

Response of sand dune systems in  
the SW USA to climate change -  
past, present, and future

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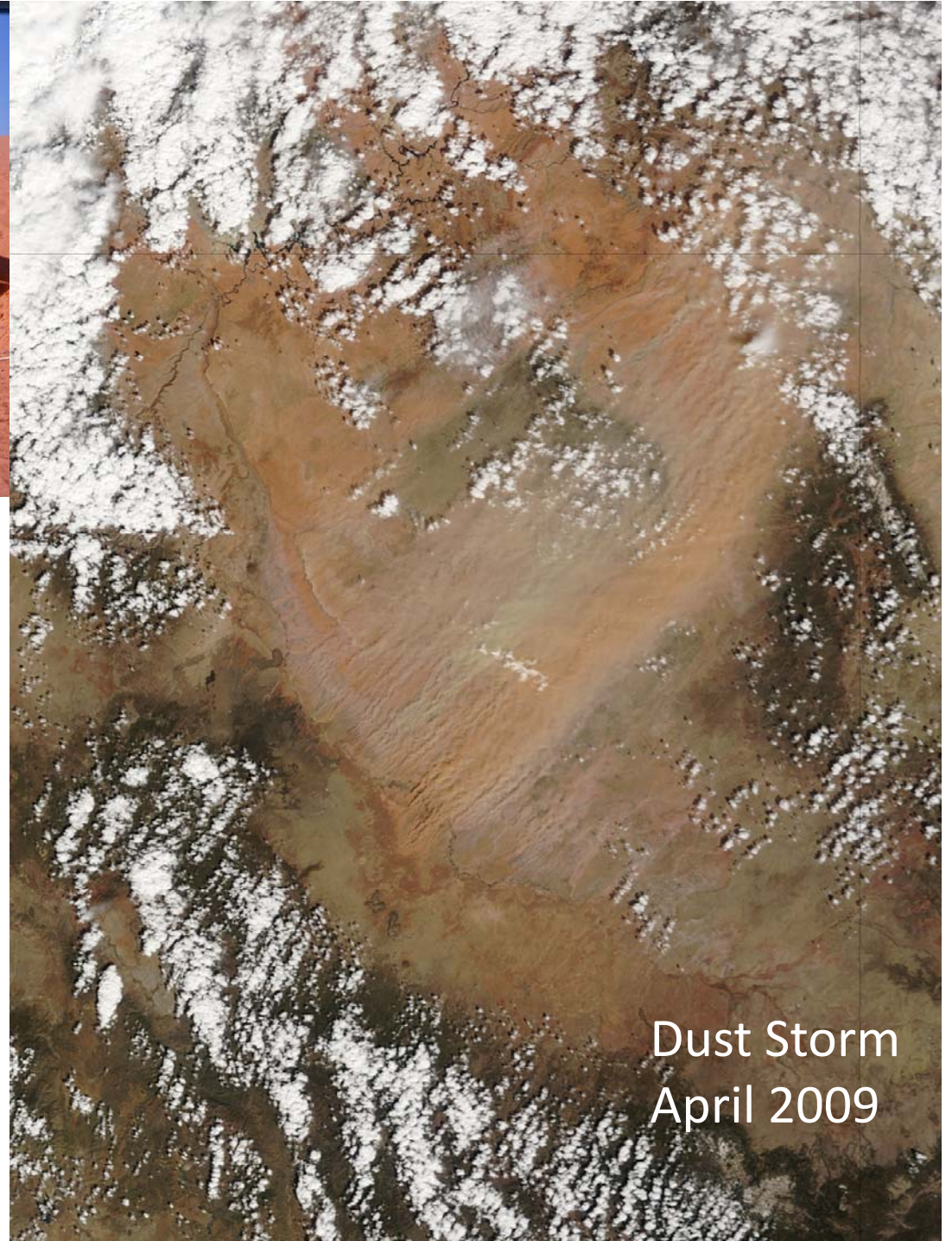
Reno, Nevada



