Assessing the Potential for Dust Emission Hotspots

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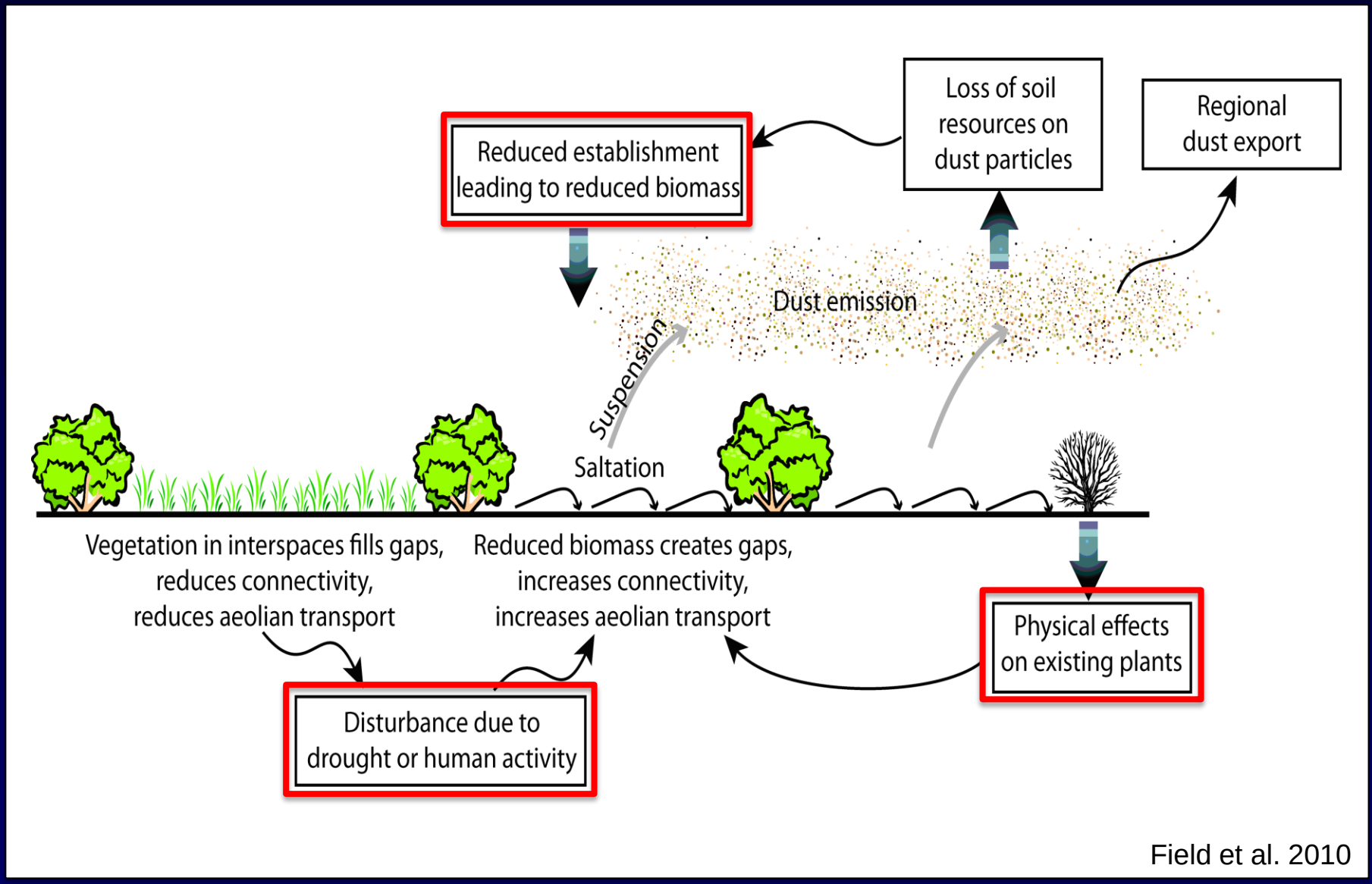
The Nature Conservancy
SAVING THE LAST GREAT PLACES ON EARTH

U.S. DEPARTMENT OF THE INTERIOR
BUREAU OF LAND MANAGEMENT

C.W.P.

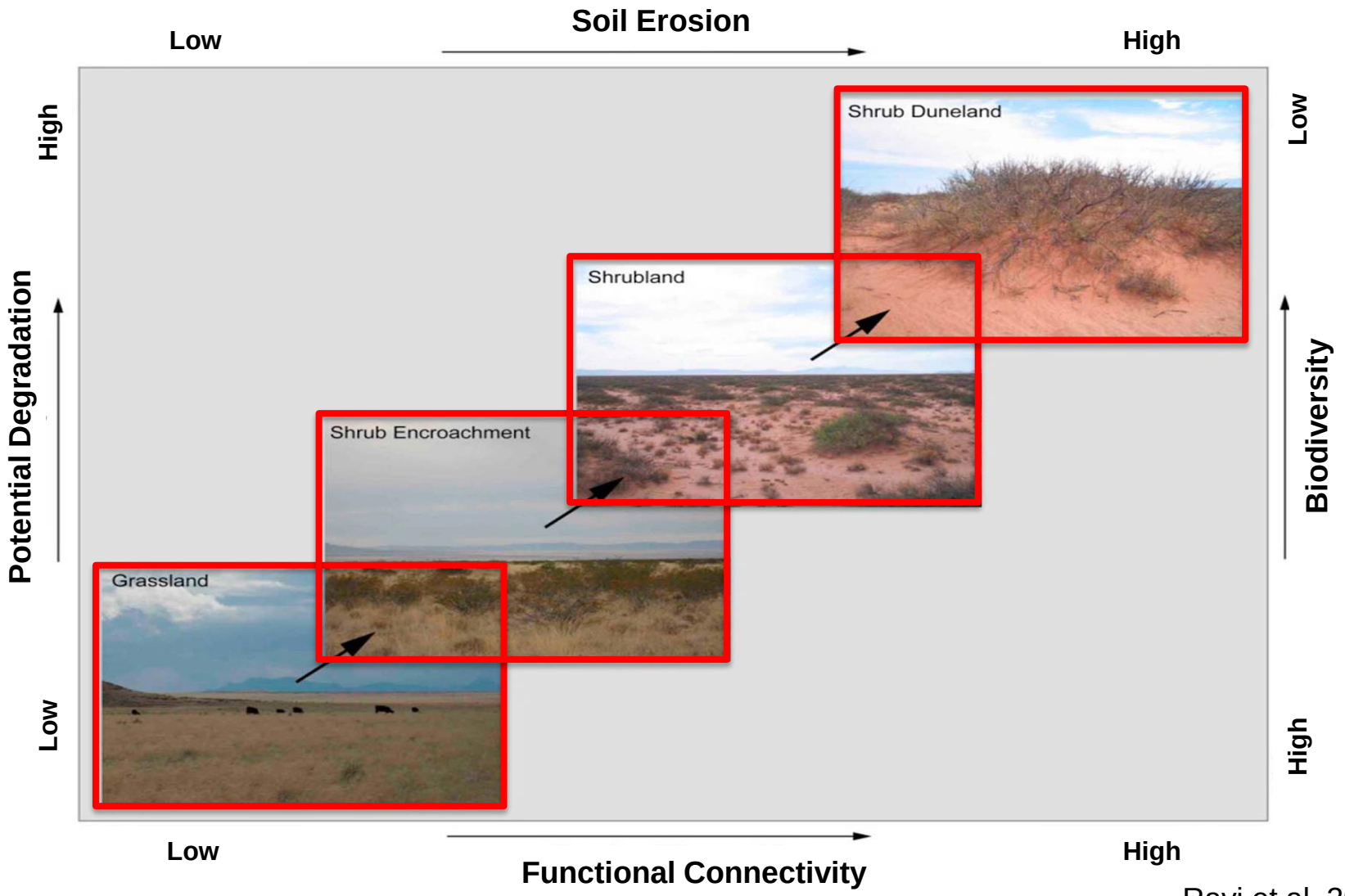
NIEHS
National Institute of Environmental Health Sciences

Ecosystem Health and Dust Emission Hotspots



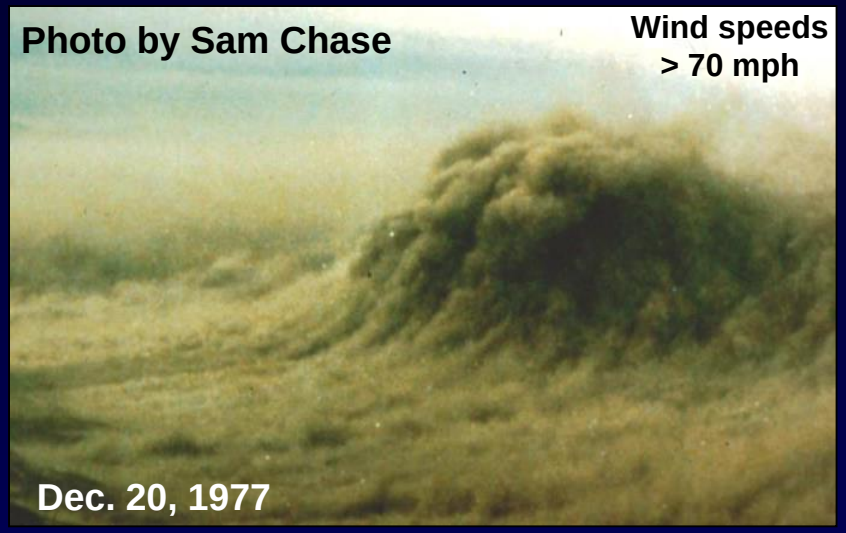
Field et al. 2010

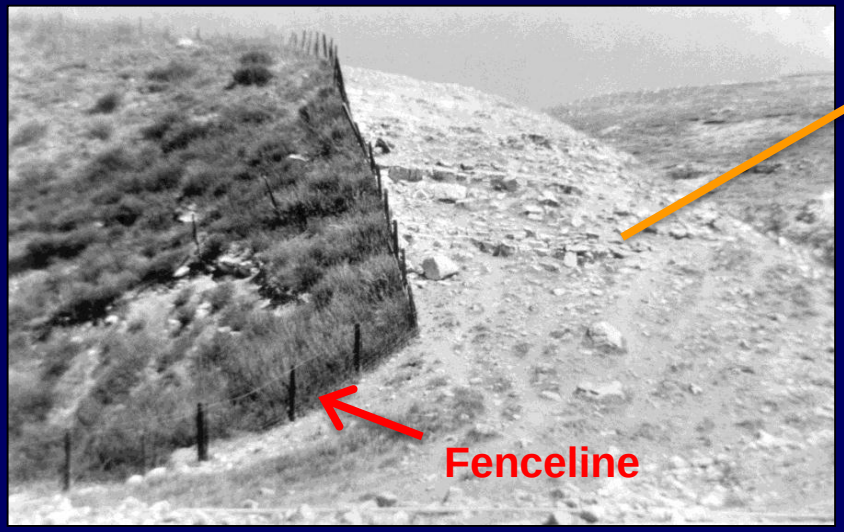
Ecosystem Health and Dust Emission Hotspots

