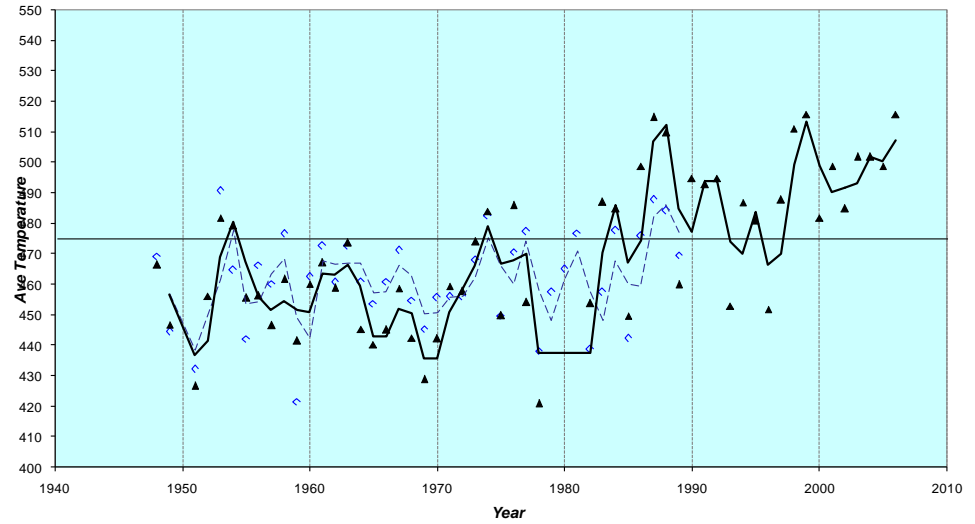


# Climate Change Challenges

- GCM models *AVERAGE* in space and time
- Indian country: hottest, driest, windiest, coldest
- Land use and climate change linked