Sand encroachment

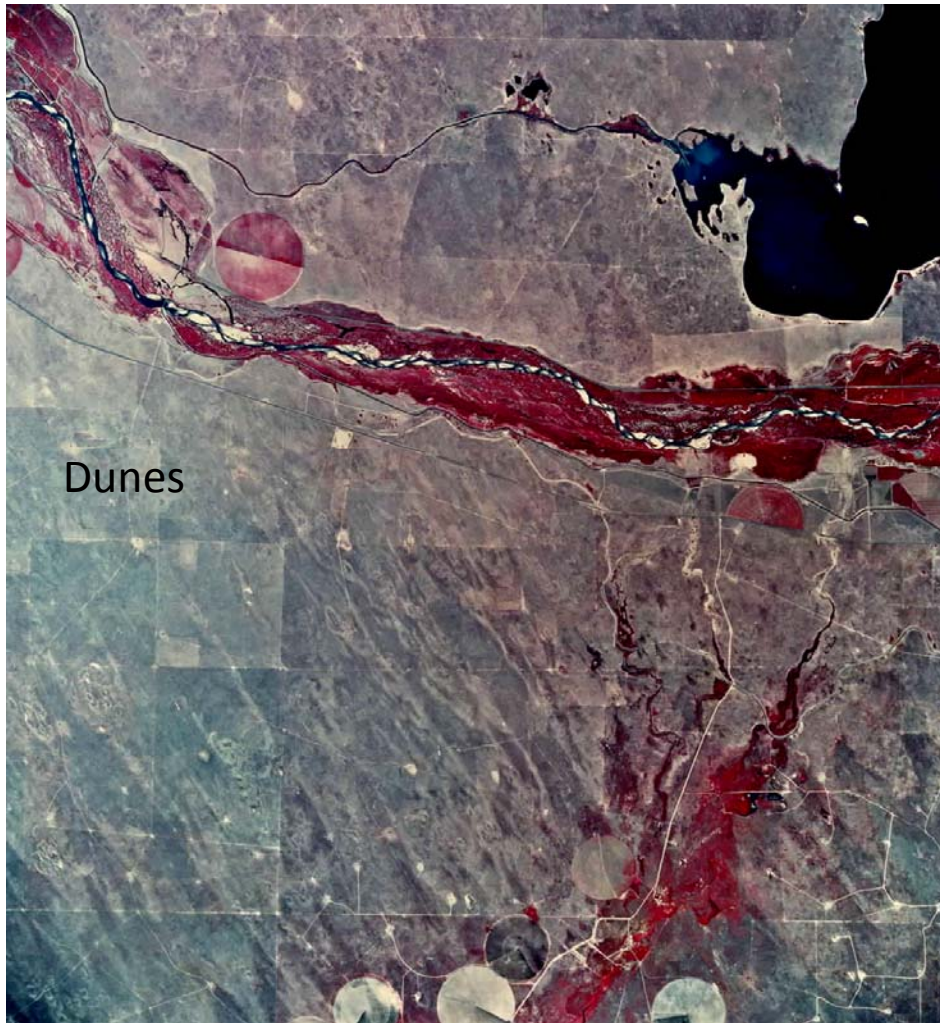
Pictures by Margaret Hiza, USGS

# Significance of dune processes



Dust Storm  
April 2009

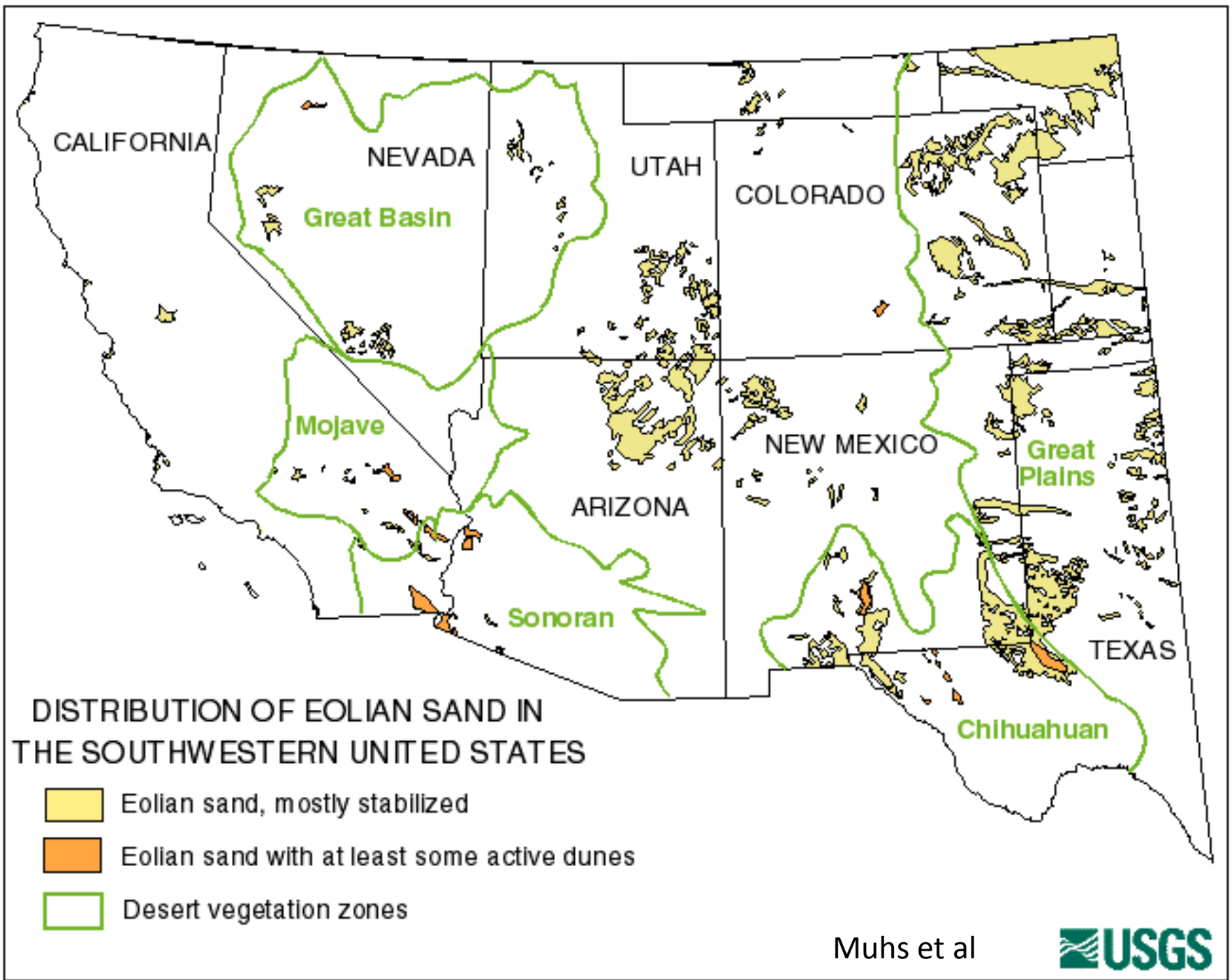
# Proximity of vegetation-stabilized dunes to infrastructure and agriculture



Reactivation of dunes a result of climate change and variability may impact agriculture and other activities

Many dunes on the Great Plains were reactivated in the 1930's droughts and previously in mega-droughts (e.g. 1390, 670, 470, 240, 140, and 70 years ago)