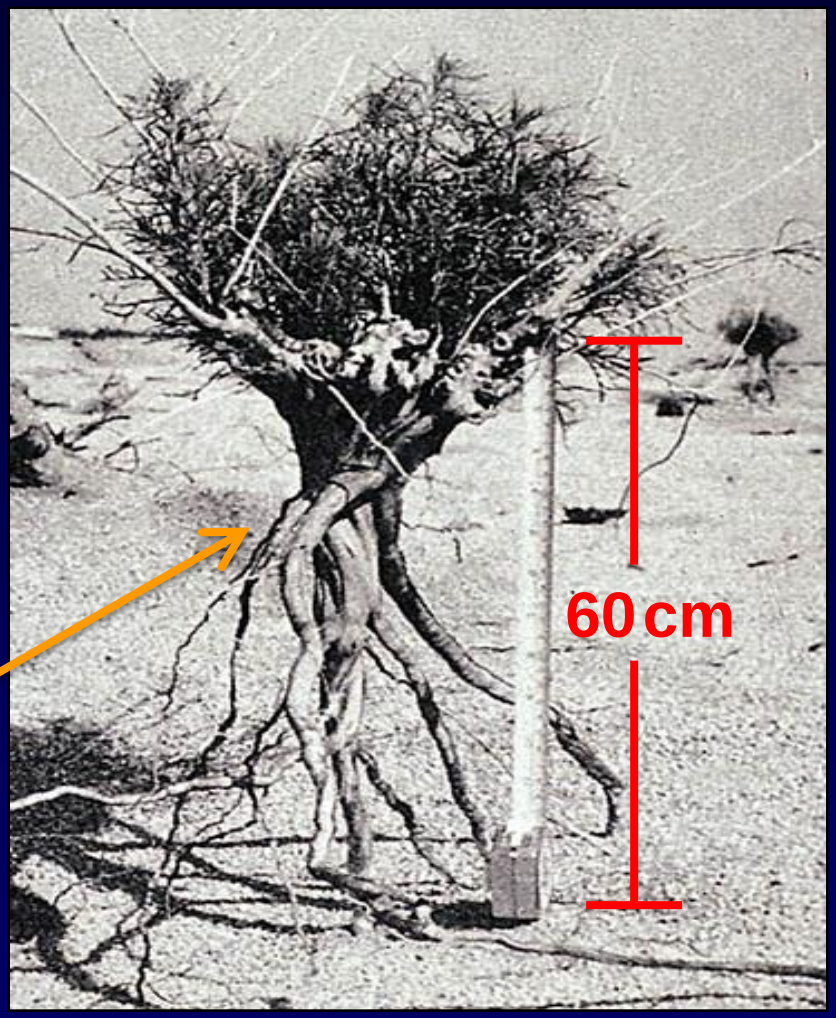


Ravi et al. 2011

Ecosystem Health and Dust Emission Hotspots



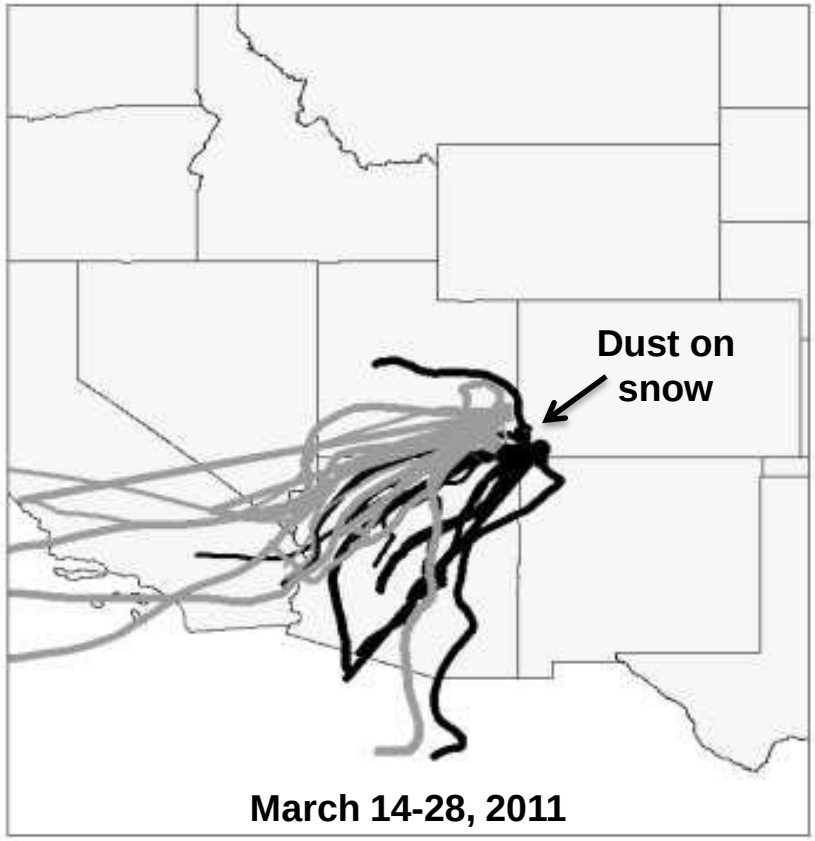




60 cm of soil loss in a single wind event in the San Joaquin Valley, CA (Wilshire et al. 1981)

Ecosystem Health and Dust Emission Hotspots

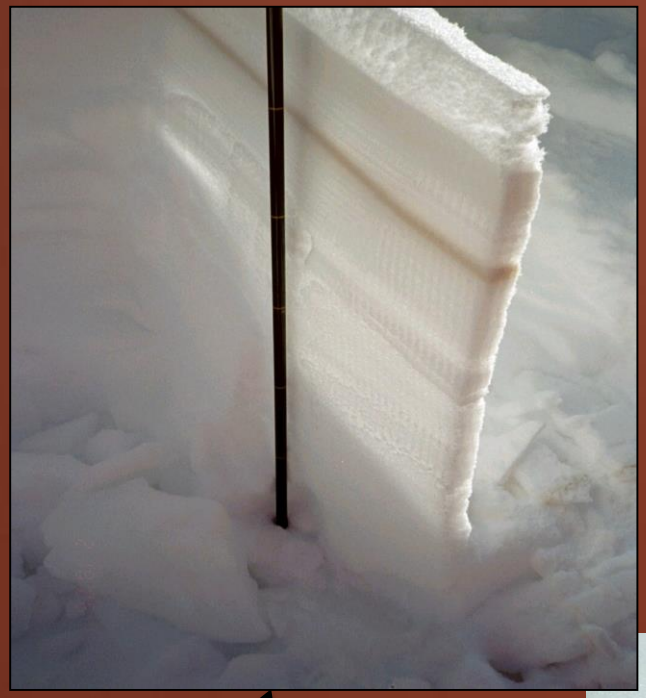
Back Trajectory Analysis –
NOAA Hysplit Model

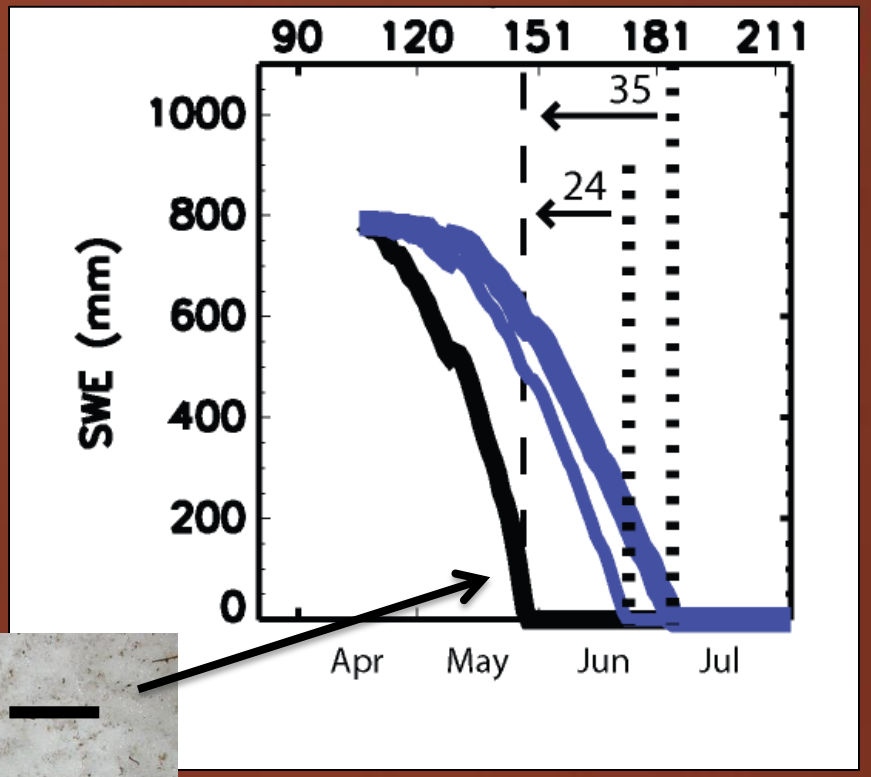


Neff et al., *JGR-Atmosphers*, 2013

San Juan Mountains, Colorado, 19 May 2009
Photo courtesy of T. H. Painter

Field et al., *Front. Ecol. Envniron.*, 2010





Painter et al. *Geophys. Res. Let.*, 2010

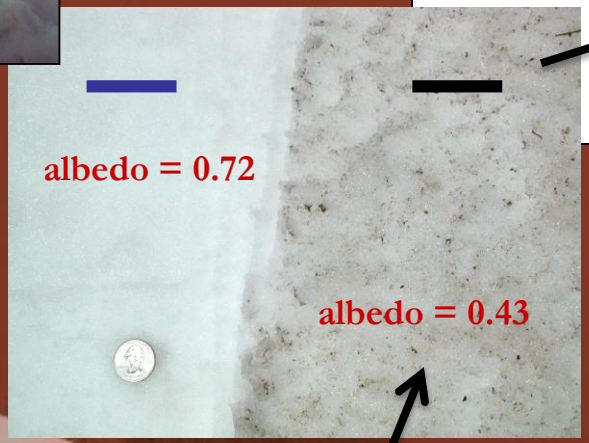
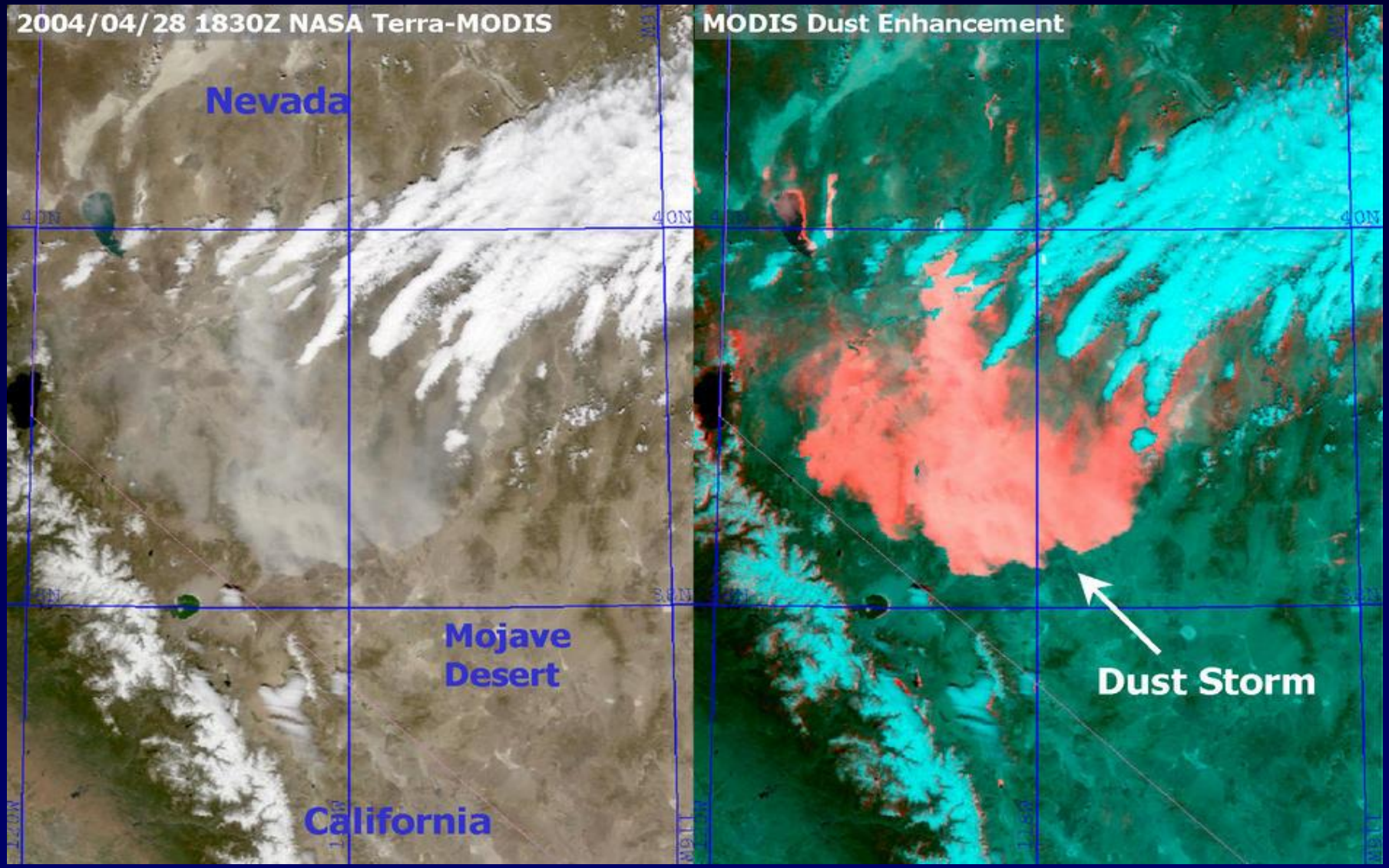