# Temperature Trends in Crow Region

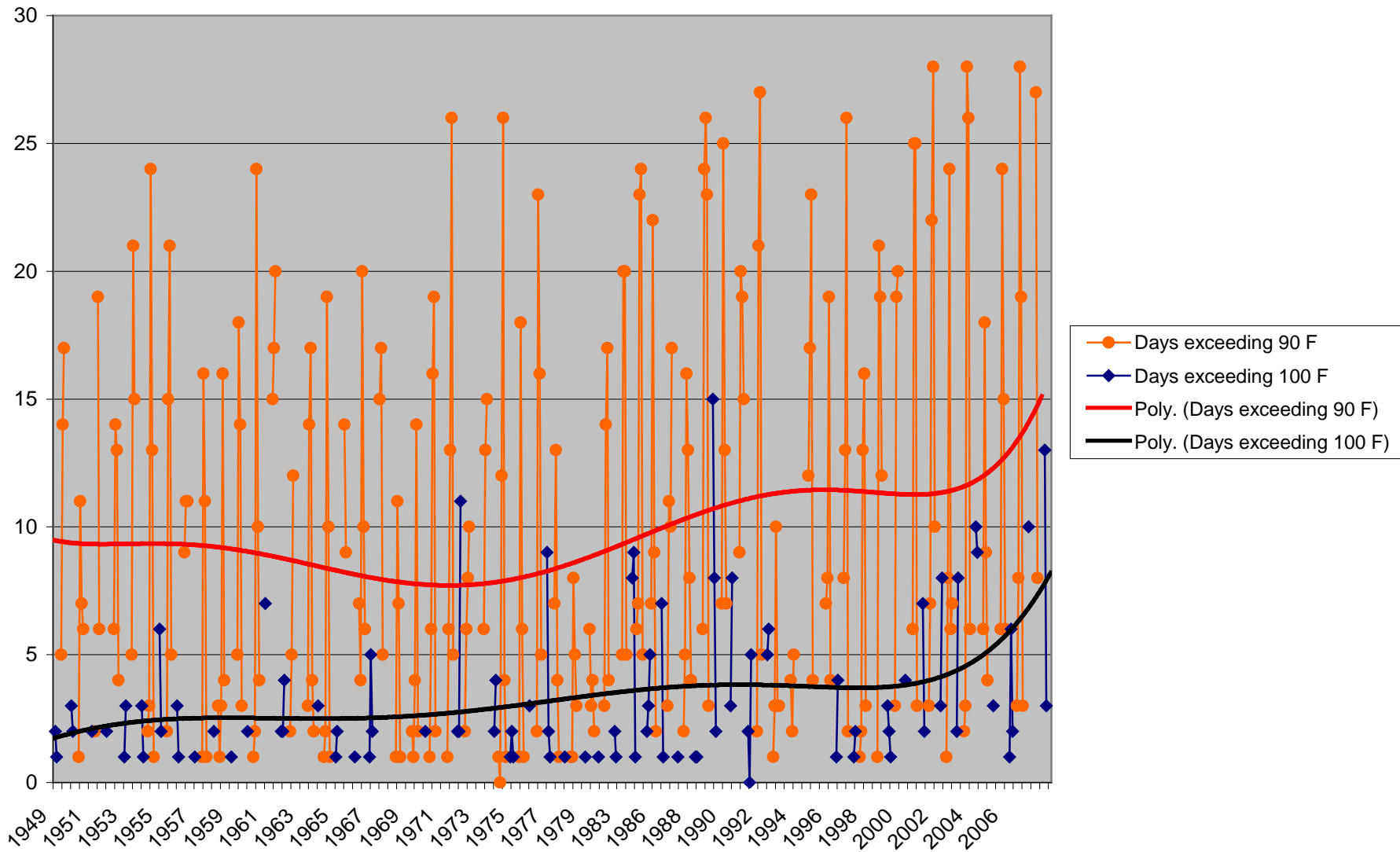


## Crow Agency Data

## Hardin Data

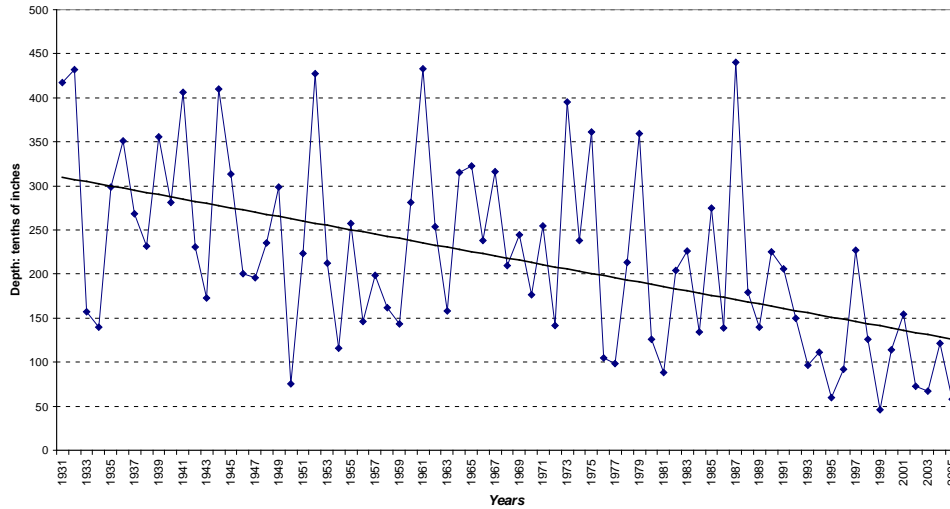


# Days of high temperatures in Hardin MT



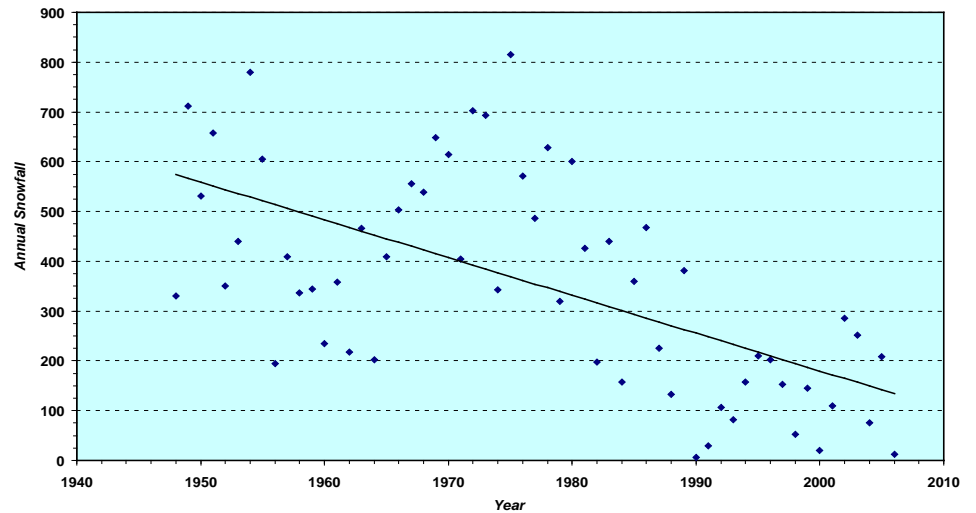


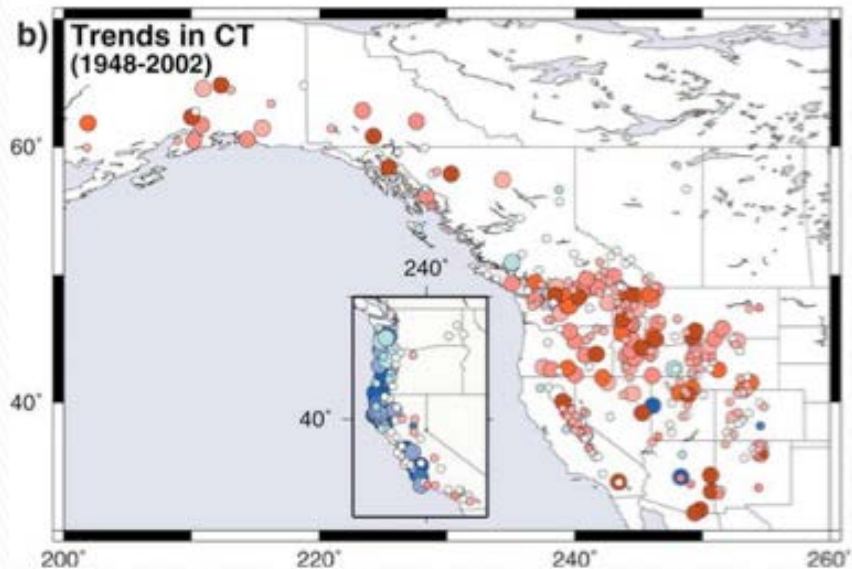
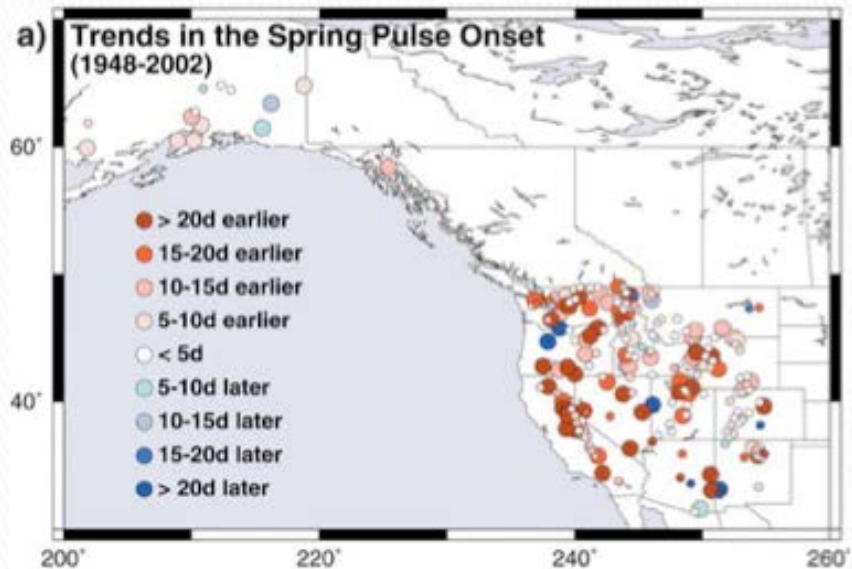
# Current Snowfall Trends



**Hardin MT**

**Navajo Nation**



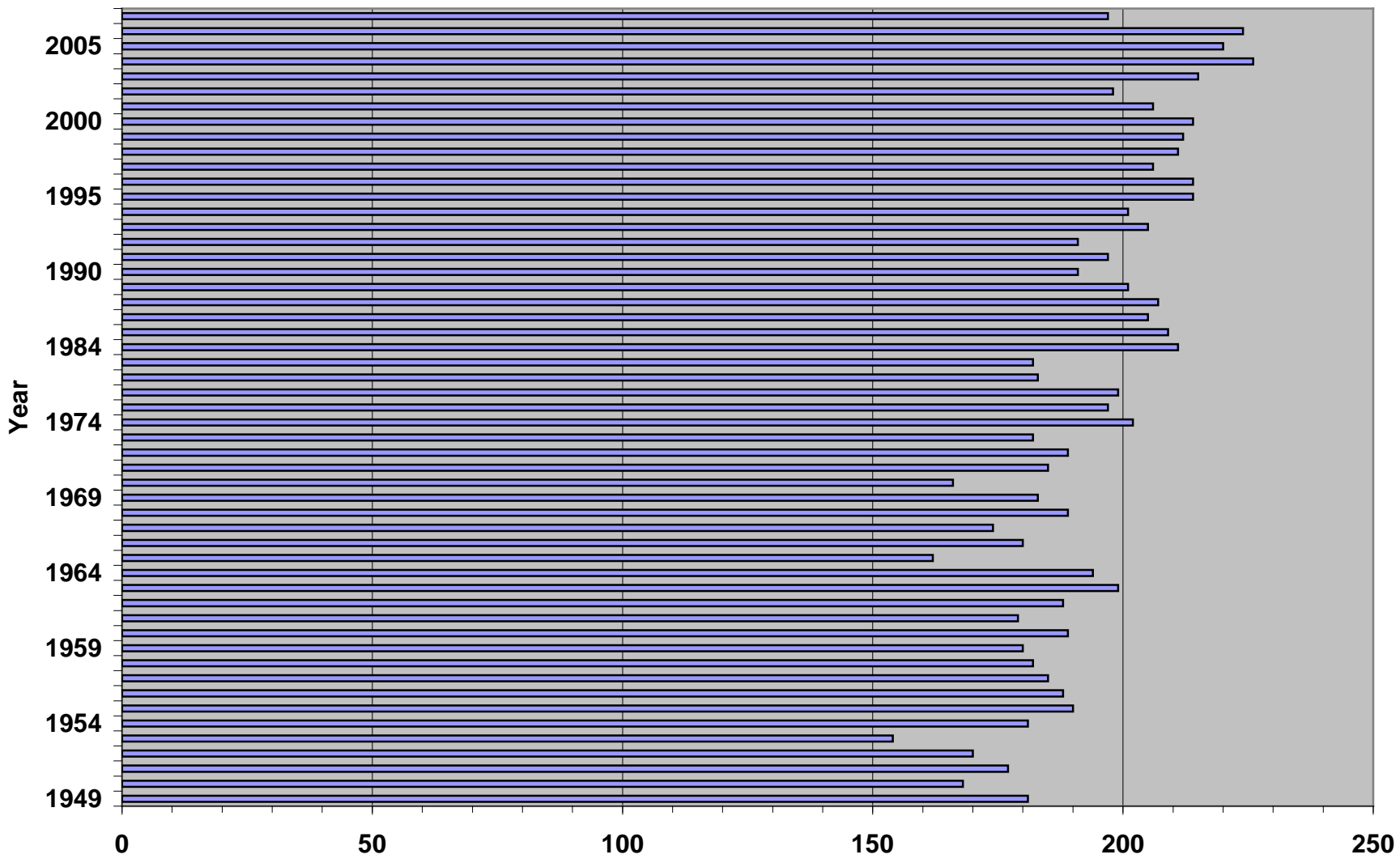


# Changes in Spring Run-Off

- Timing of moisture arrival important for plant and animal survival
- Seasonal changes in temperature produce out-of-synch ecosystem  
DISHARMONIOUS



# Number of frost free days



Hardin Frost Free Days

# Bugs love Climate Change

- Fewer hard frosts mean better survival through winter
- Longer warm season means higher reproductive rates
- Warmer temperatures
  - Some species of mosquito can extend range further north
  - Bark beetles can attack new species of trees



"The debate [about climate change] is over ..."