Center pivot irrigation, oil and gas wells



# Dunes of the SW USA and northern Mexico



More dunes occur in northern Nevada and Idaho

From Dan Muhs, USGS

# Dune landscapes



Many dune areas highly vulnerable to effects of extended drought

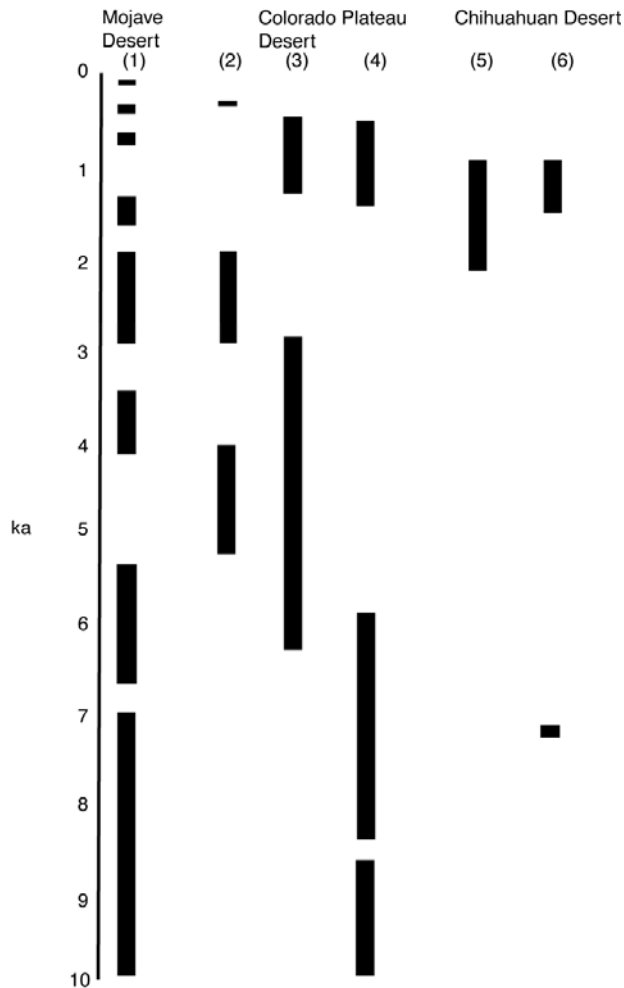


## Dune field response to climate variability

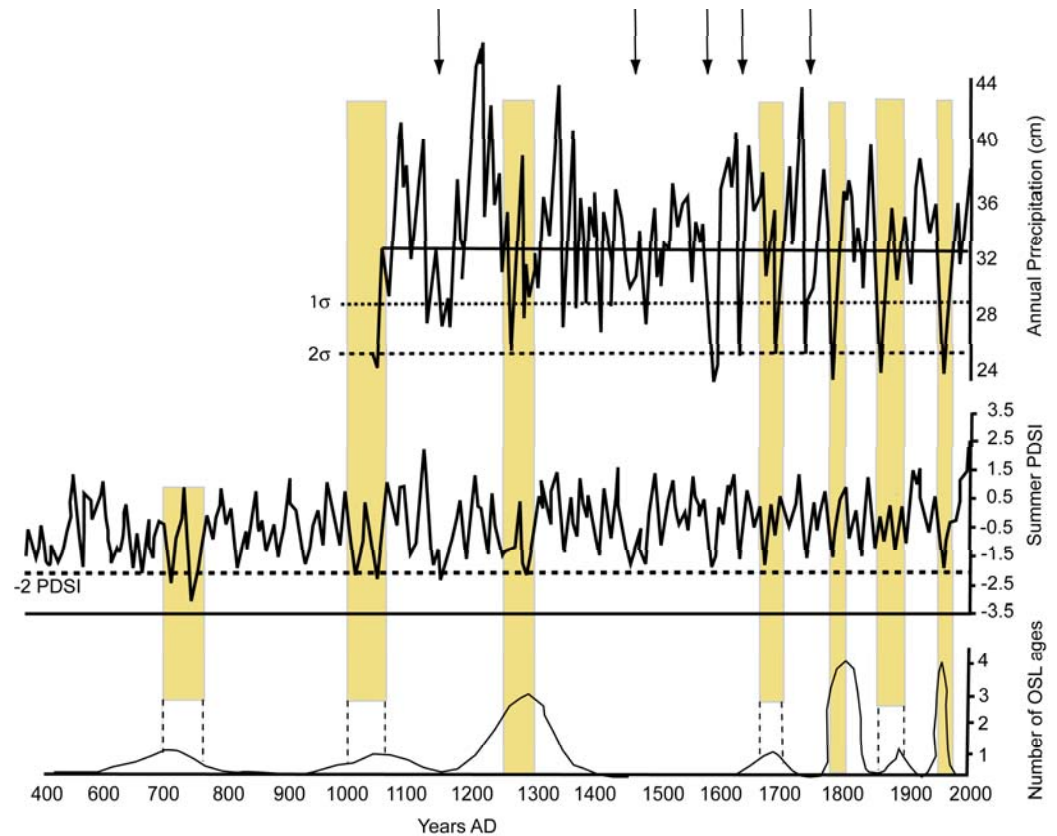


Gran Desierto, Mexico

# Evidence for past activity widespread



Lancaster 2003

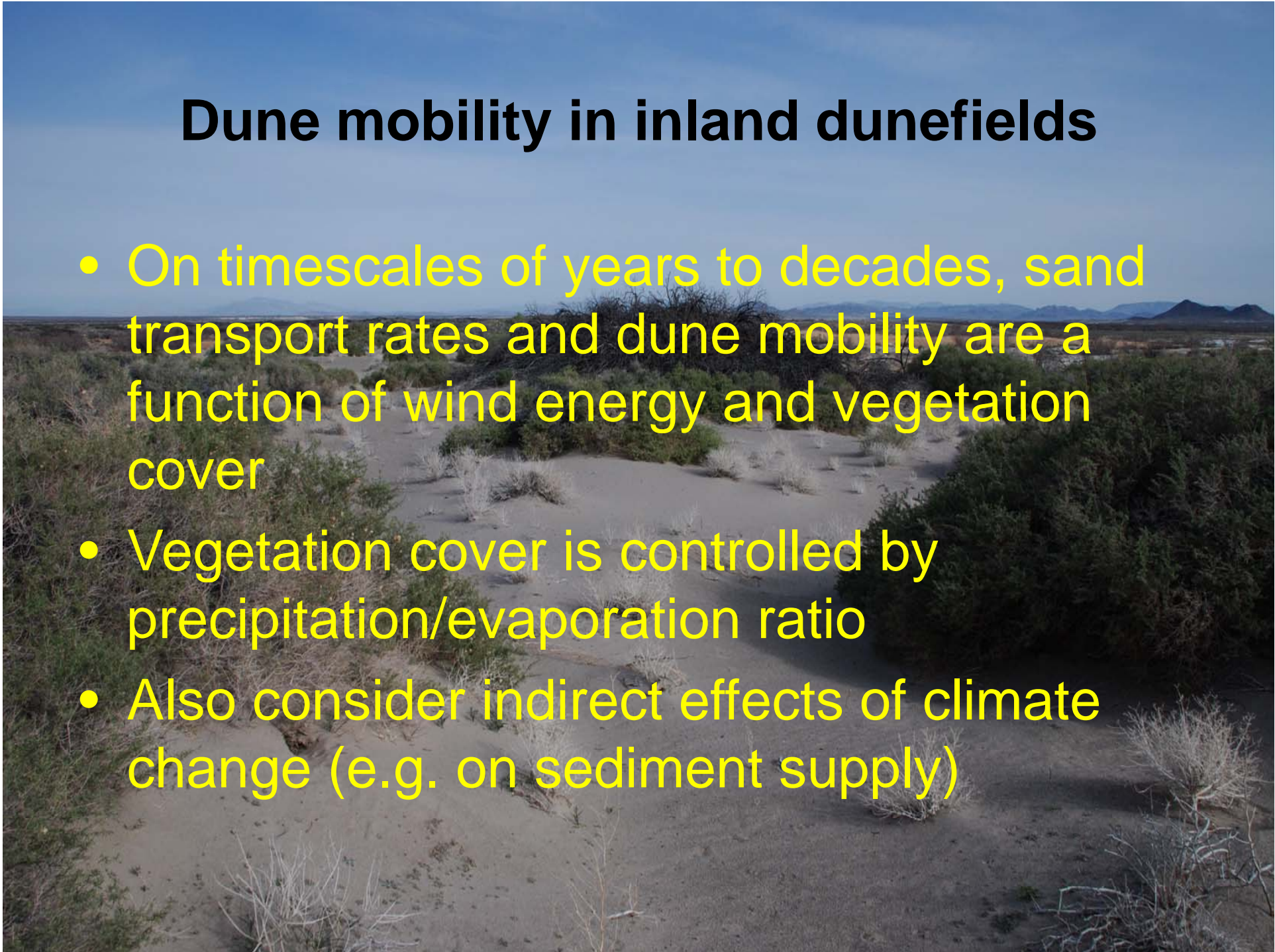


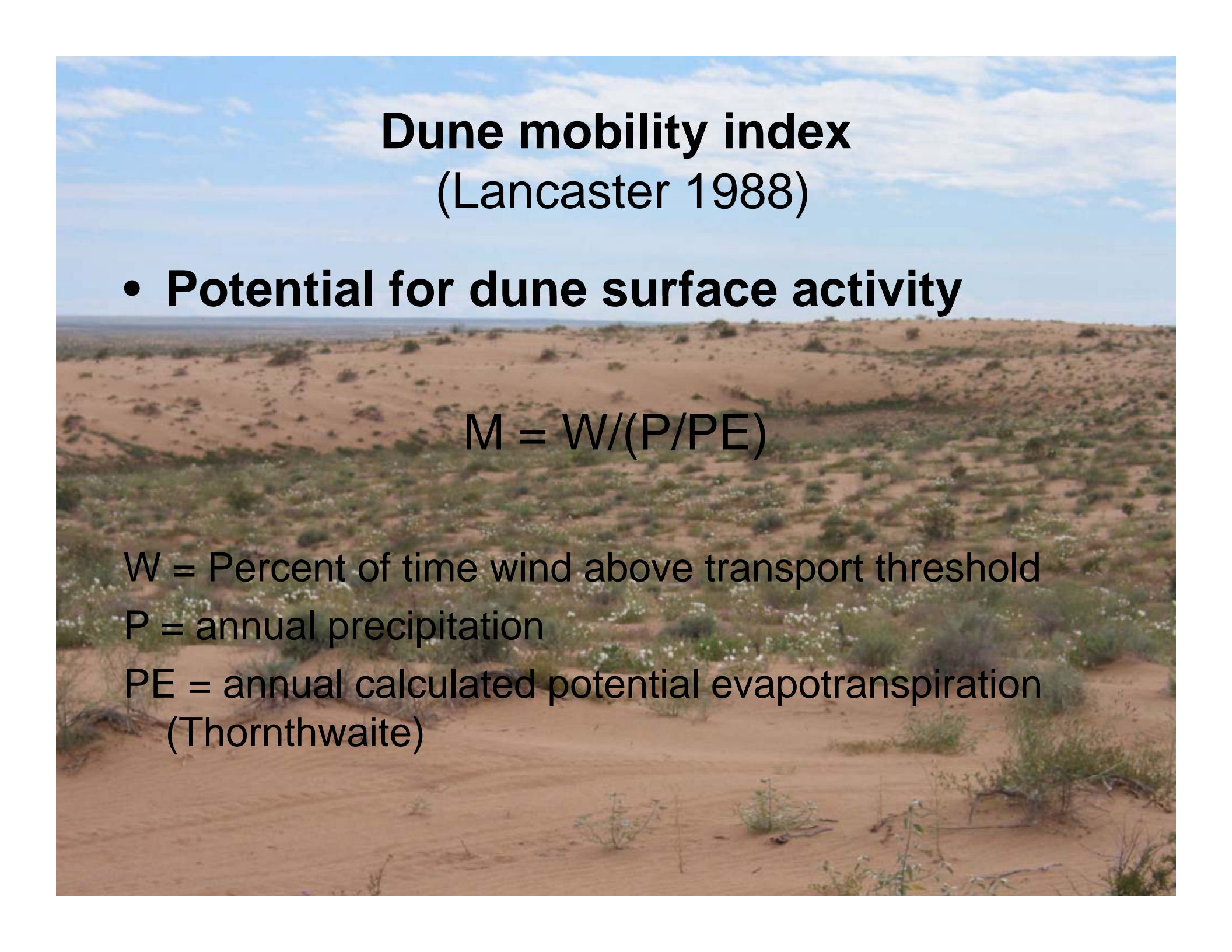
Great Sand Dunes response to climate change  
After Forman et al., 2006