Photo: T. Painter

Characterizing Dust Emission Hotspots



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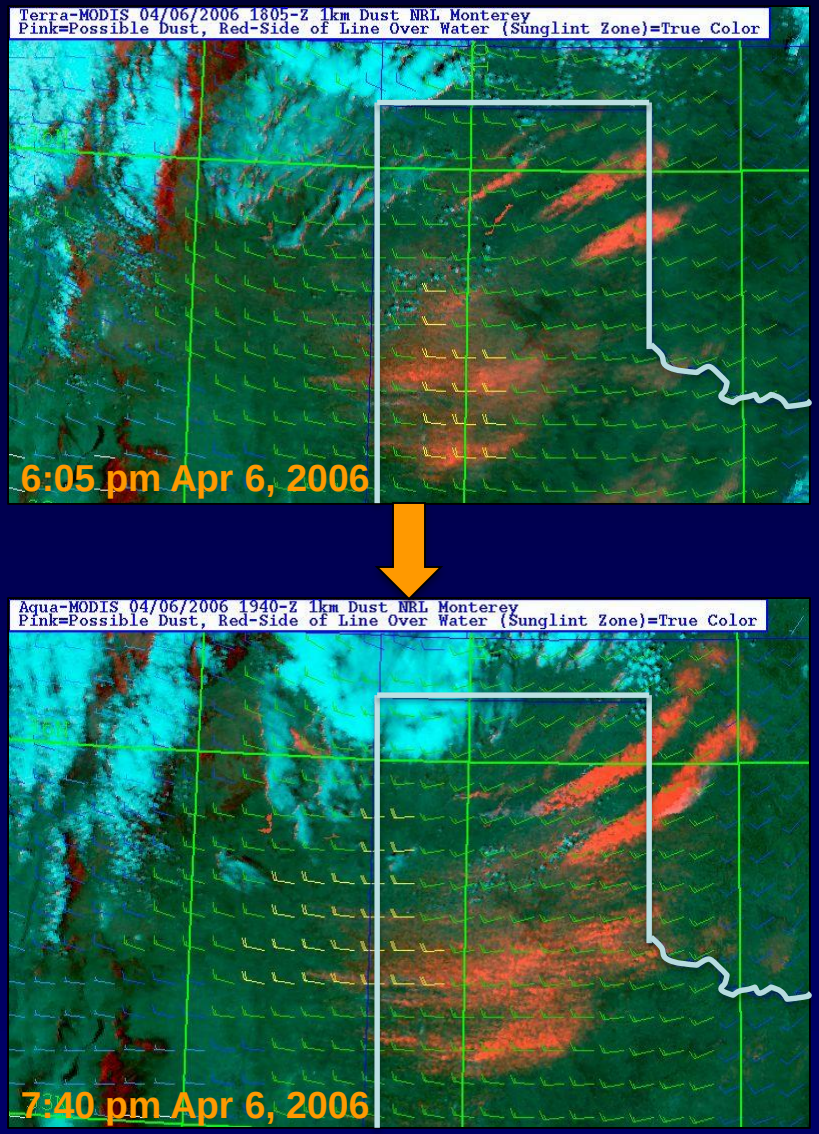
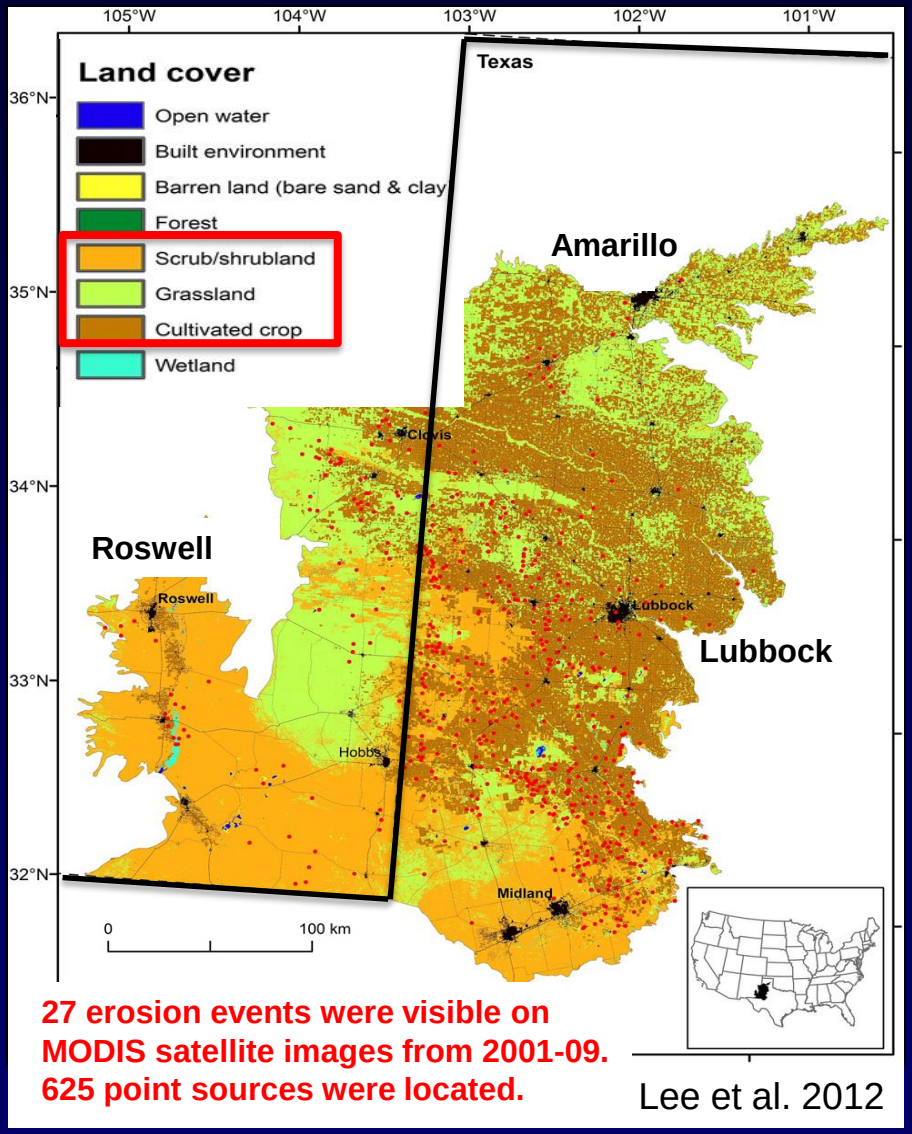
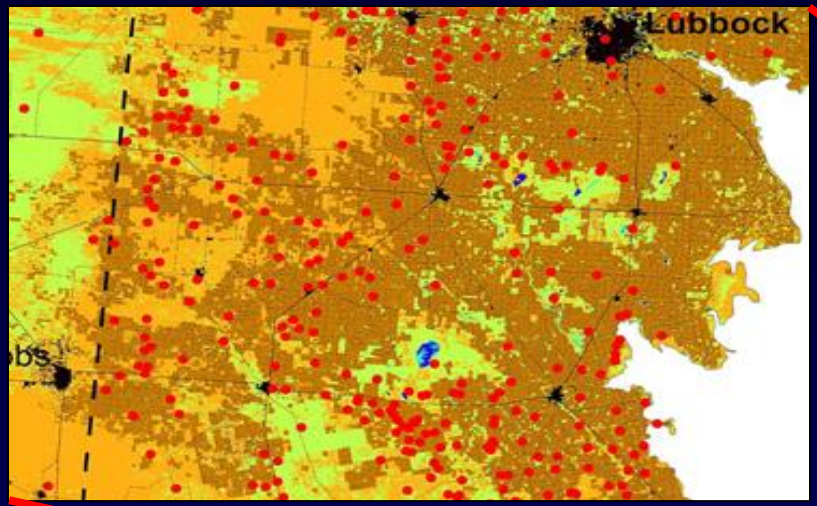




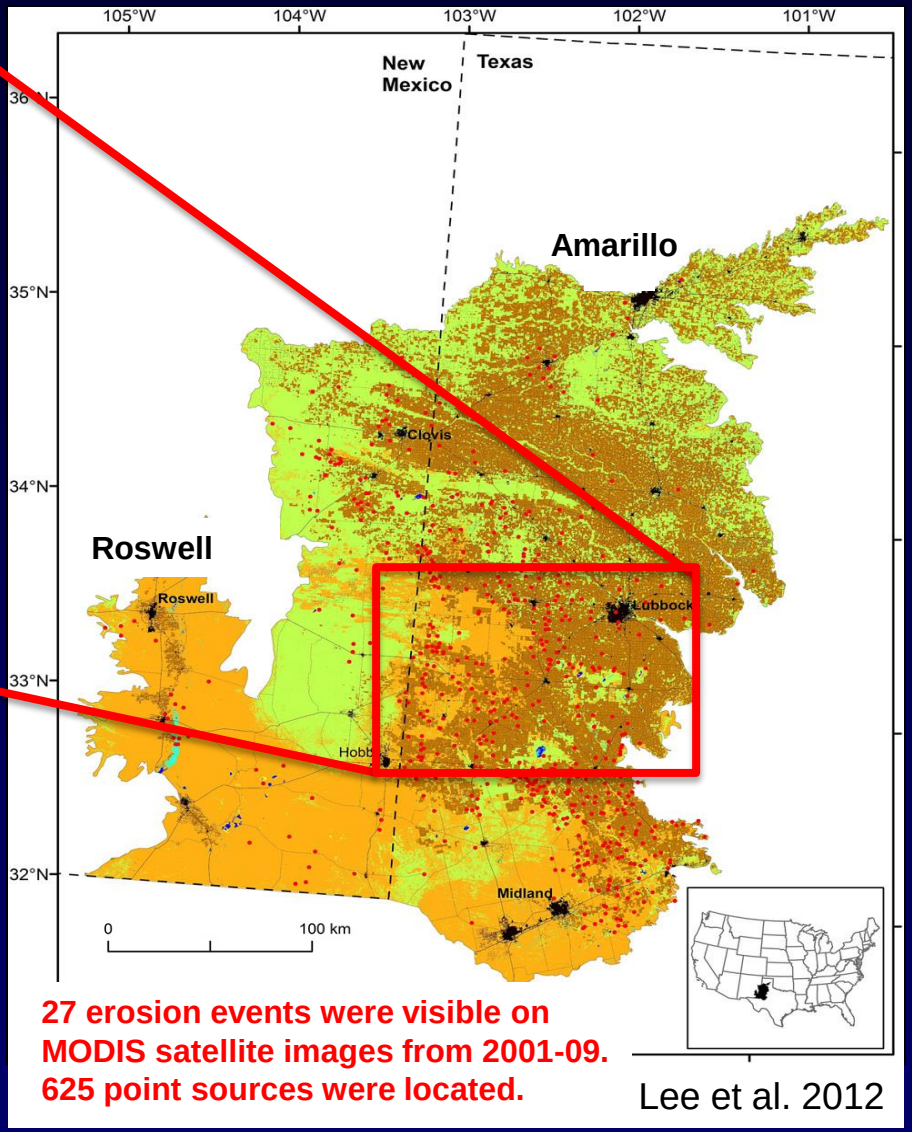
27 erosion events were visible on MODIS satellite images from 2001-09. 625 point sources were located.

Lee et al. 2012

Characterizing Dust Emission Hotspots



Land cover class	Area (%)	Dust hotspots
Shrubland	31.8	104
Grassland	30.7	126
Cropland	32.7	359
Other	4.8	36