*Arnold Schwarzenegger, among others, 2007*

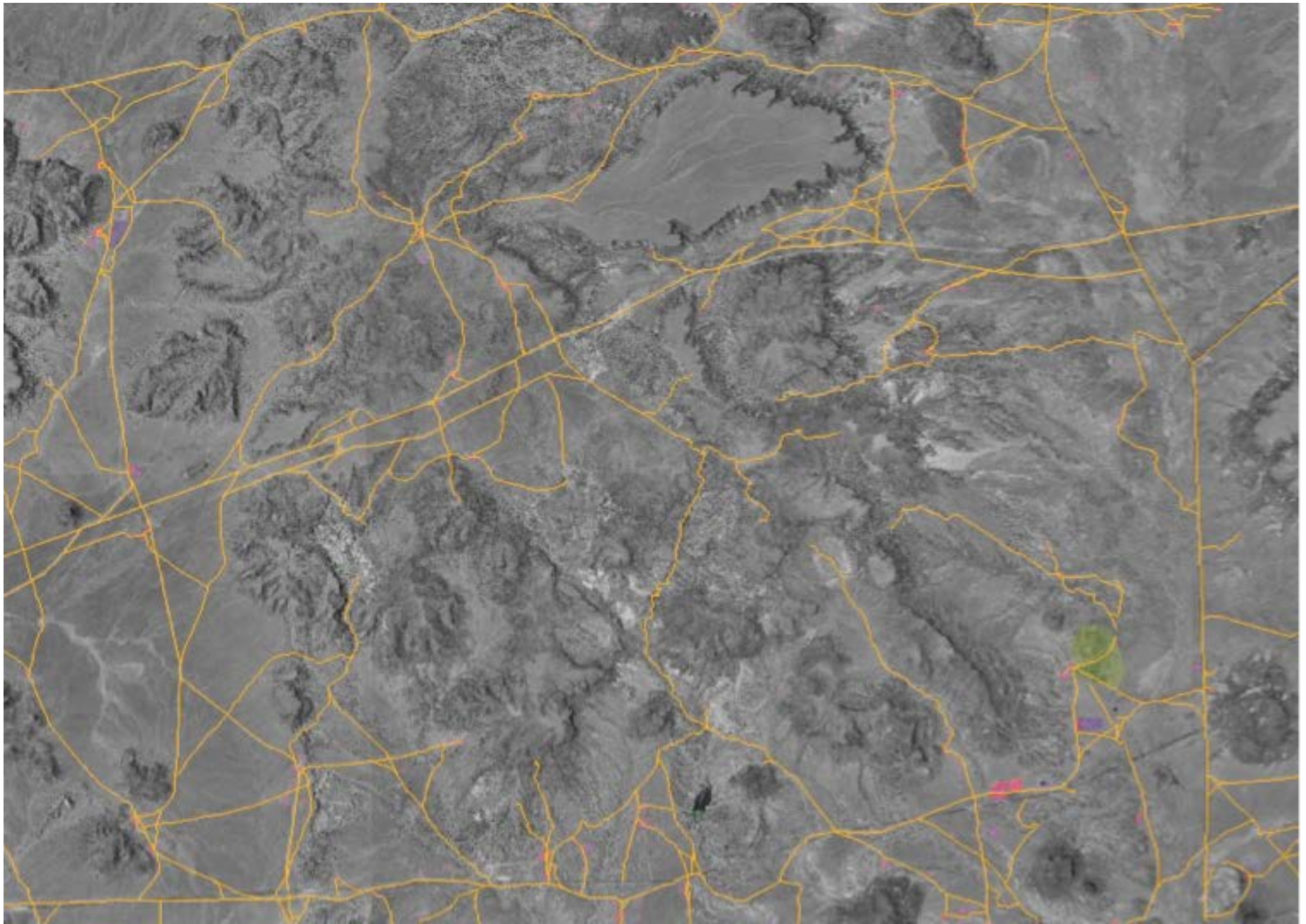
The real debate is just beginning:

What can we do about climate change?

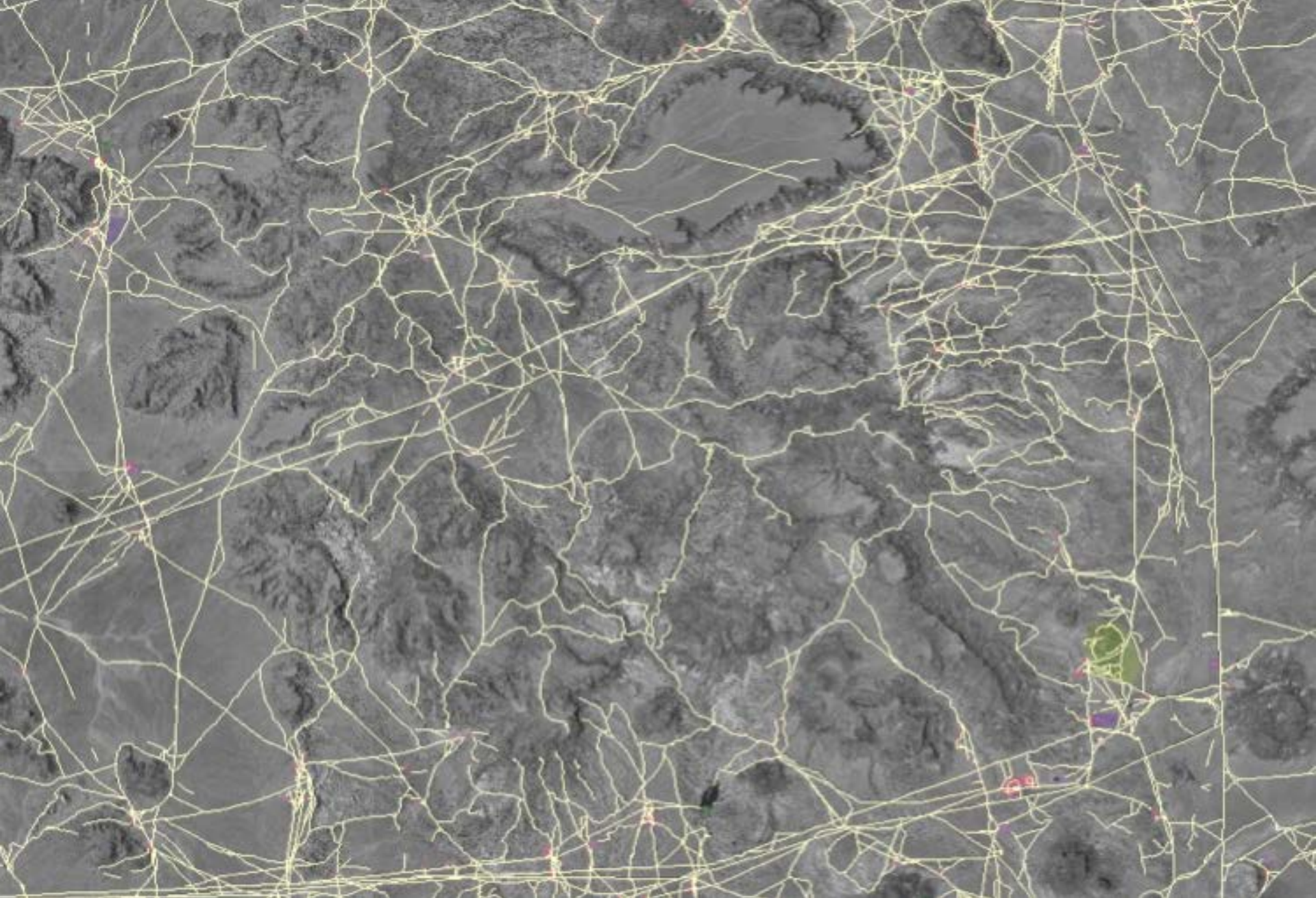
The nature of the problem requires basic societal decisions in the face of **ongoing uncertainties for the foreseeable future.**

Understanding the impacts, observing and measuring the changes and communication of scientific information will be critical.