# Dune mobility in inland dunefields

- On timescales of years to decades, sand transport rates and dune mobility are a function of wind energy and vegetation cover
- Vegetation cover is controlled by precipitation/evaporation ratio
- Also consider indirect effects of climate change (e.g. on sediment supply)





## Dune mobility index (Lancaster 1988)

- **Potential for dune surface activity**

$$M = W/(P/PE)$$

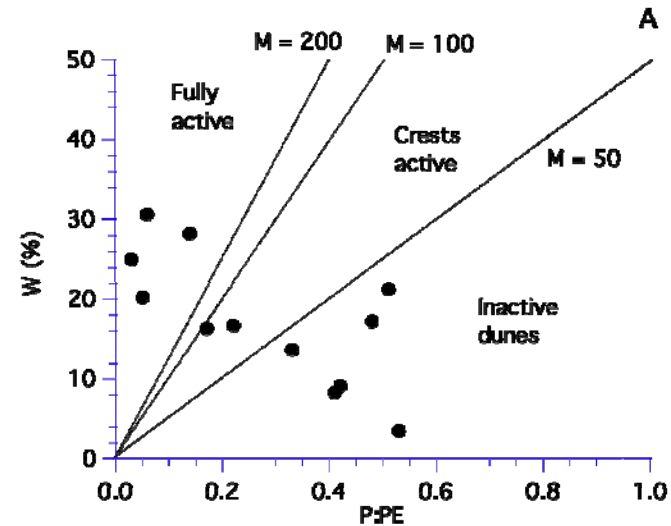
W = Percent of time wind above transport threshold

P = annual precipitation

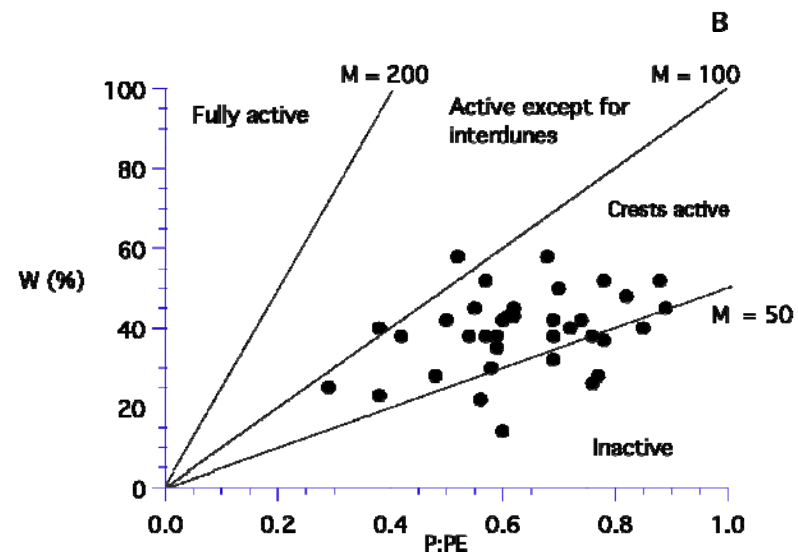
PE = annual calculated potential evapotranspiration  
(Thornthwaite)

# Dune mobility index Lancaster (1988)

- **Critical values of index**
  - $< 50$  - dunes inactive
  - $50 - 100$  - dune crests active
  - $100 - 200$  dunes active, interdunes inactive
  - $>200$  fully active dune landscape