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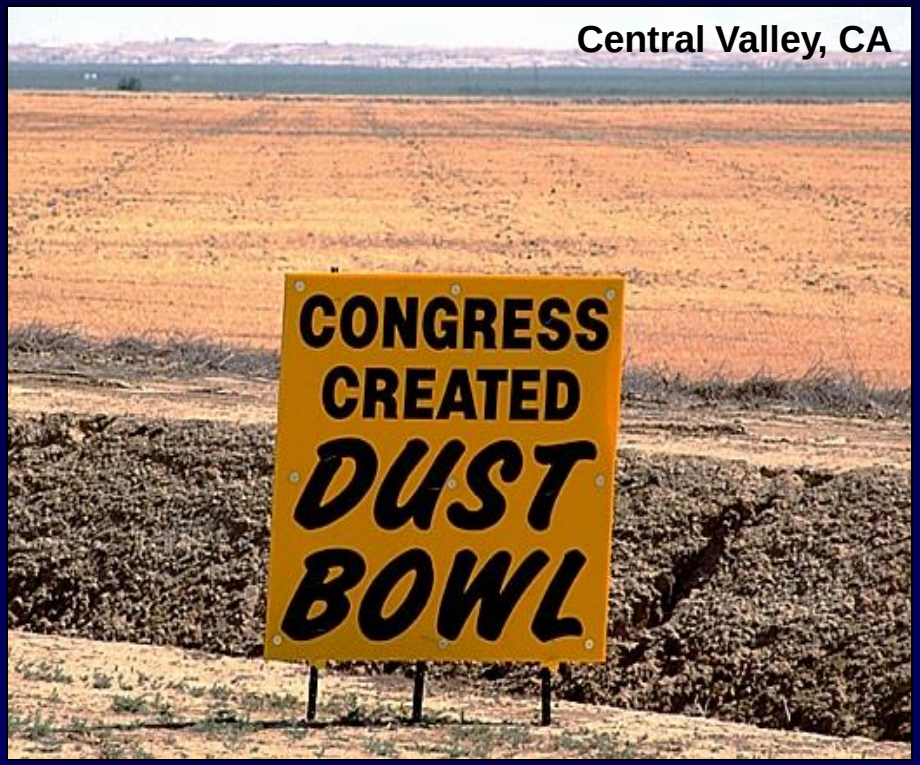
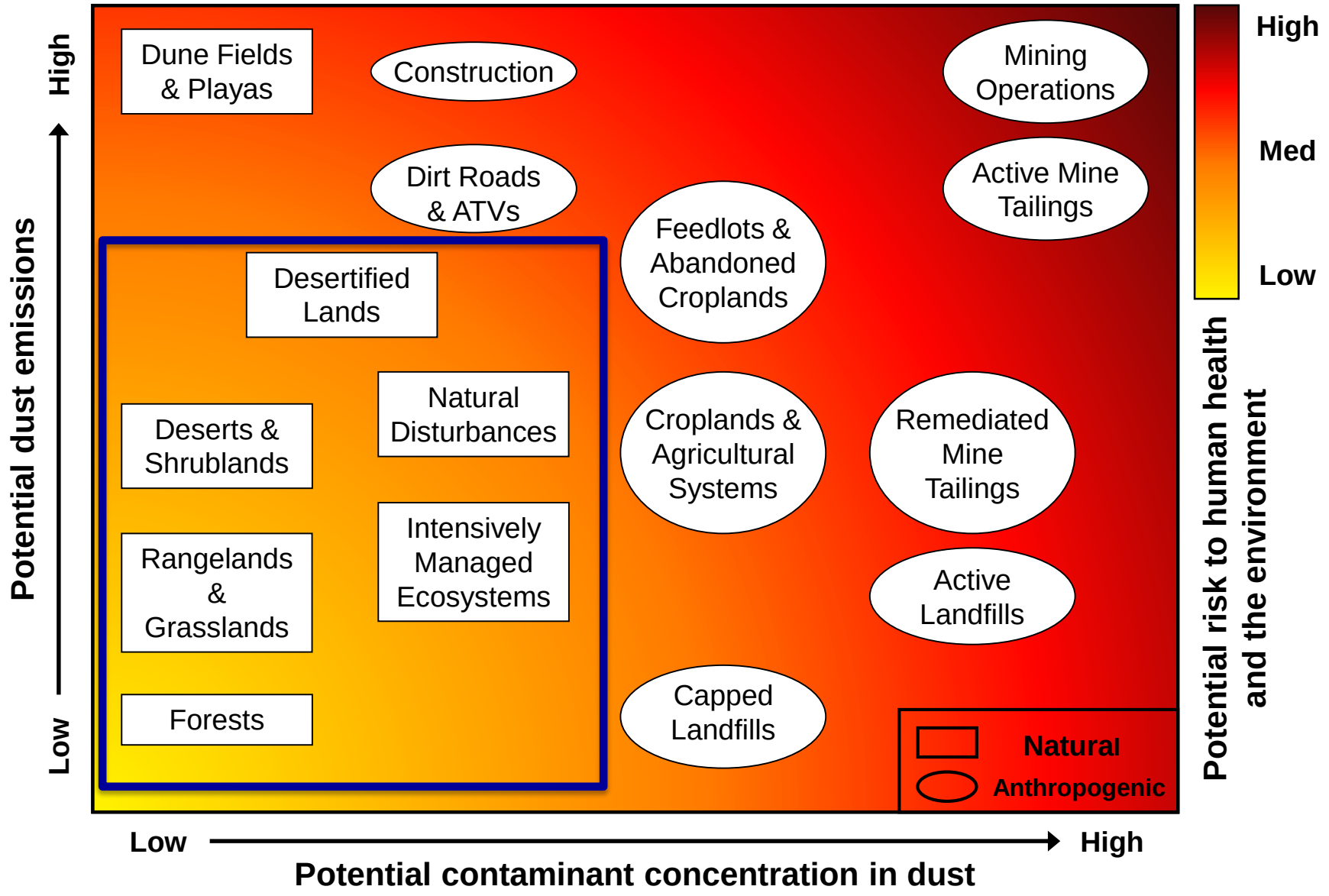
Characterizing Dust Emission Hotspots

Most probable locations and conditions for dust emission hotspots (from Gillette 1999):

1. Unvegetated and free of gravel
2. Sandy sediments
3. Long fetch length
4. Smooth surface roughness (z_0)
5. Disturbed sediment
6. Lacking soil moisture/aggregates
7. Thick sediment deposits
8. Strong meso-scale winds
9. Topographically-forced wind convergence

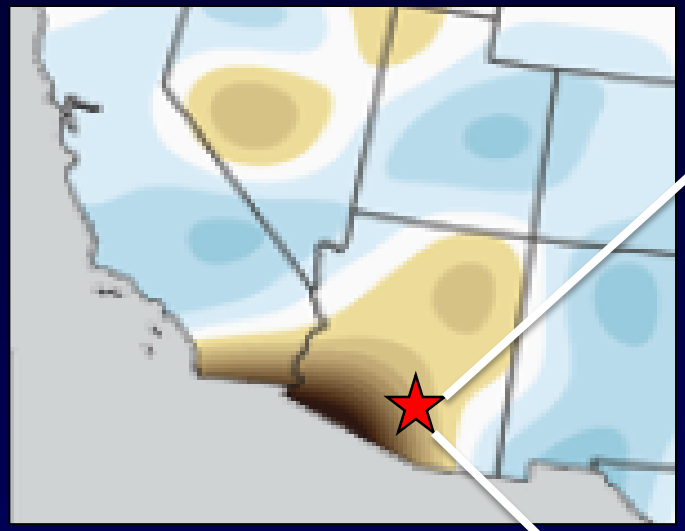


Natural and Anthropogenic Sources of Dust



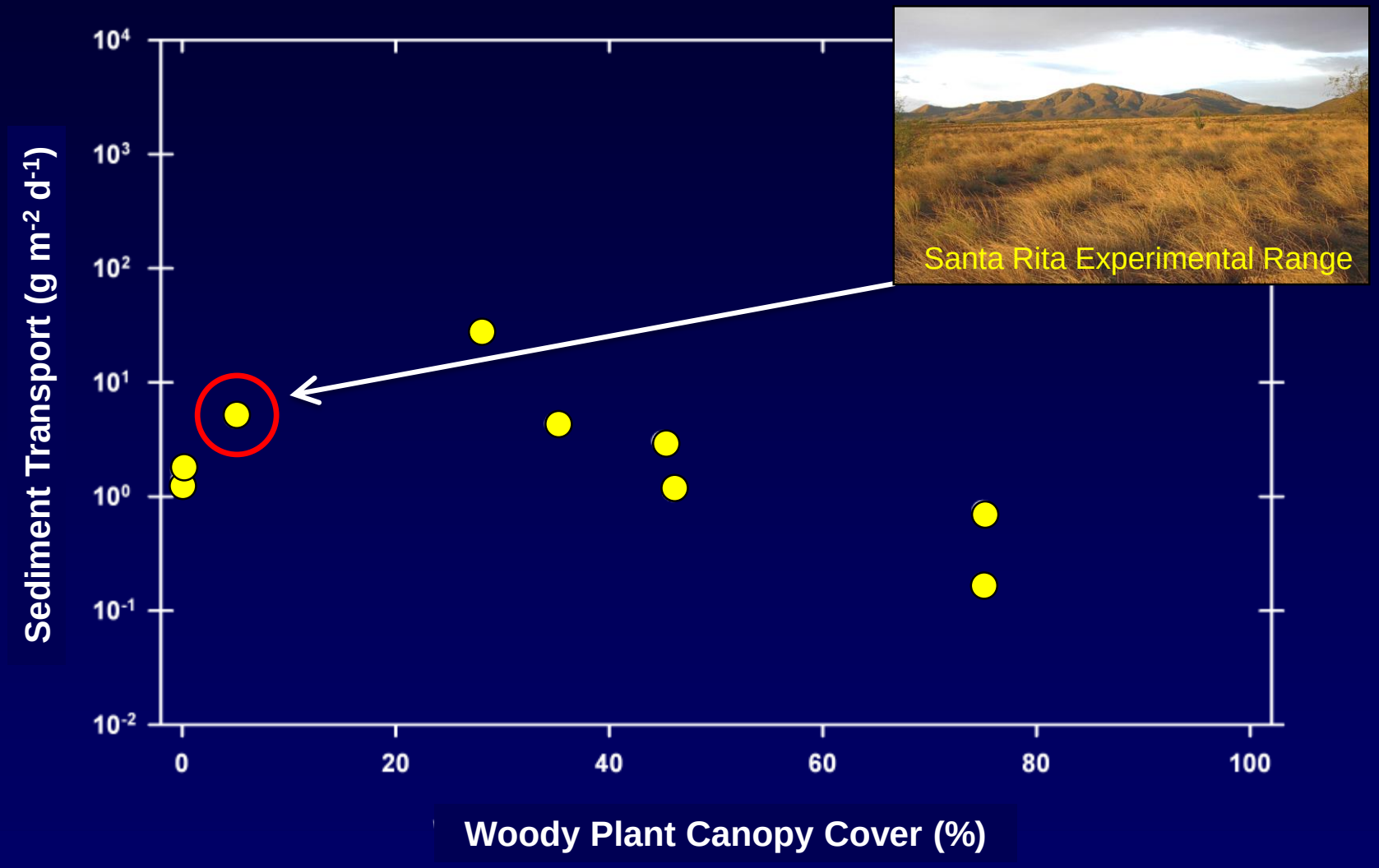
Csavina et al. 2012

Dust Emission Hotspots: Land Use and Climate



- Study site: **Santa Rita Experimental Range, AZ**
- Annual precipitation: **350 mm**

Dust Emission Hotspots: Land Use and Climate



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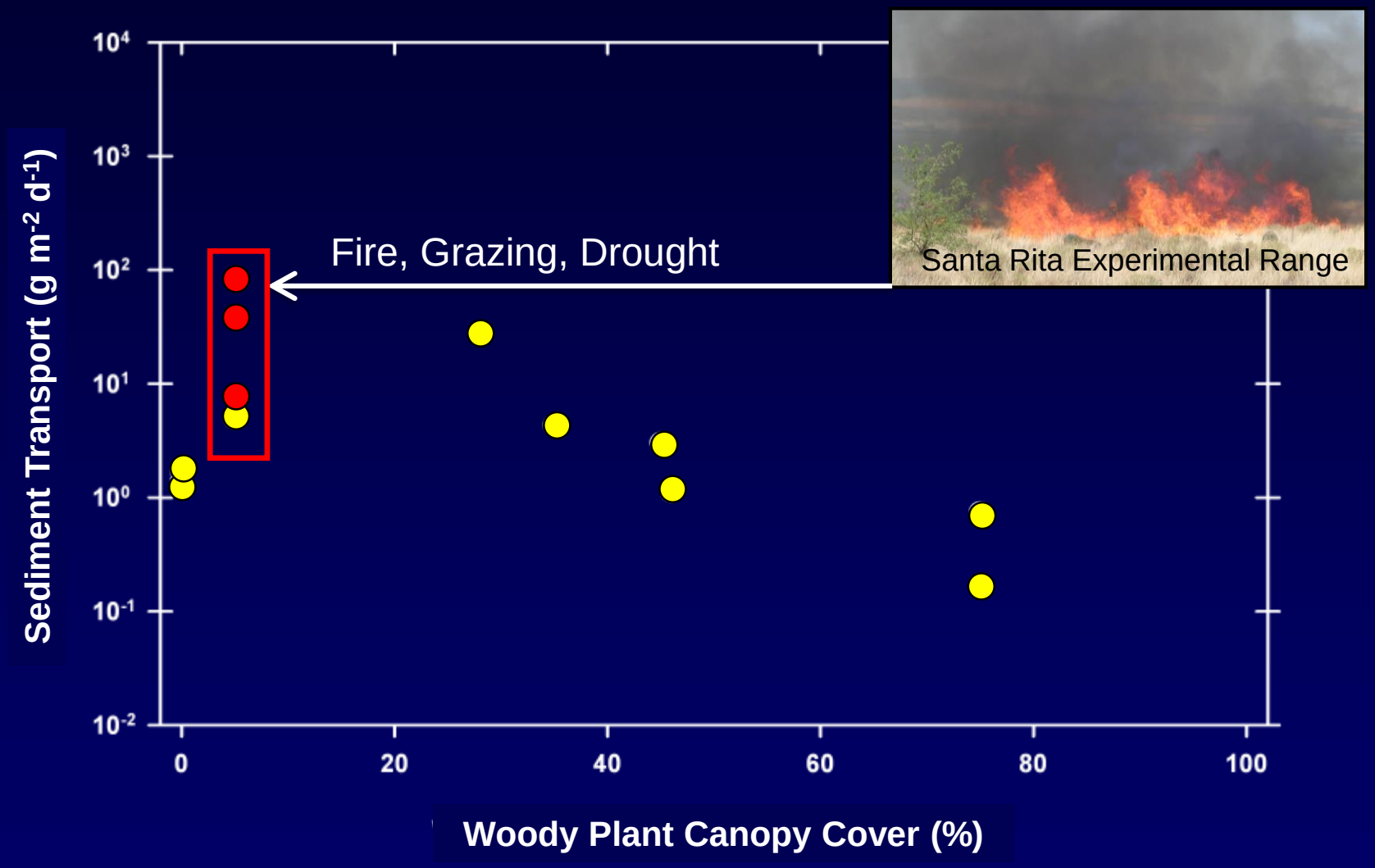