-Roads recorded on late 1960s topographic map

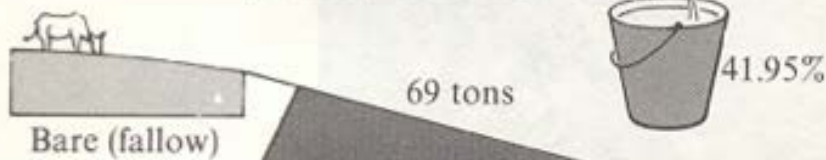
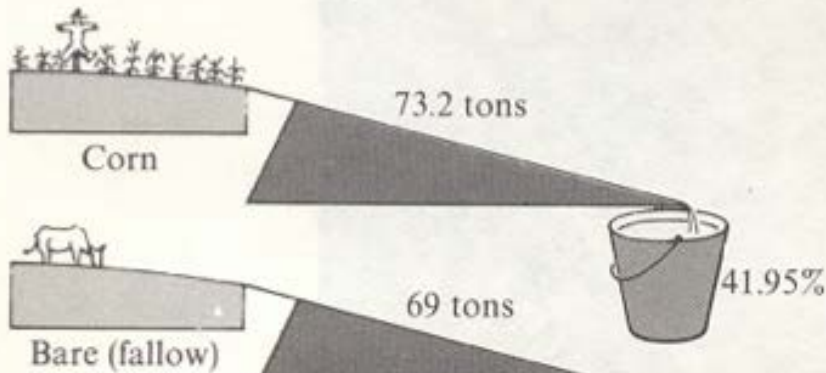
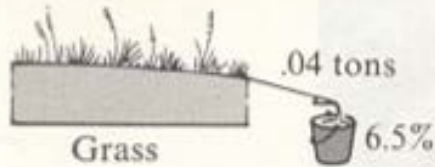
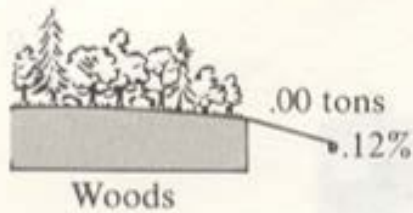


-All visible roads from 1990s DOQQs

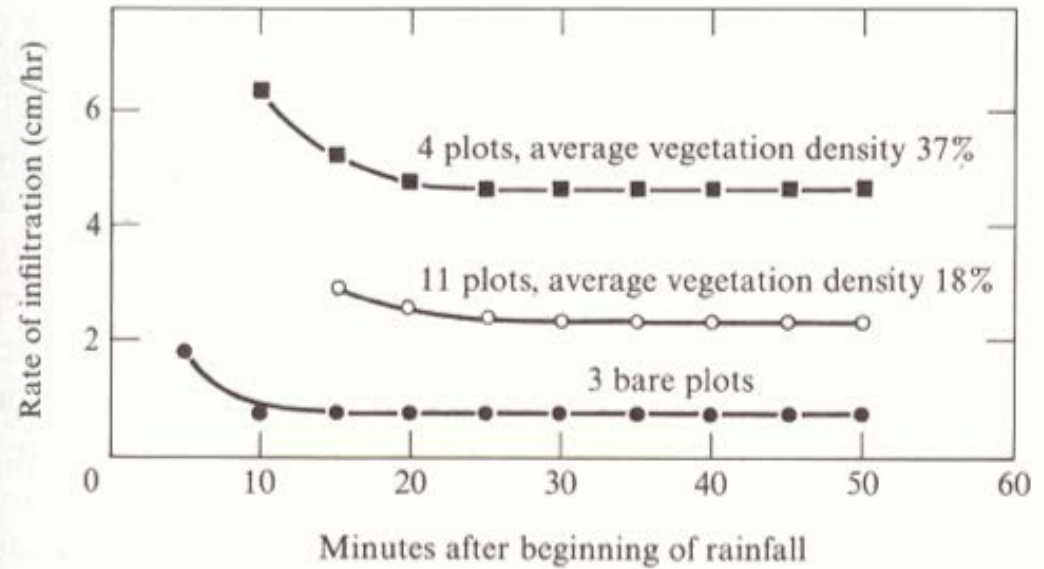




# Surface Water Run-off and Erosion



Tons/Acre Erosion



# *Kayenta AZ, September 2003*



# *Kayenta, AZ*

## *2004*



# *Sand Dunes*

*Sensitive indicators of climate change*

- *Overall moisture balance*
- *Degree of vegetation cover*
- *Wind circulation patterns*

# *Climatic Factors Describing Sand Dune Mobility*

$$*Sand dune mobility (M) = W/(P/PE)*$$

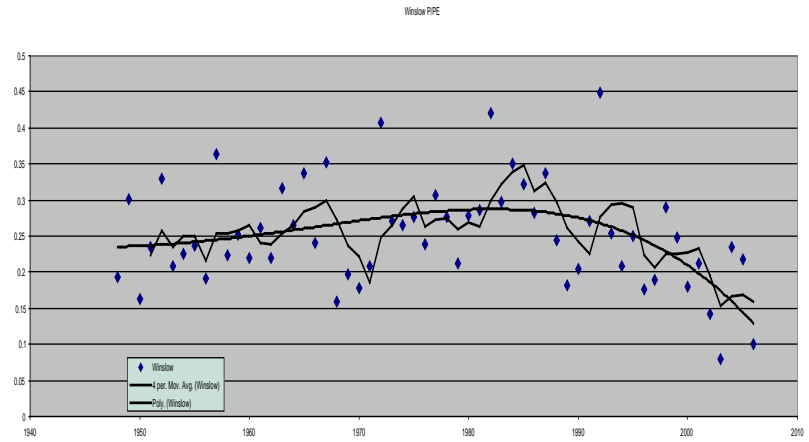
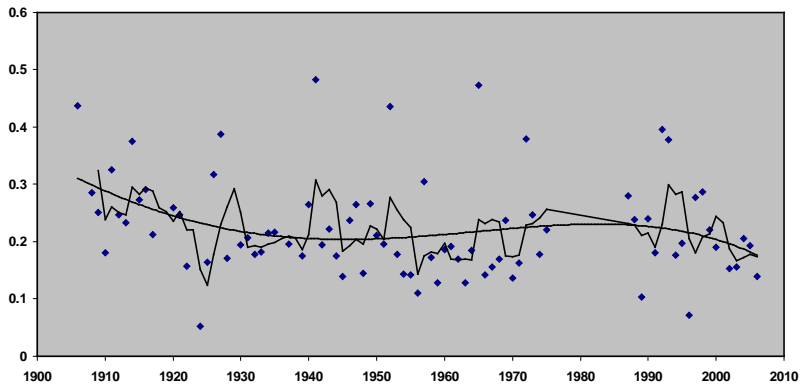
**Sand transport potential (W)** = Percent of time wind velocities high enough to transport sand grains