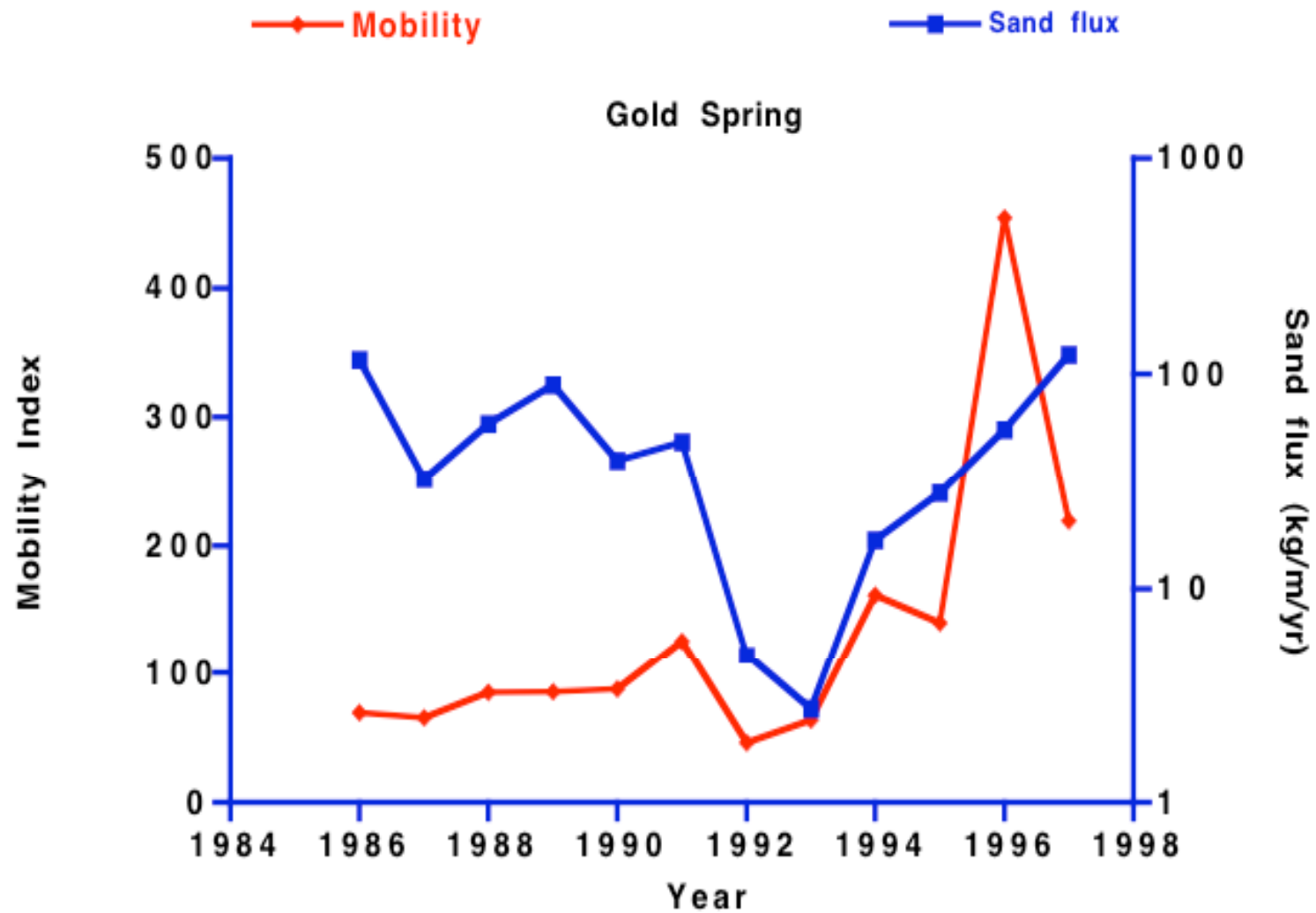


Southern Africa (Lancaster 1988)



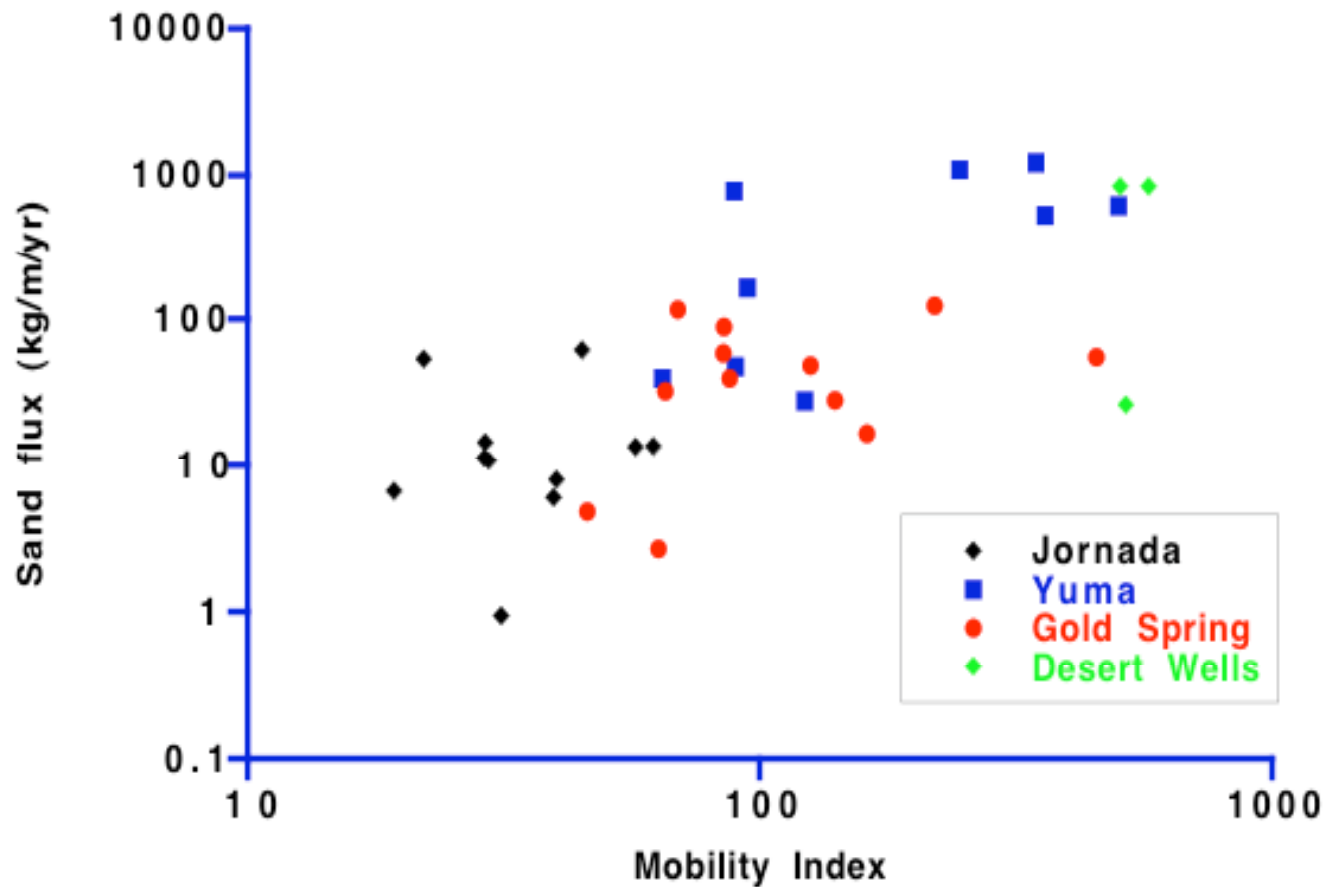
Great Plains (Muhs and Maat 1993)

# Testing the index

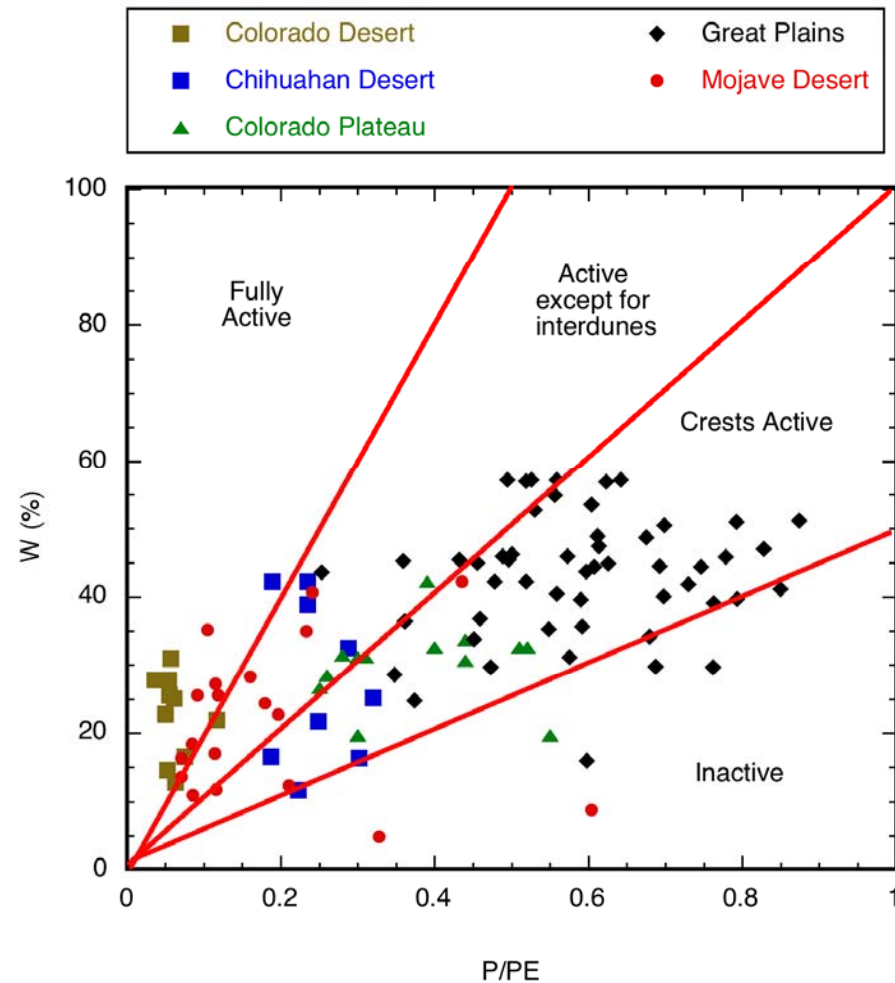


Lancaster and Helm (2002)