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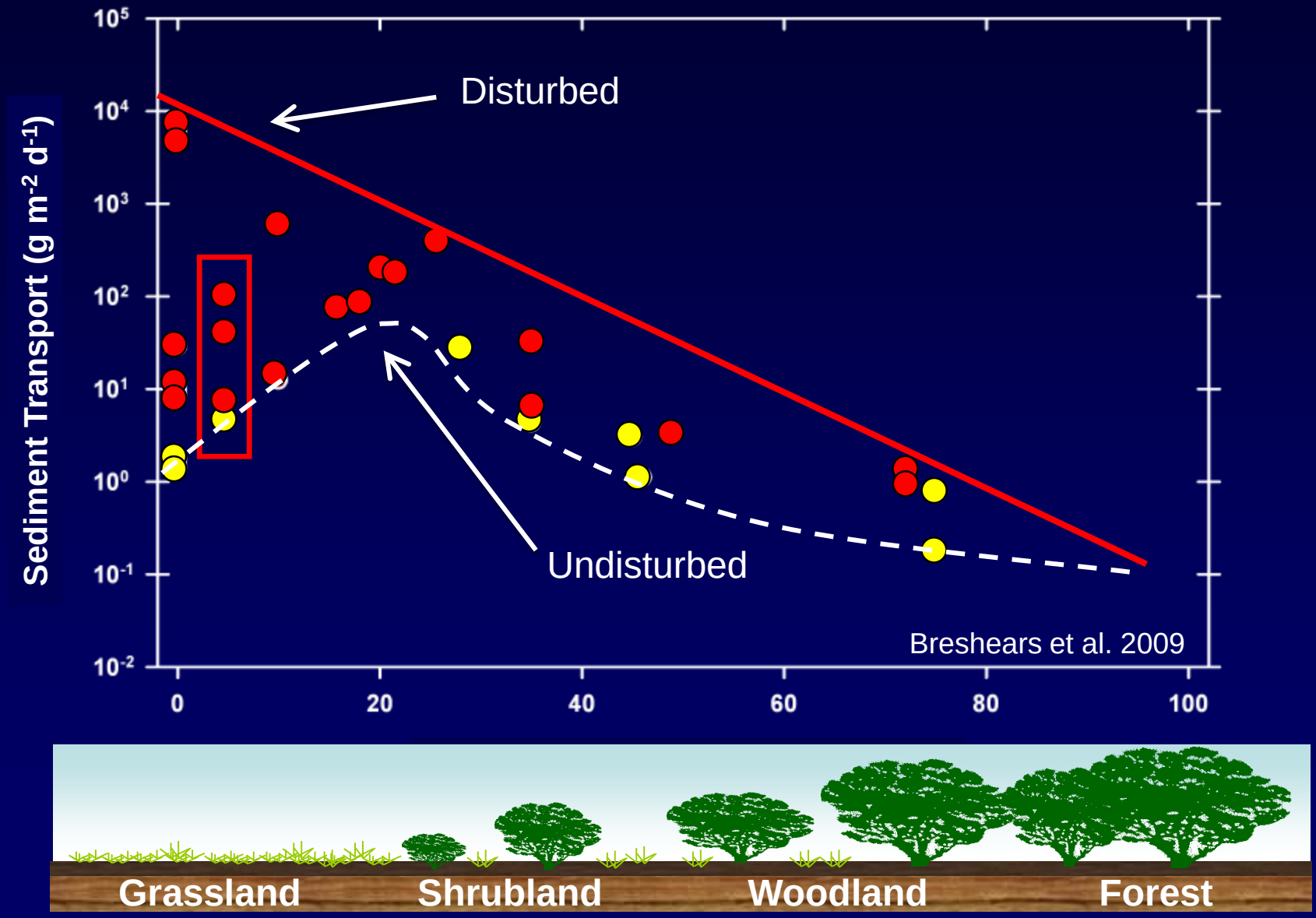
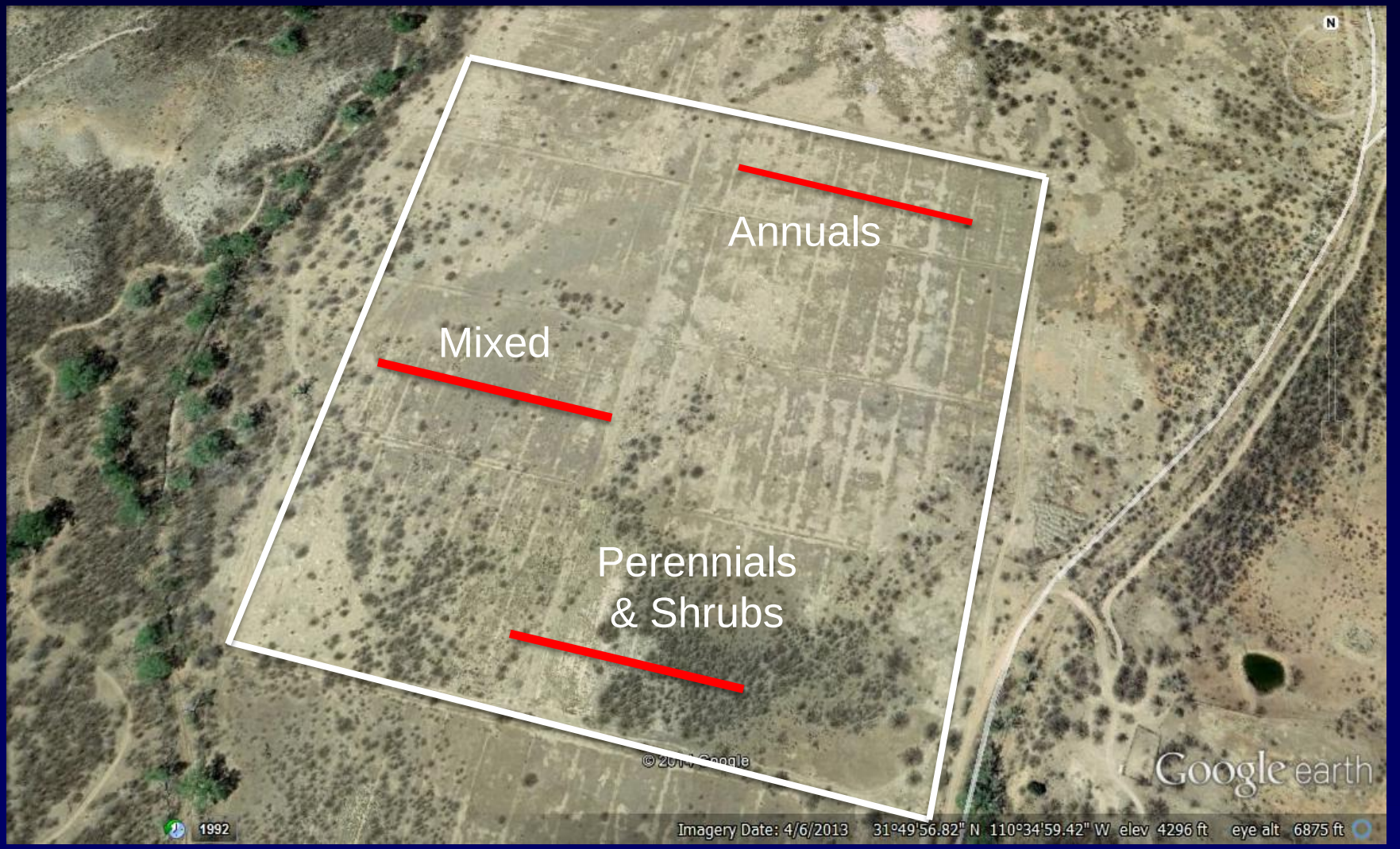


Dust Emission Hot Spots: Las Cienegas NCA, Arizona



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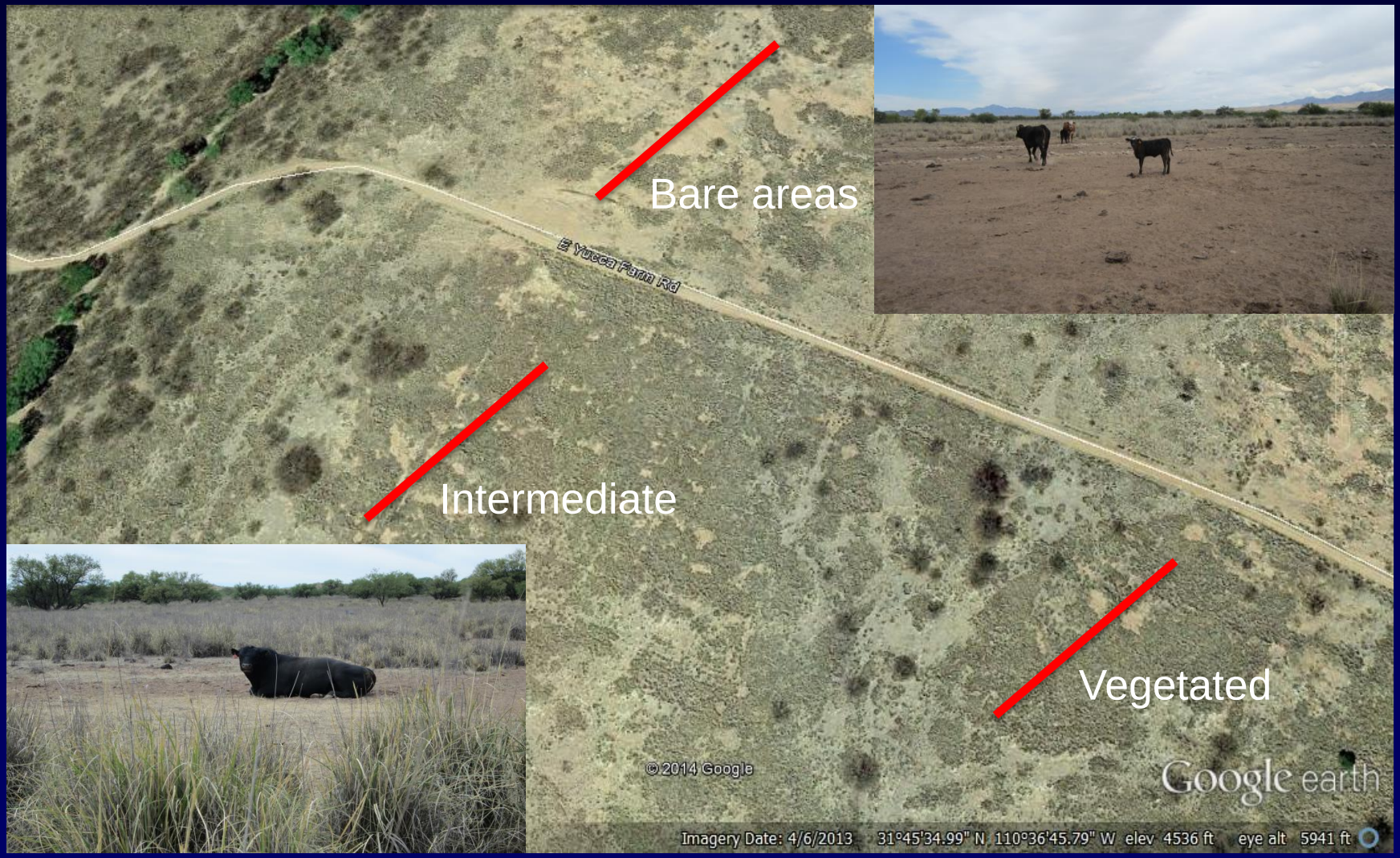

Dust Emission Hot Spots: Las Cienegas NCA, Arizona

Sediment Transport (g m^{-2} d^{-1})

10^{5}
10^{4}
10^{3}
10^{2}
10^{1}
10^{0}
10^{-1}
10^{-2}

0 20 40 60 80 100

Woody Plant Canopy Cover (%)