**Effective precipitation (P/PE)** = Ratio of total precipitation (P) over potential evapotranspiration (PE)

# *May 20 Windstorm, Red Mesa, NN*

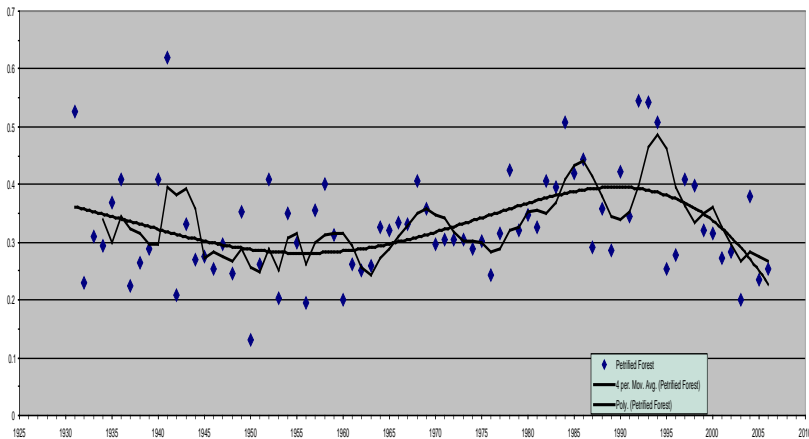


# Effective precipitation for Tuba City, Winslow, Wupatki, AZ, & Aneth UT

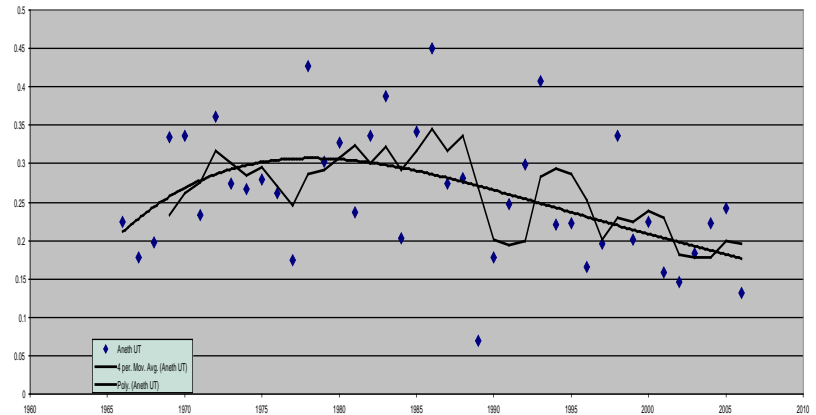


P/PE

Pentfed Forest



Aneth UT P/PE



Year



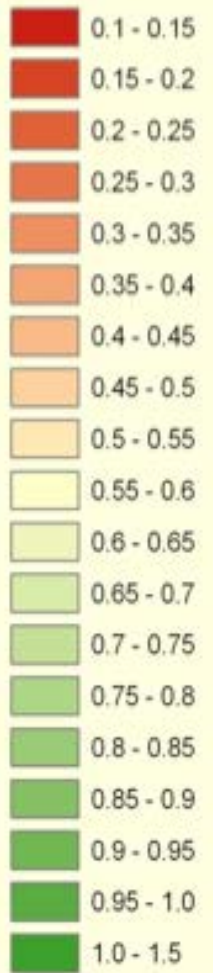