# Testing the mobility index

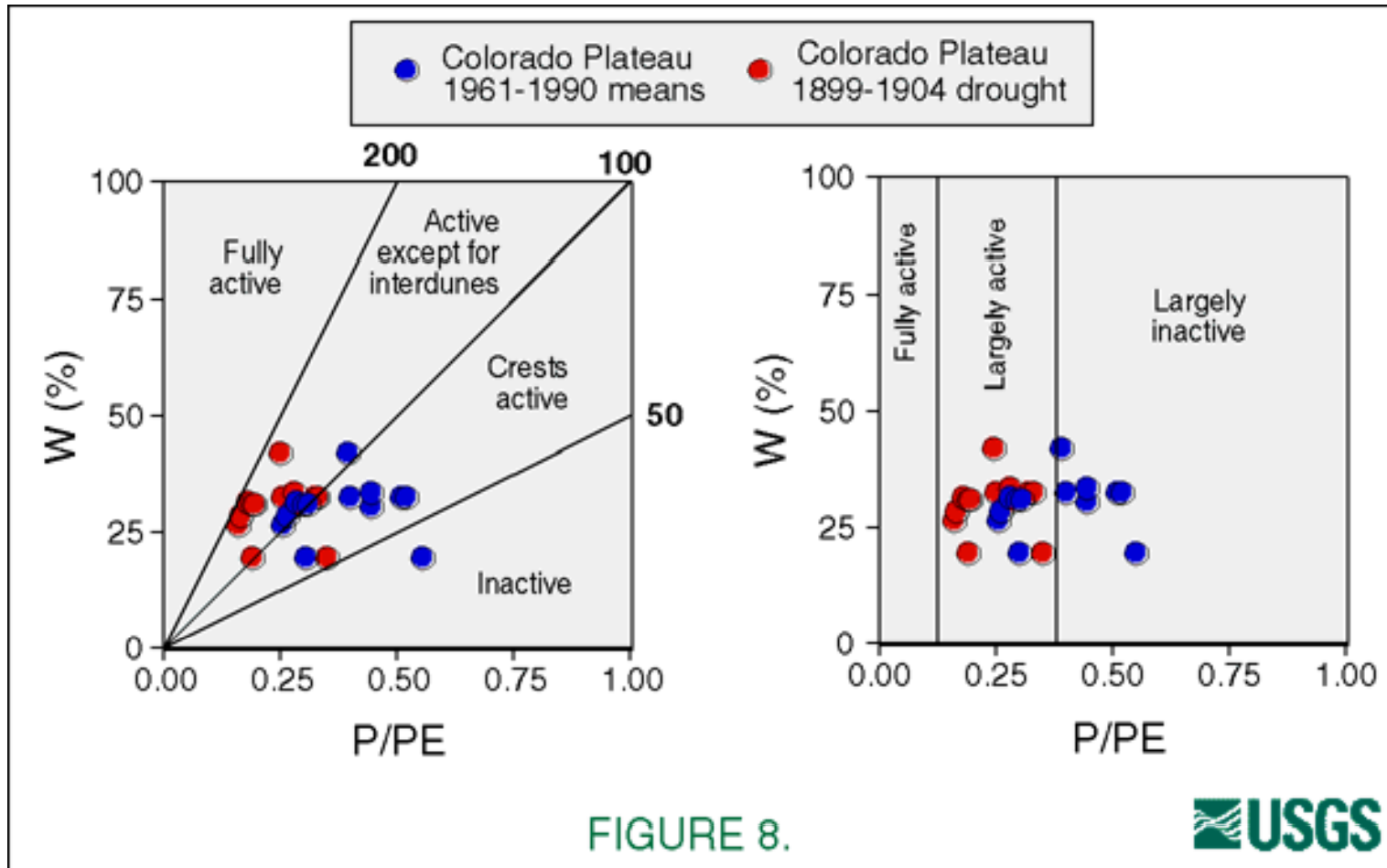


# Dune mobility in the SW USA



Data set from USGS (Dan Muhs)

# Response to change in the SW USA



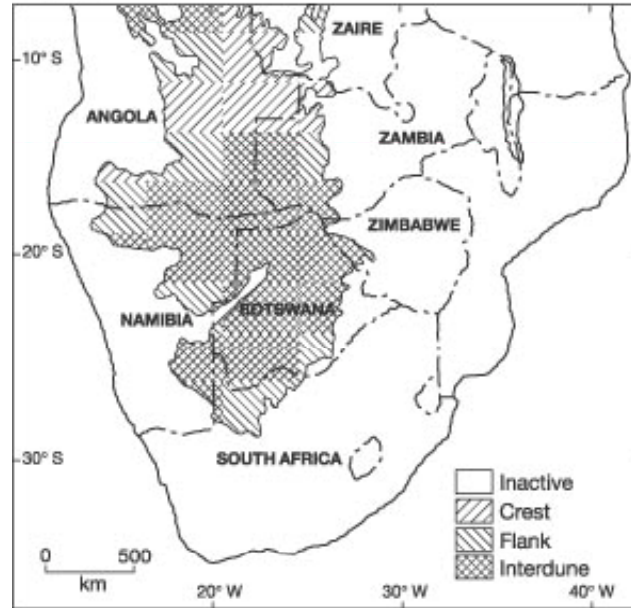
Muhs: <http://geochange.er.usgs.gov/sw/impacts/geology/sand/>

# Coupling of mobility index with climate model output

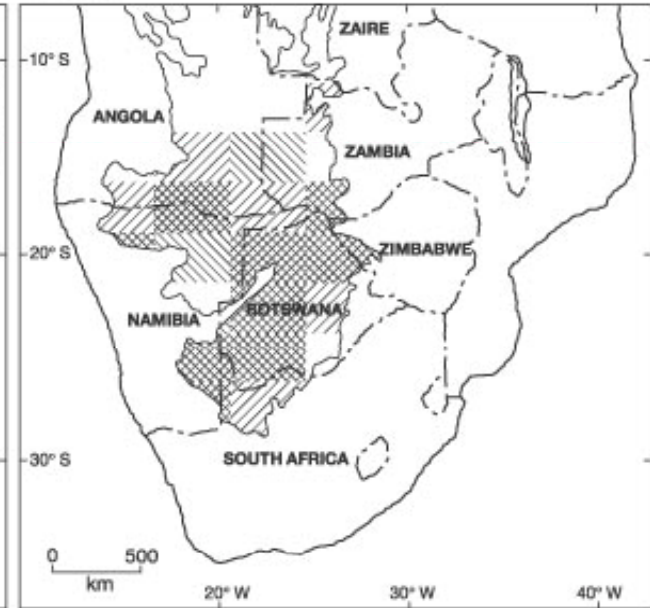
Predicted 3-month dunefield activity after 2070