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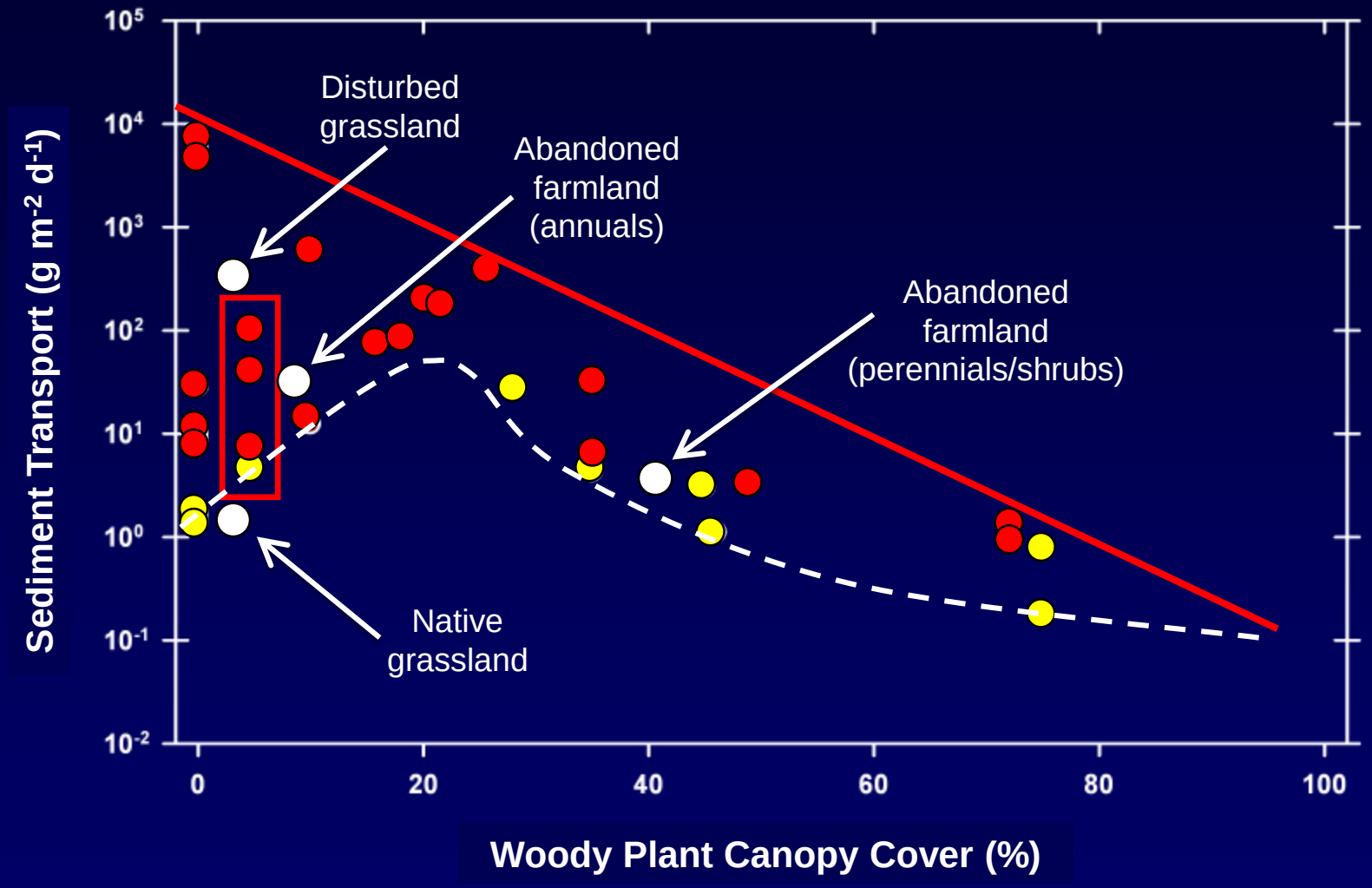

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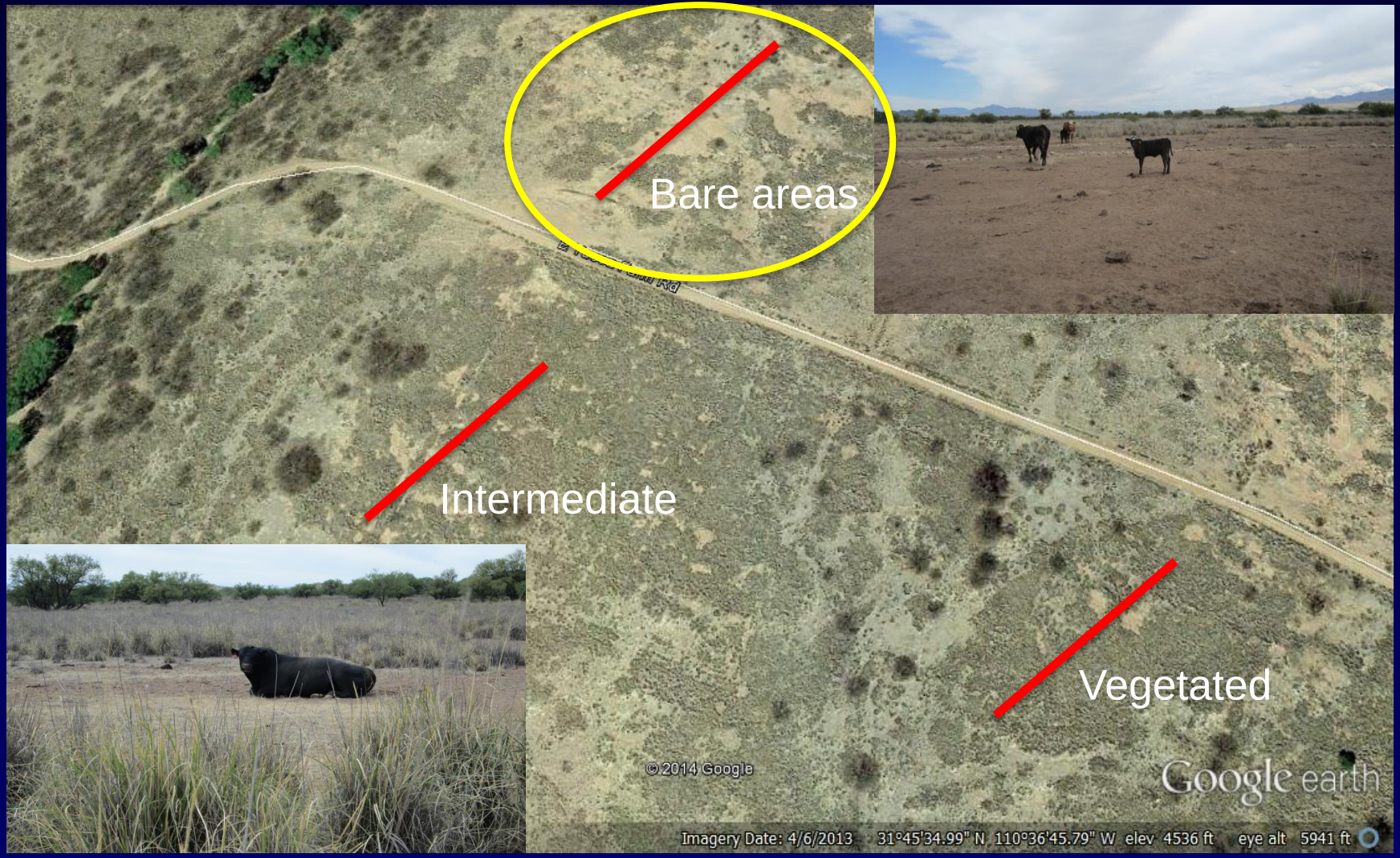
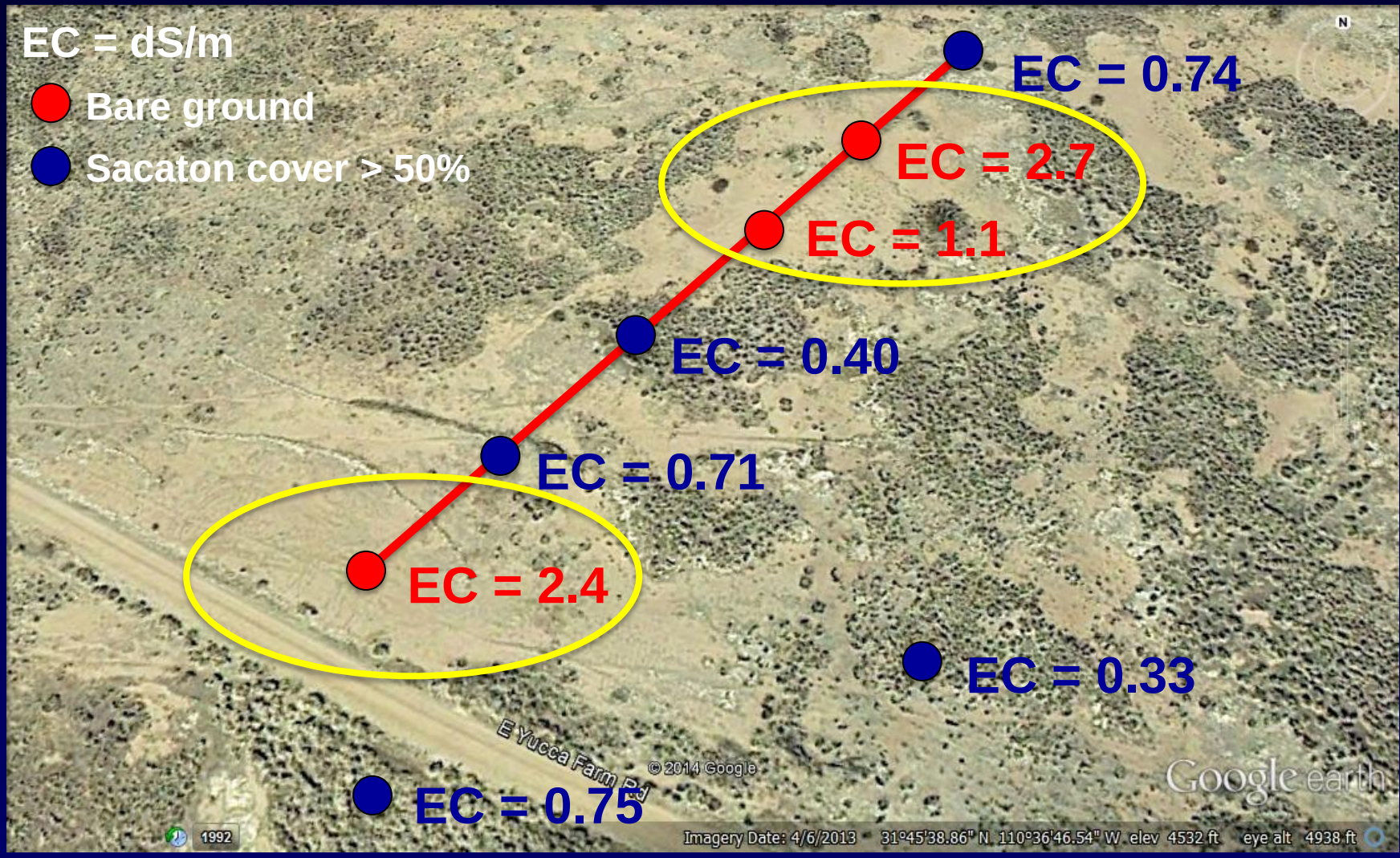
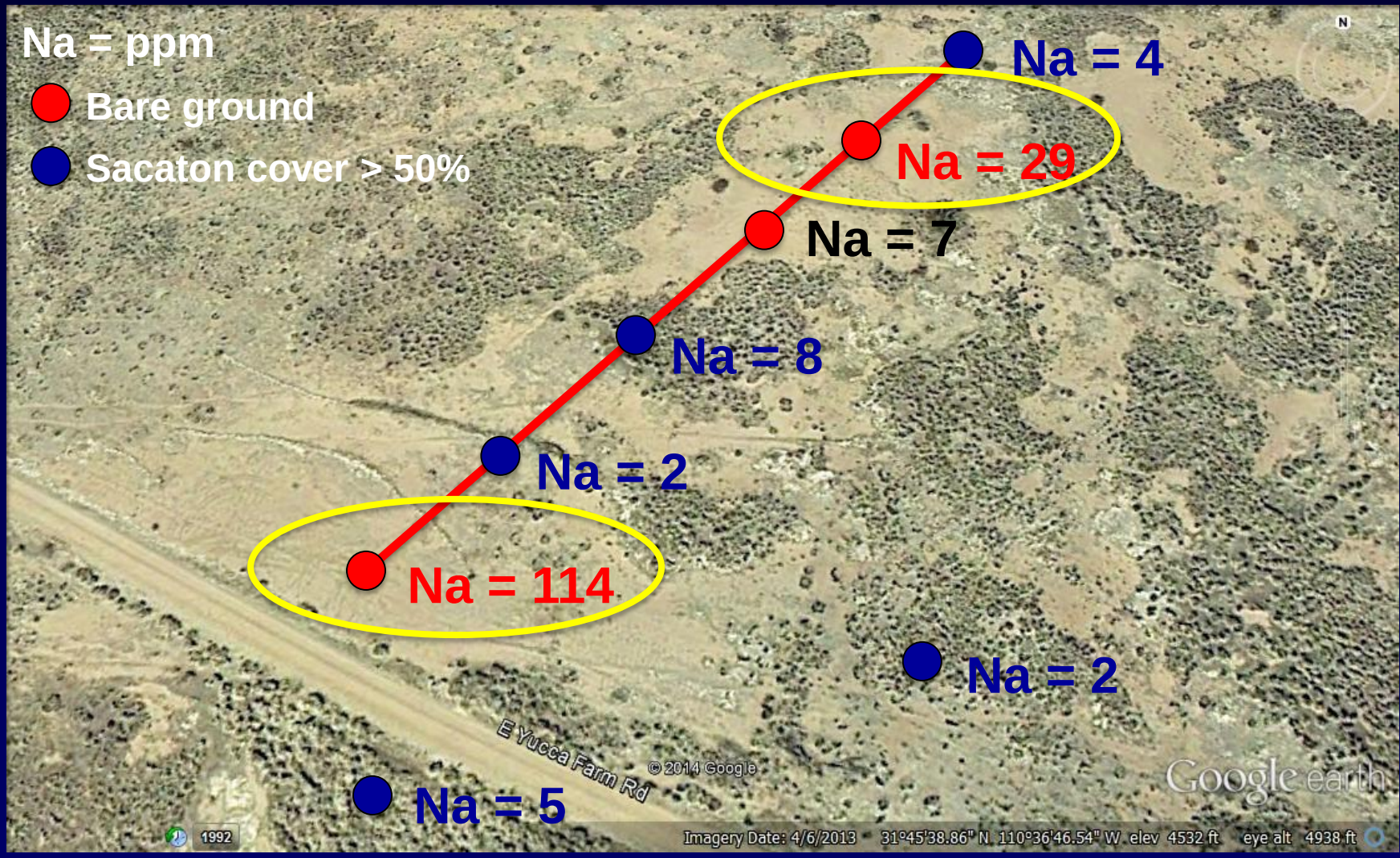