# Inactive / Stable Sand Dunes



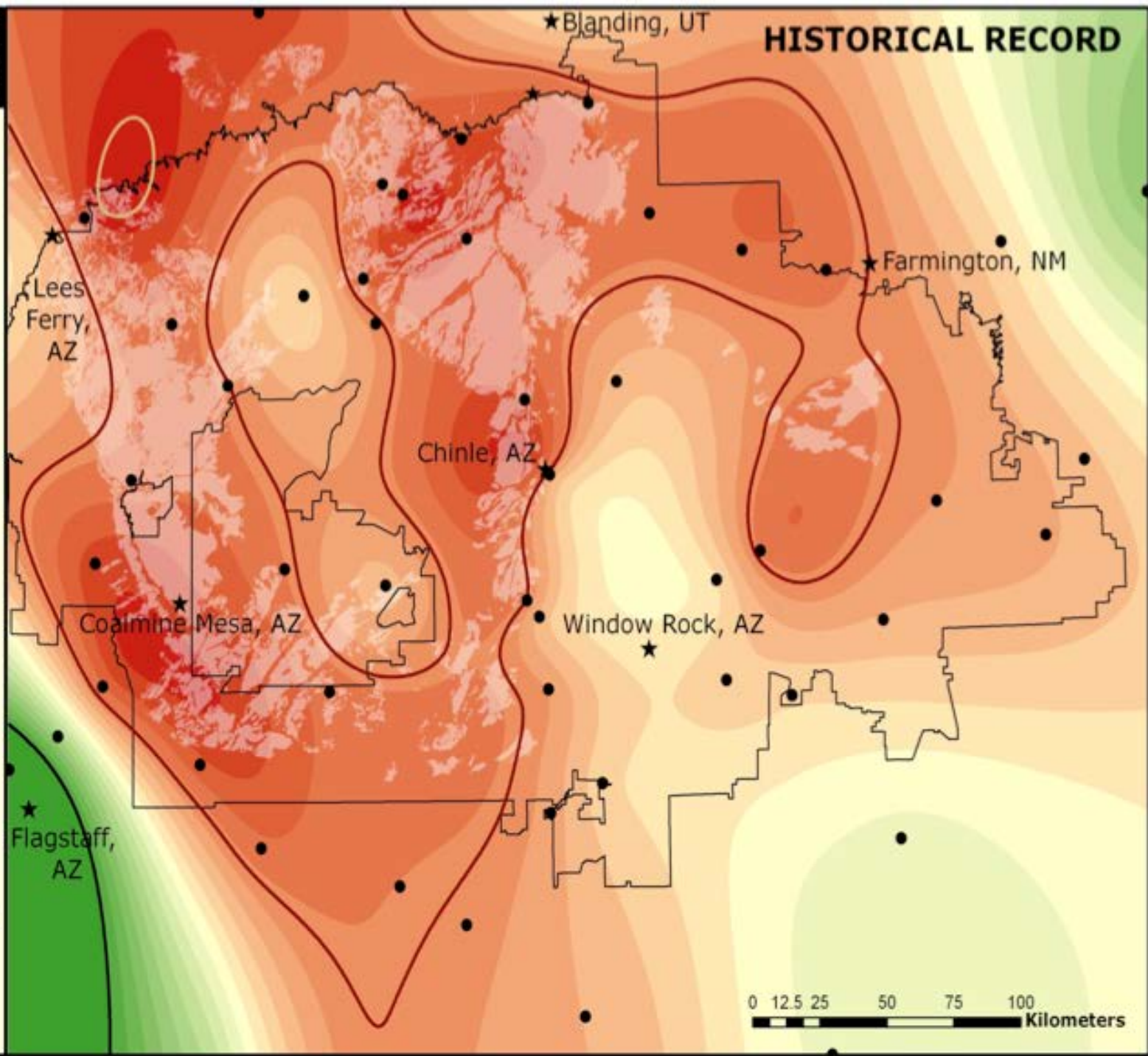
# *Fully Active Dunes – Tuba City*



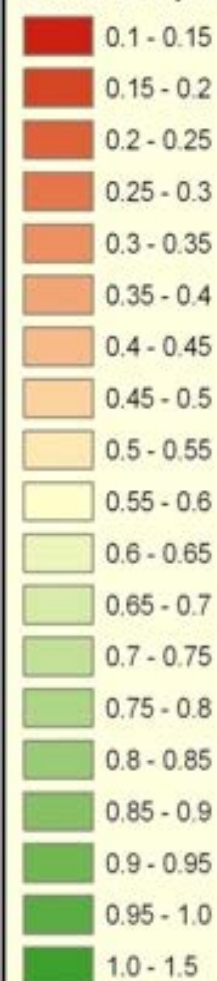
**Ratio of P/PE**



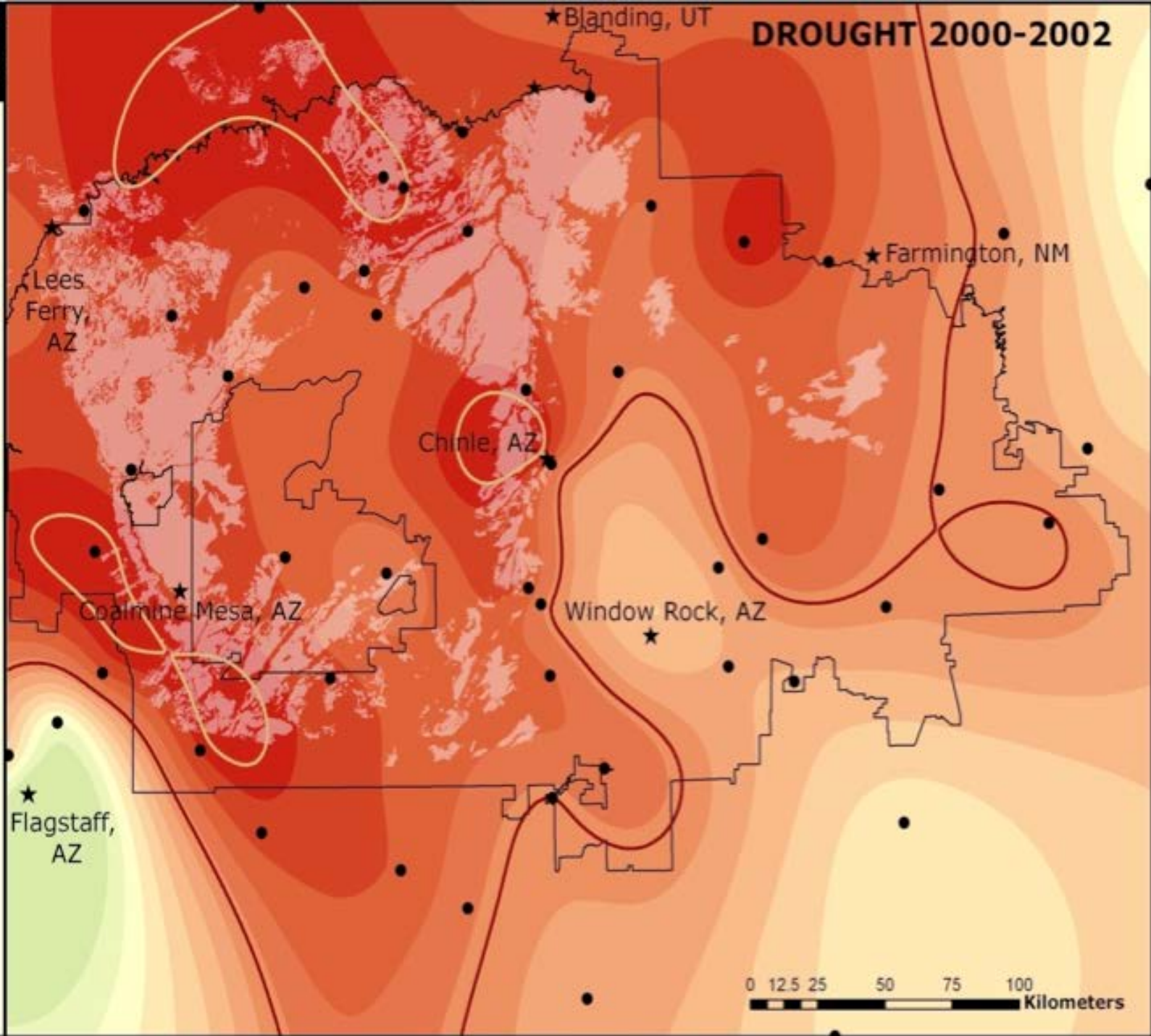
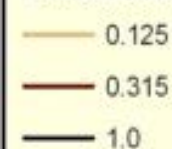
**Threshold Contour**



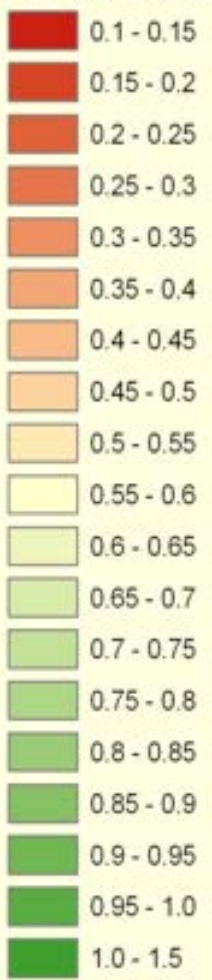
**Ratio of P/PE**



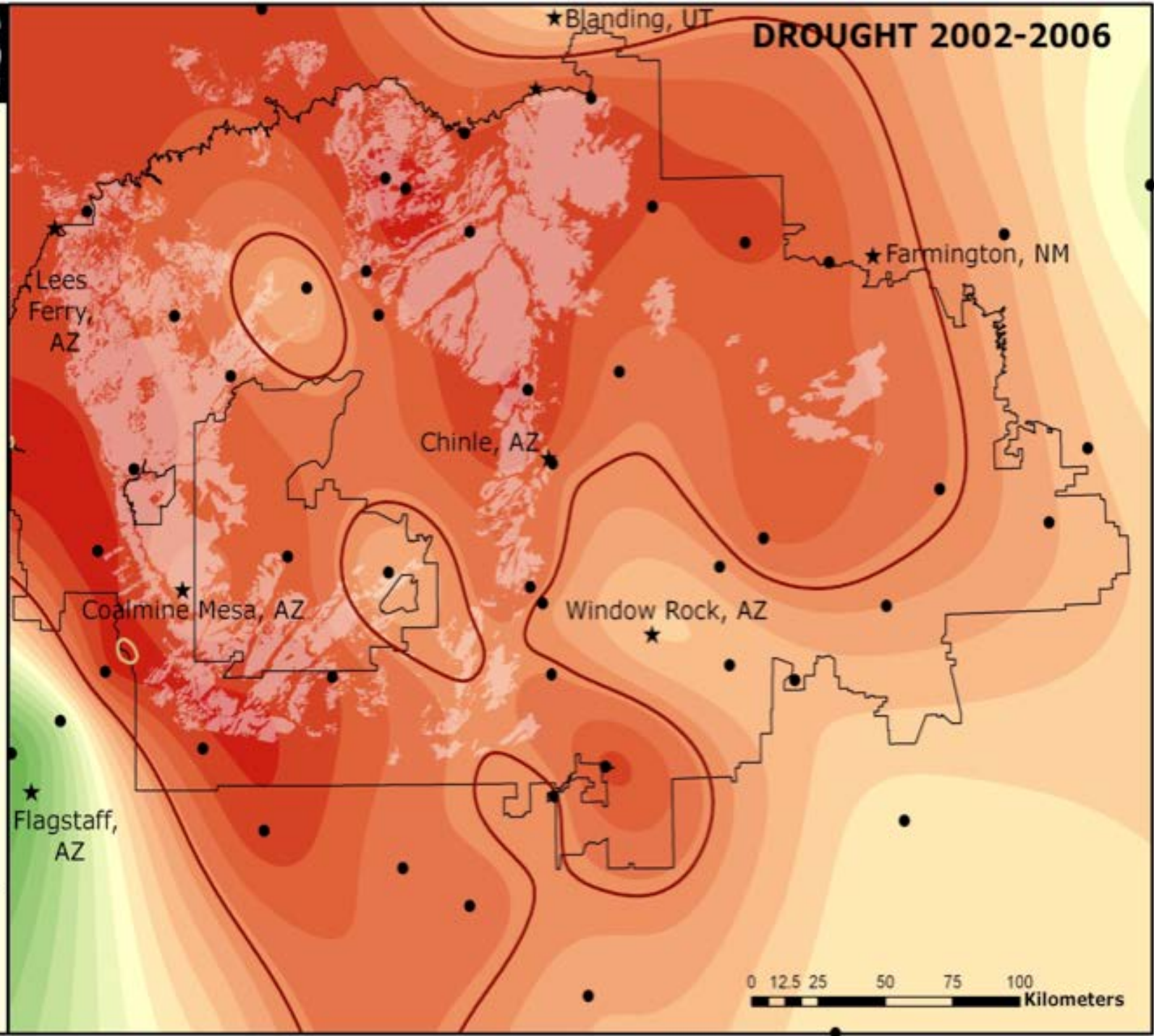
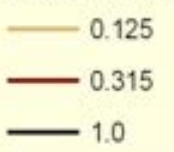
**Threshold Contour**