Thomas et al., 2005

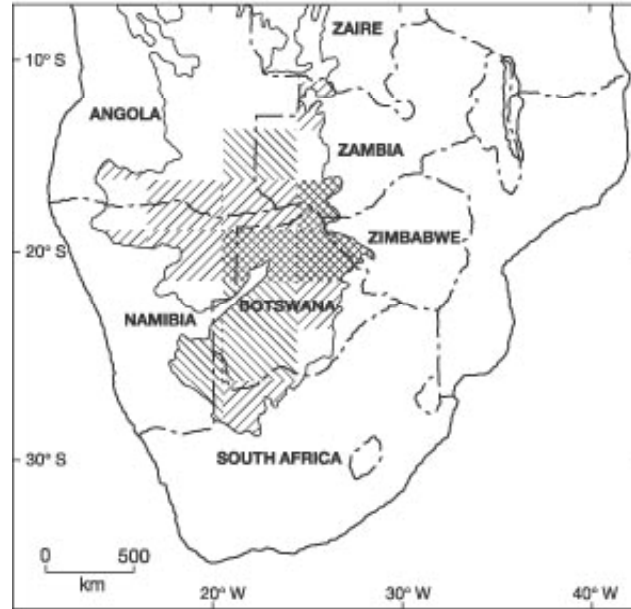
ASO2070



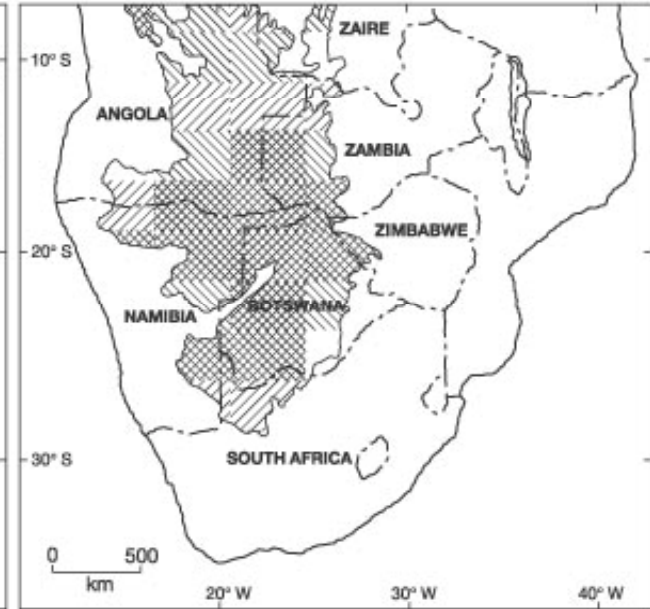
NDJ2070



FMA2070

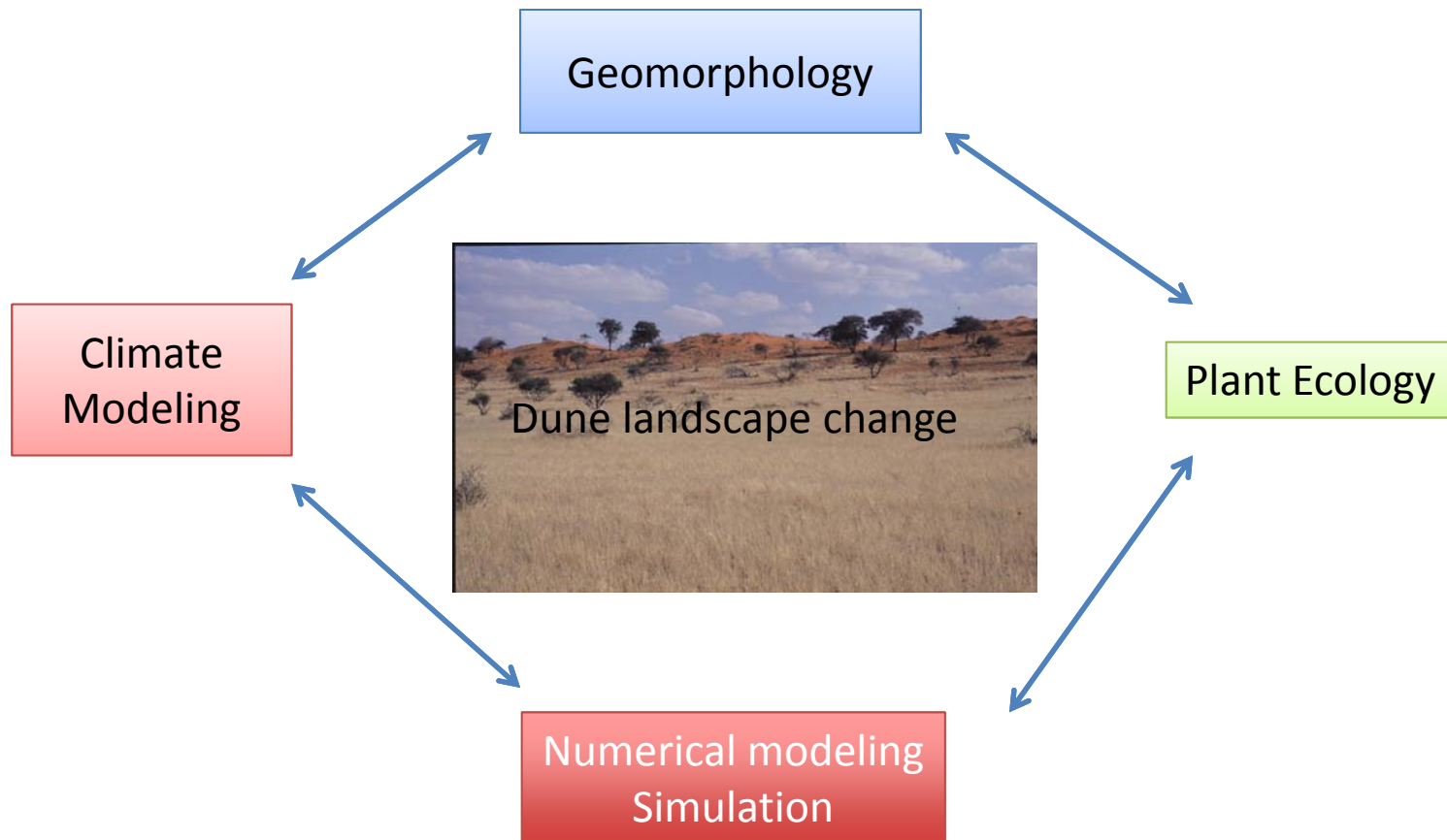


MJJ2070

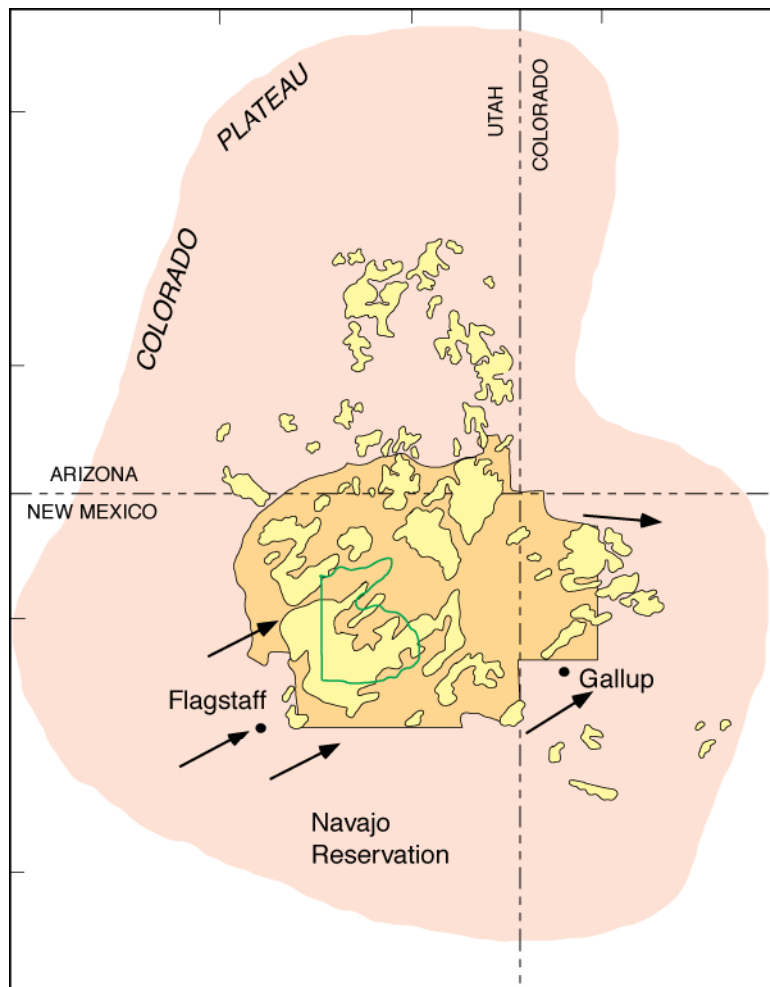




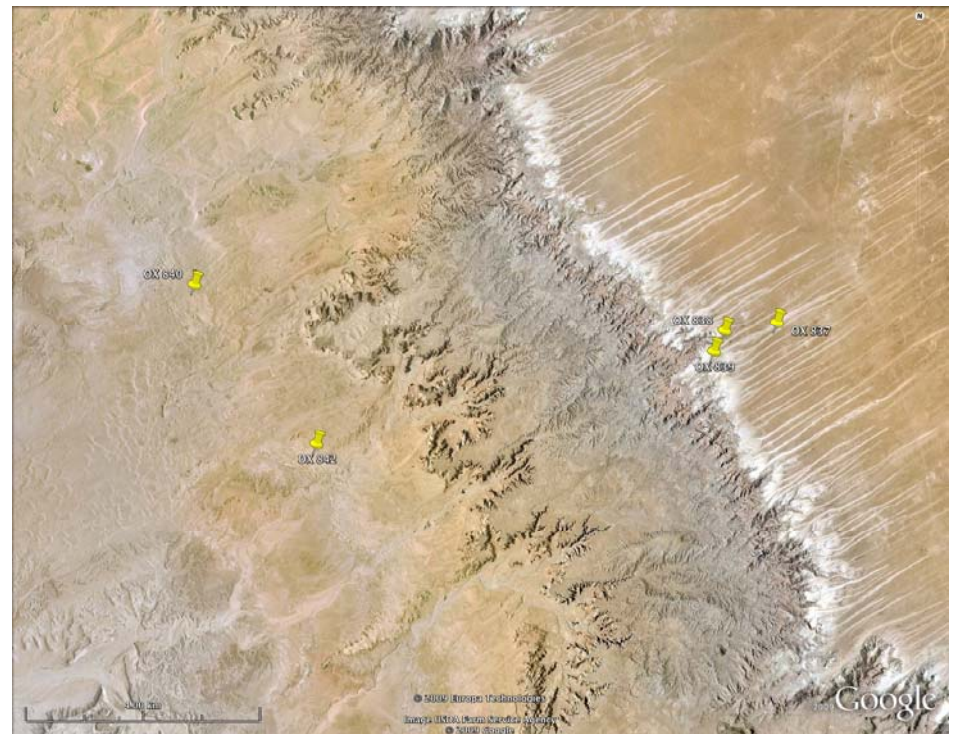