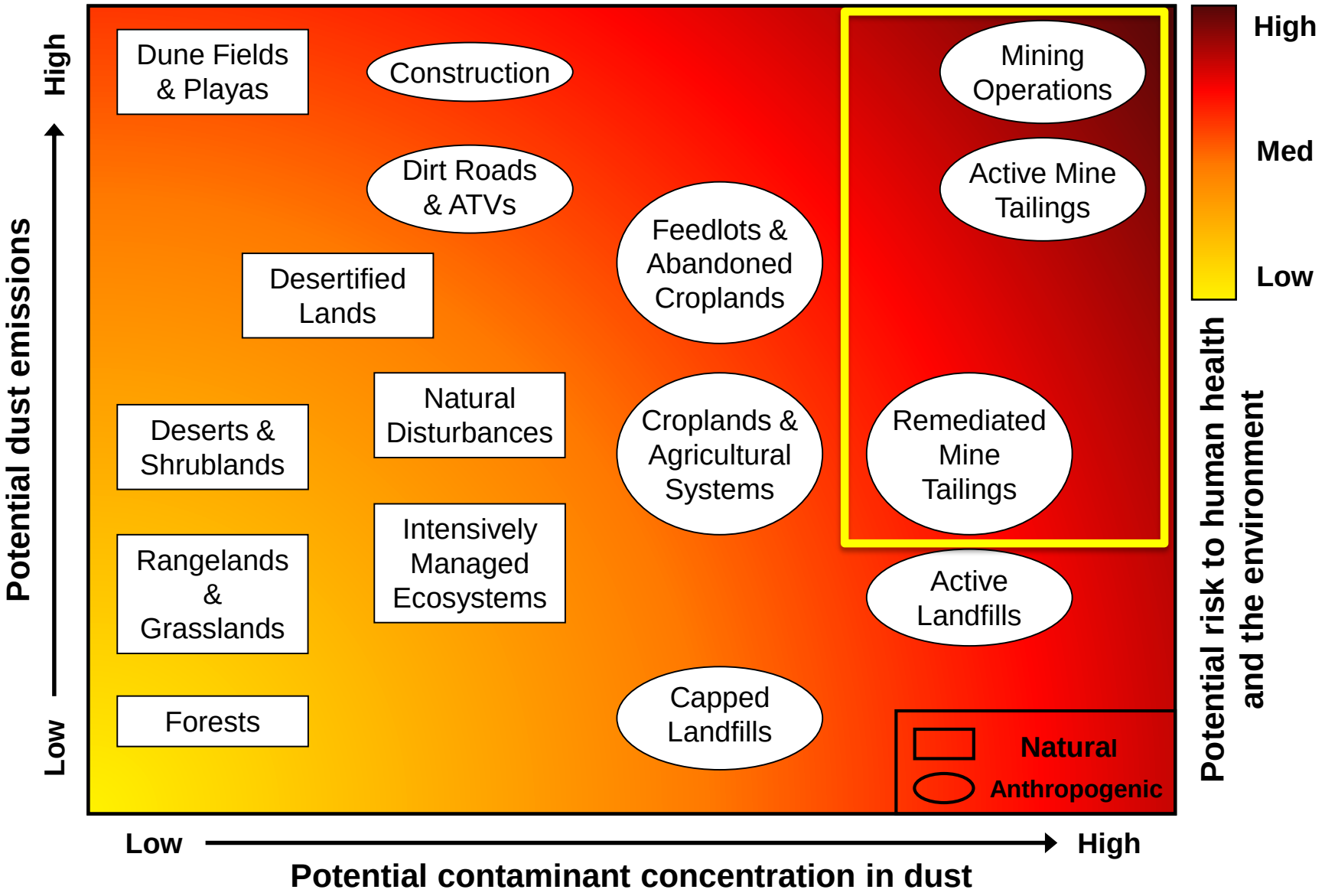
Sacaton grassland soil salinity: Preliminary results



Na concentration in soil: Preliminary results



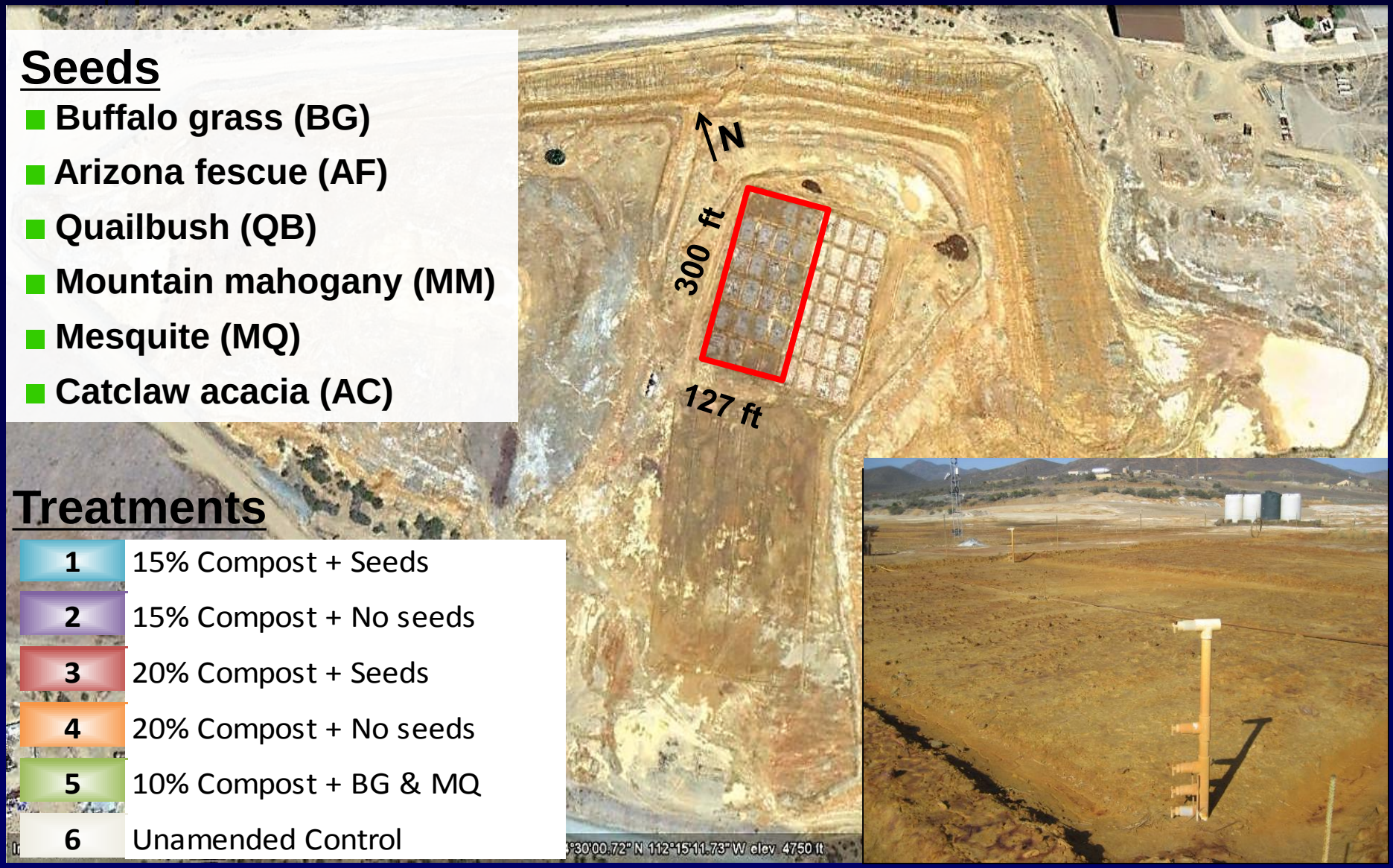
Natural and Anthropogenic Sources of Dust



Iron King Superfund Site at Dewey-Humboldt, Arizona

Seeds

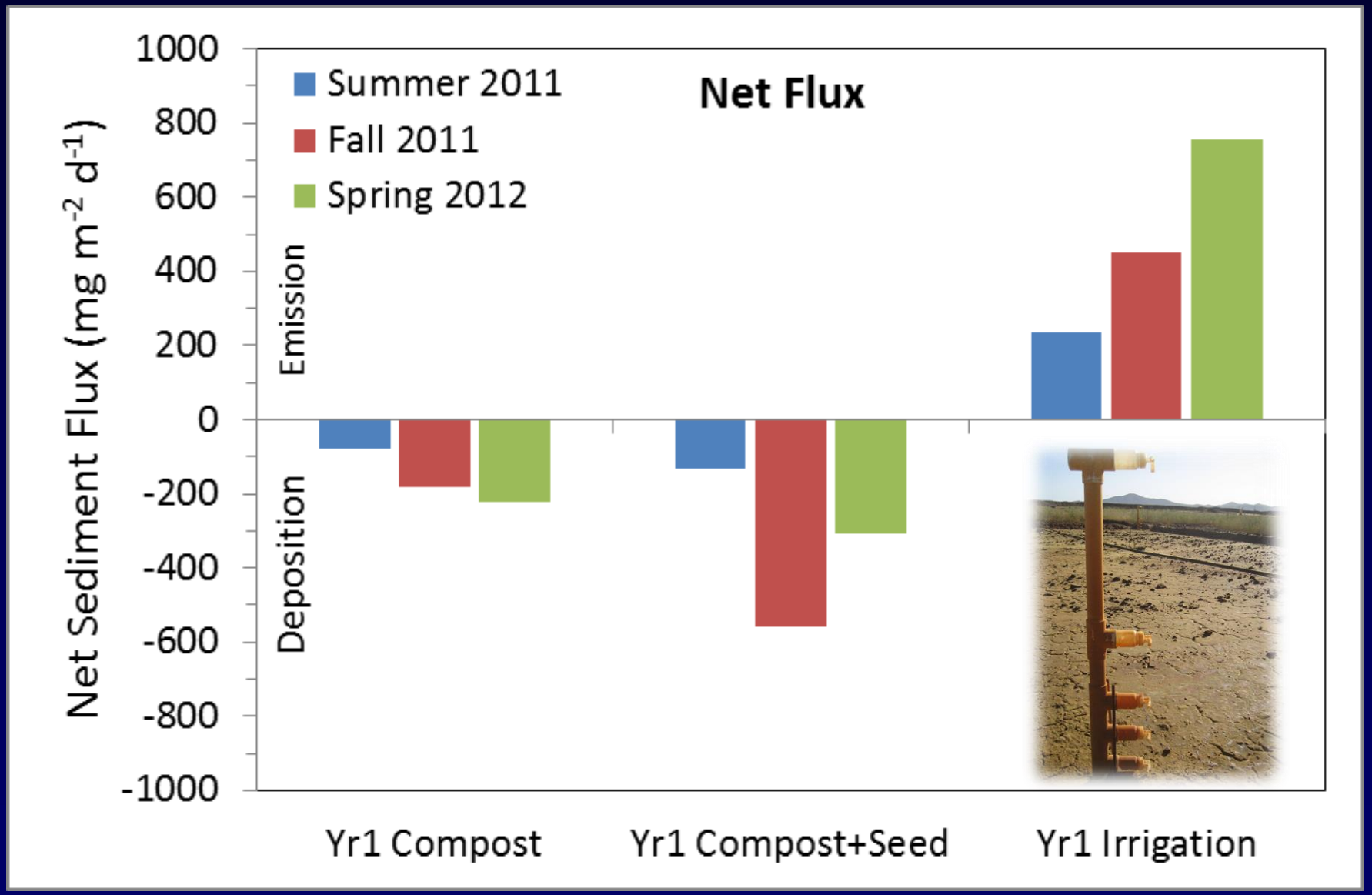
- Buffalo grass (BG)
- Arizona fescue (AF)
- Quailbush (QB)
- Mountain mahogany (MM)
- Mesquite (MQ)
- Catclaw acacia (AC)