**Ratio of P/PE**



**Threshold Contour**





# *Processes Responsible for Changes in the Ecosystem*



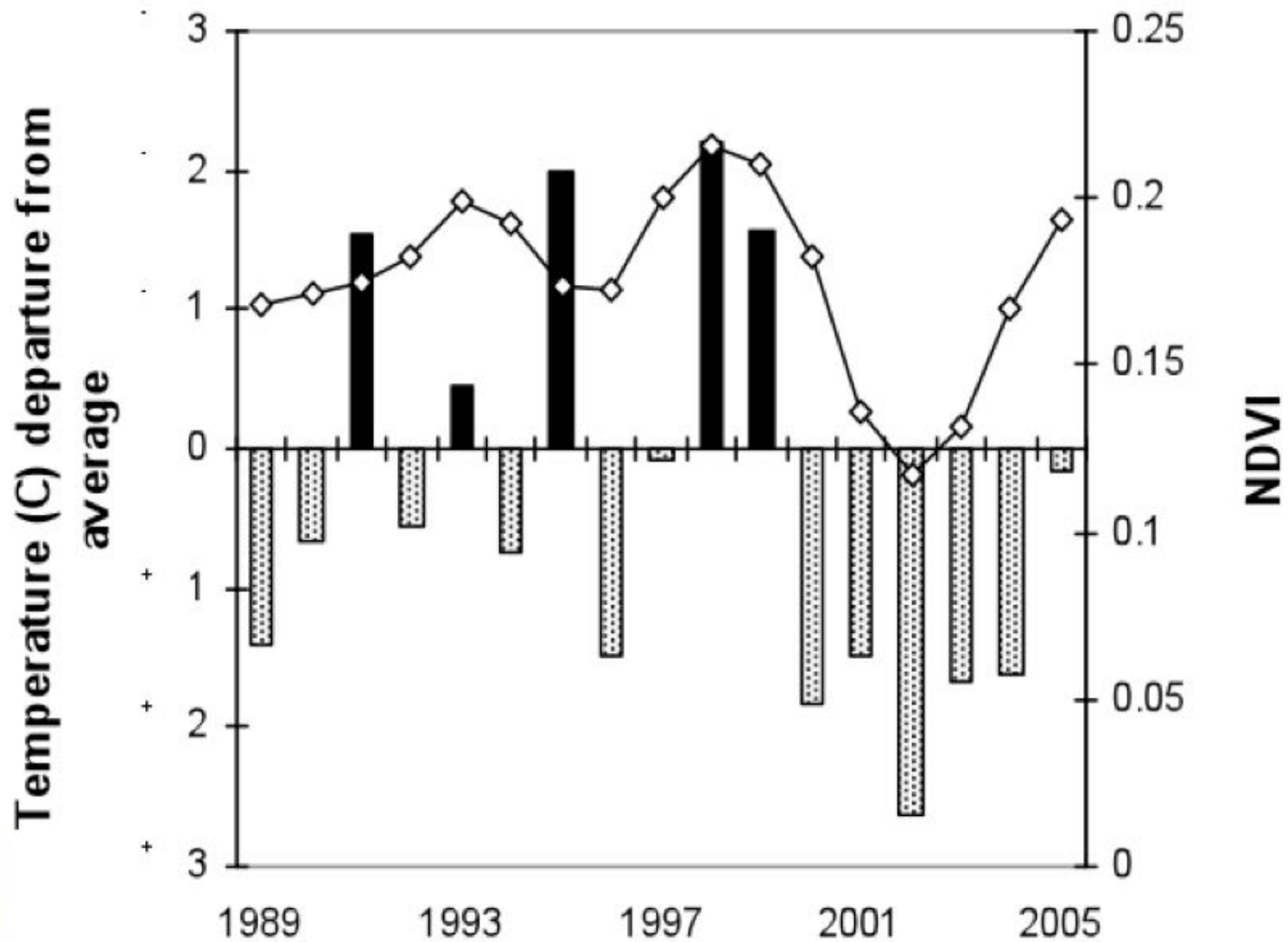


# NDVI

## Normalized Difference Vegetation Index

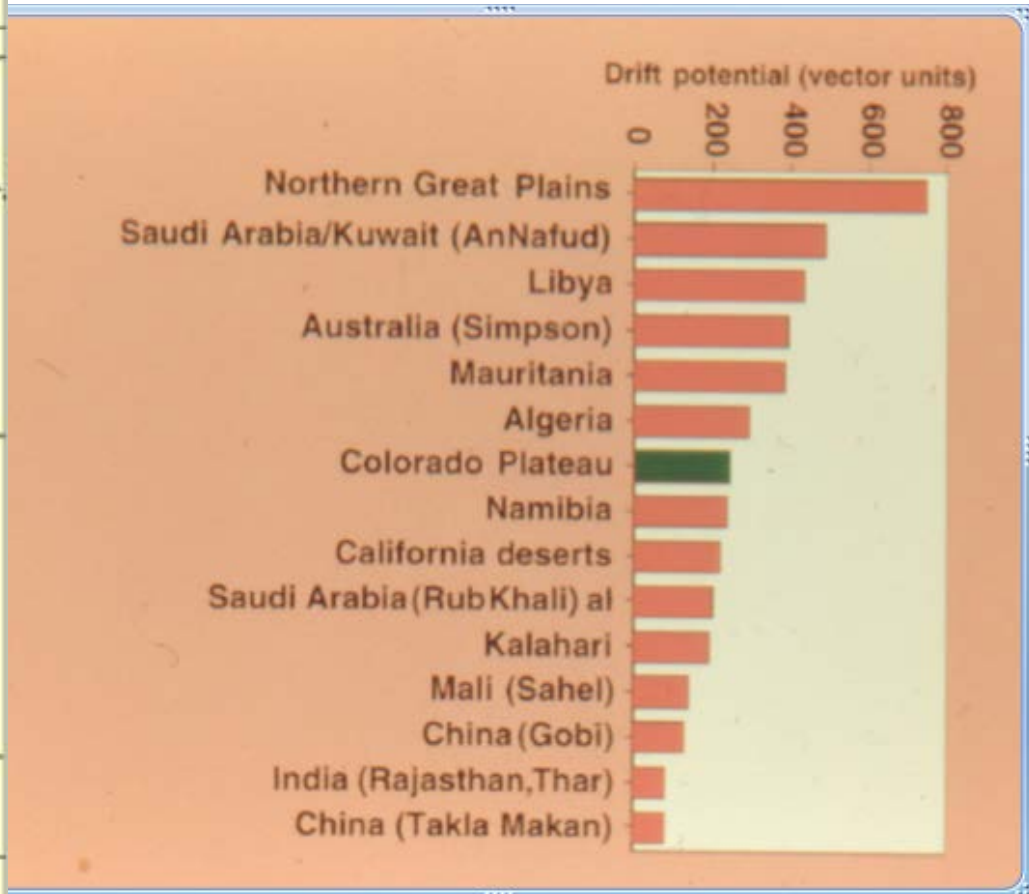
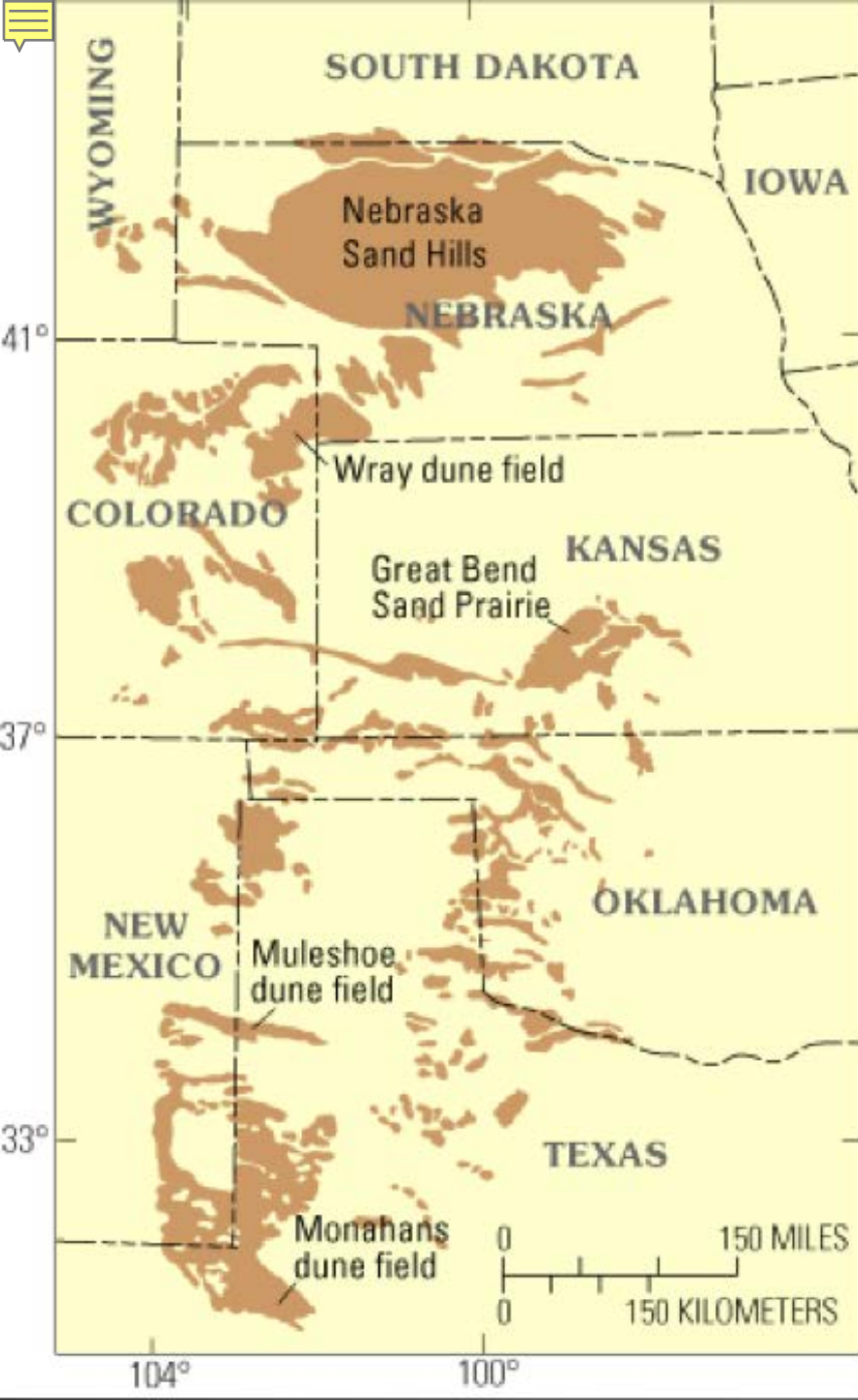
- *Measures relative vegetation productivity from AVHRR Satellite data*
- *Applicable to various vegetation bio-types*
- *Used to assess vegetation response to precipitation in US Great Plains, Chihuahuan Desert, and Kalahari of Botswana*