# An interdisciplinary approach to understand dunefield response to climate change



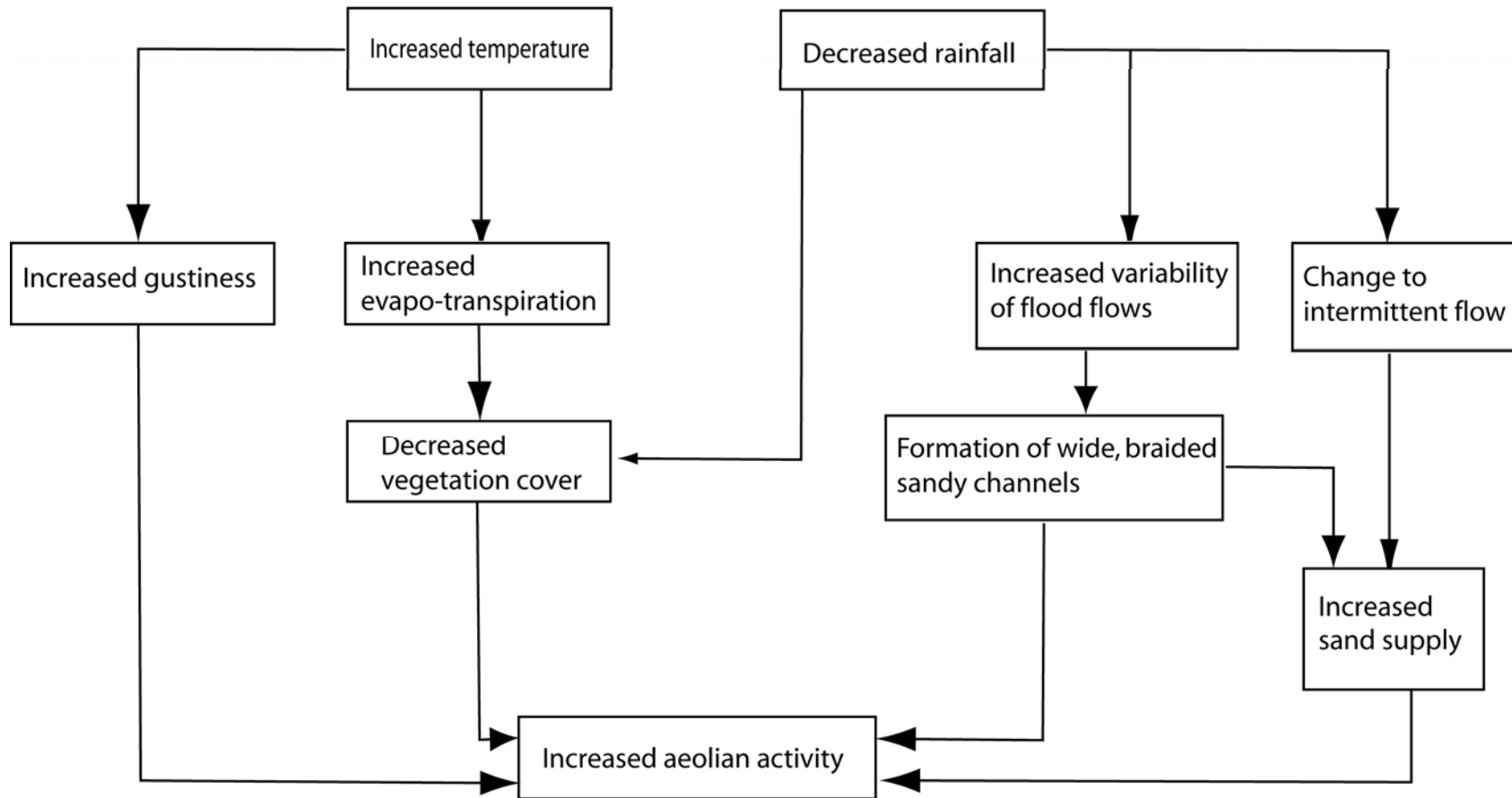
# Navajo Dunes



- Wind blown sand
- Direction of sand-moving winds
- Native lands
- Hopi reservation



# Dune system response to climate on the Great Plains, USA



After Muhs and Holliday, 1995