# Above-Normal AMJ Temperatures (dotted bars) Concurrent with Low NDVI

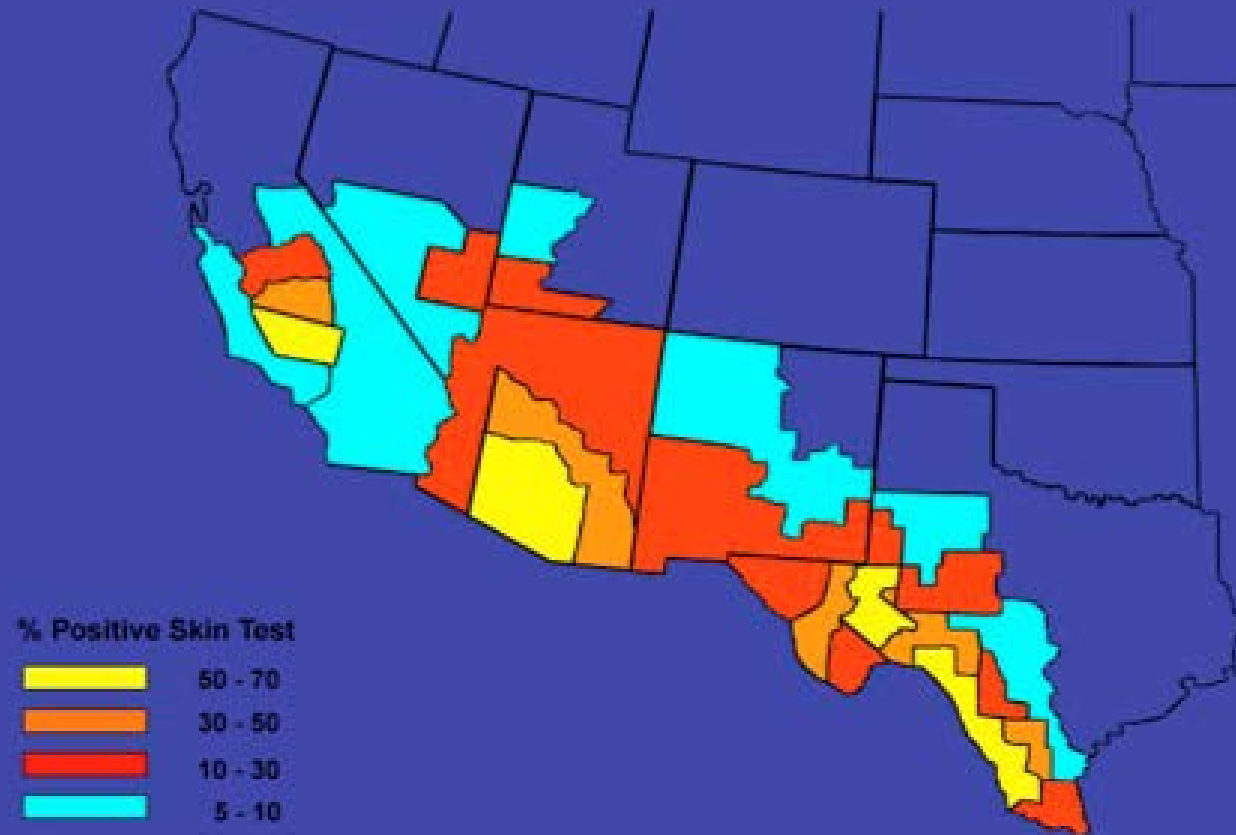




# Dune Deposits on the Great Plains



# Valley Fever in the U.S.



% Positive Skin Test



The Valley Fever Center for Excellence



# Are Averages meaningful???

*Extremes are what we feel*

- Understanding variability will help us understand impacts
- Tribal lands need their own data – our local climates are important and have been impacted by land use and climate change

*Land use and climate change effects are linked*

# Climate Change Impacts

## *Impacted life-ways*

- *Raising sheep*
- *Growing corn*
- *Plants needed for ceremonies*

## *Impacted quality of life*

- ▶ *Water quality and quantity*
- ▶ *Respiratory and other health effects of sand and dust*



# Climate Change Impacts

- Loss of Native plants

- Medicines
- Healthy rangeland
- Lodgepole pine
- Cottonwoods



# *Climate Change is more than “Average Temperature”*

- **Magnified drought conditions for Western U.S.**
  - Navajo Nation: 1°C warming = 2” rainfall lost to evapotranspiration
  - More heat waves
- **Less frequent rainfall, in larger storm/flood events**
- **Snowfall decreasing, may decrease water supplies**
  - Run-off for water supplies much less reliable
- **Invasive plants opportunistic, “invade” areas where native plants are stressed**
  - Loss of culturally significant plants and grazing land