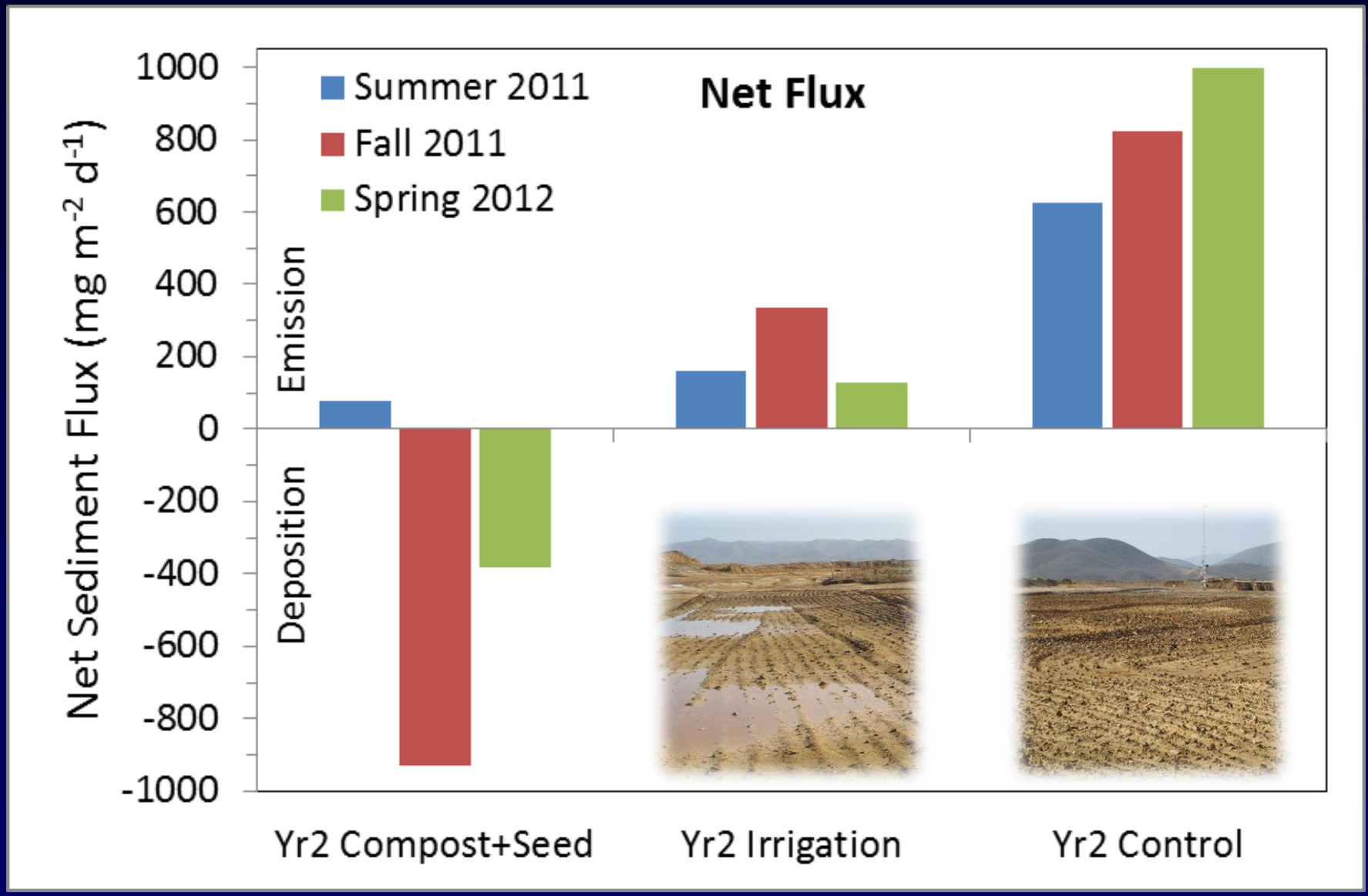
Treatments

1	15% Compost + Seeds
2	15% Compost + No seeds
3	20% Compost + Seeds
4	20% Compost + No seeds
5	10% Compost + BG & MQ
6	Unamended Control

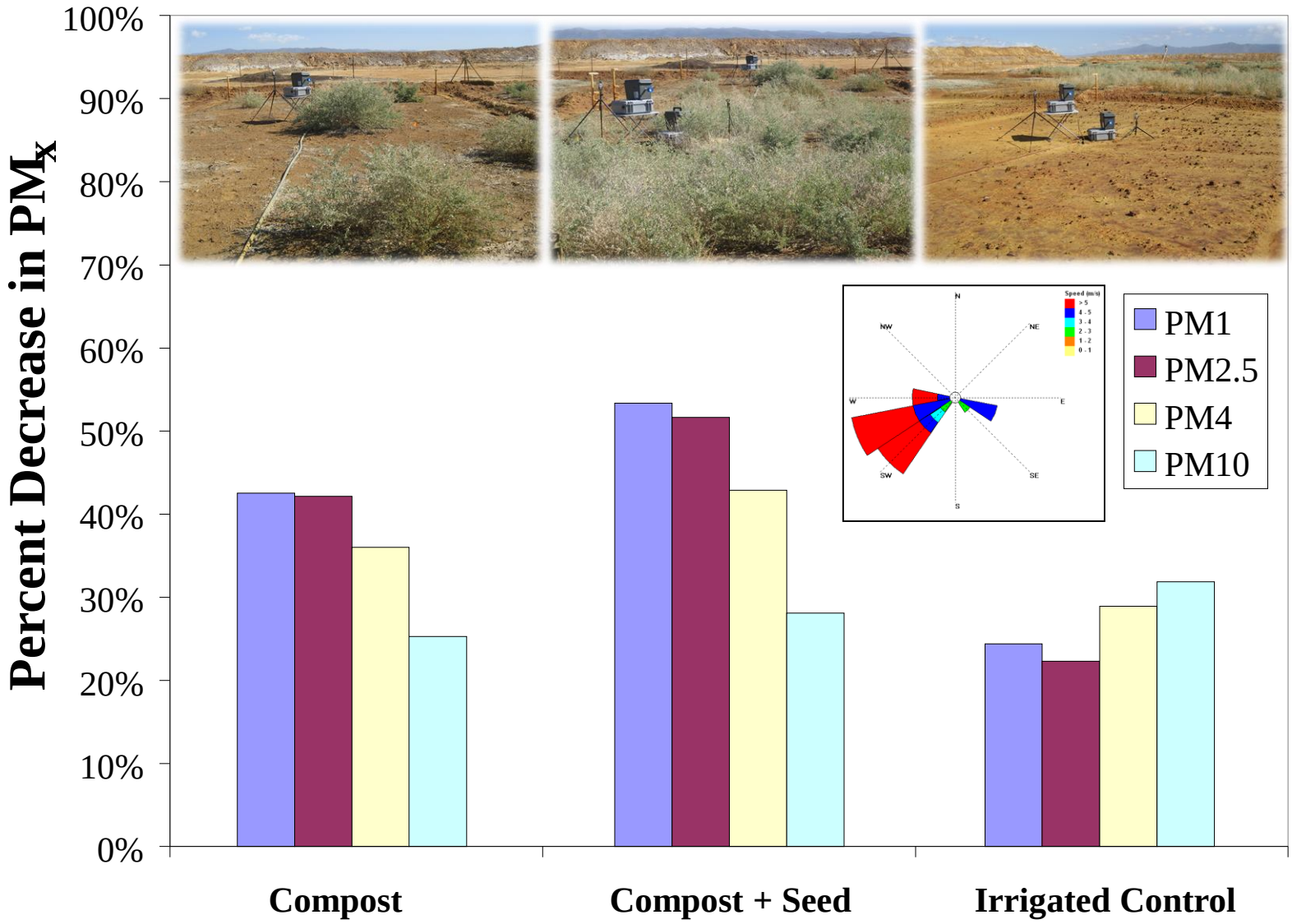
Results for Passive Dust Samplers (Phase I)



Results for Passive Dust Samplers (Phase II)



Results for DustTrak Samplers (Phase I)



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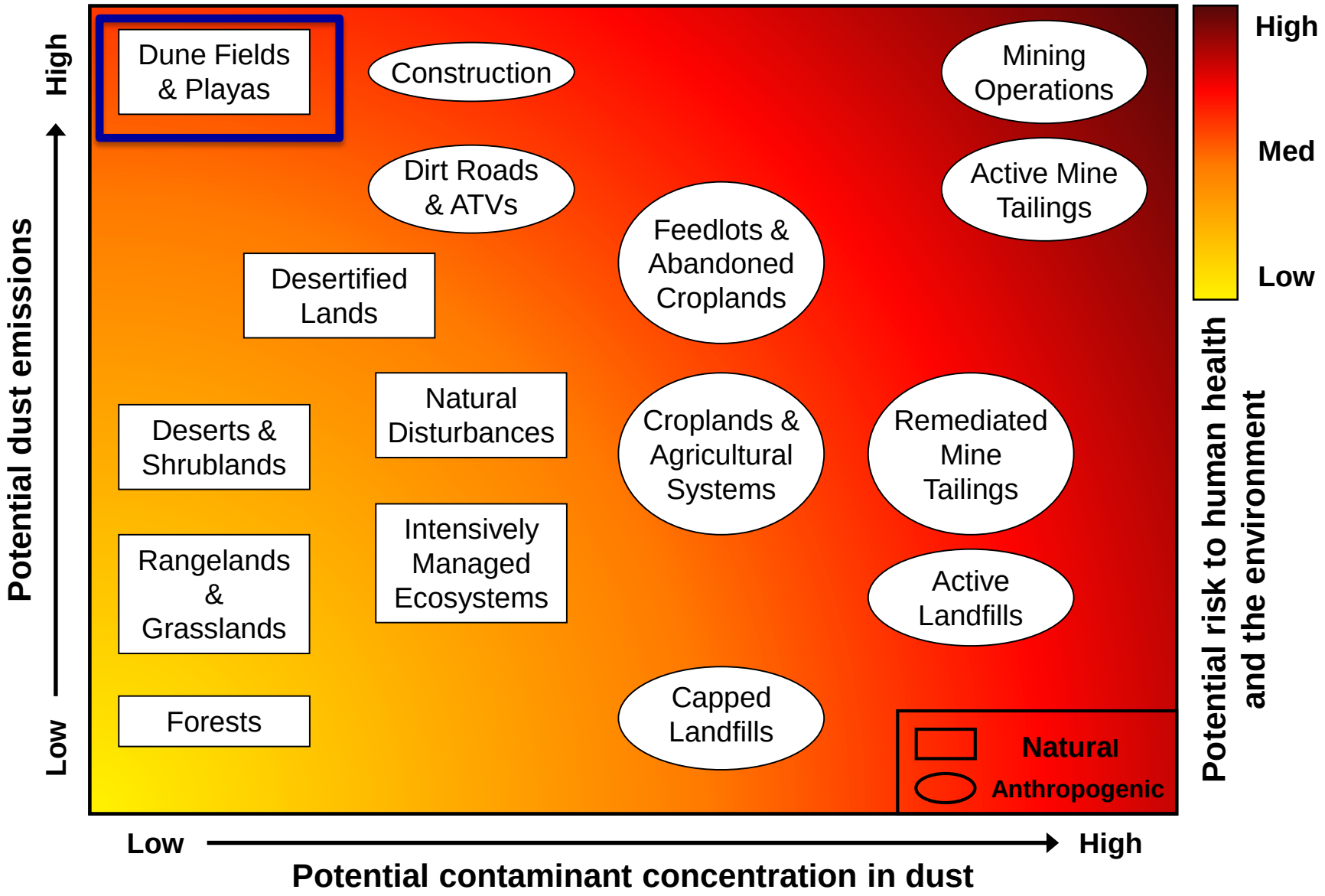
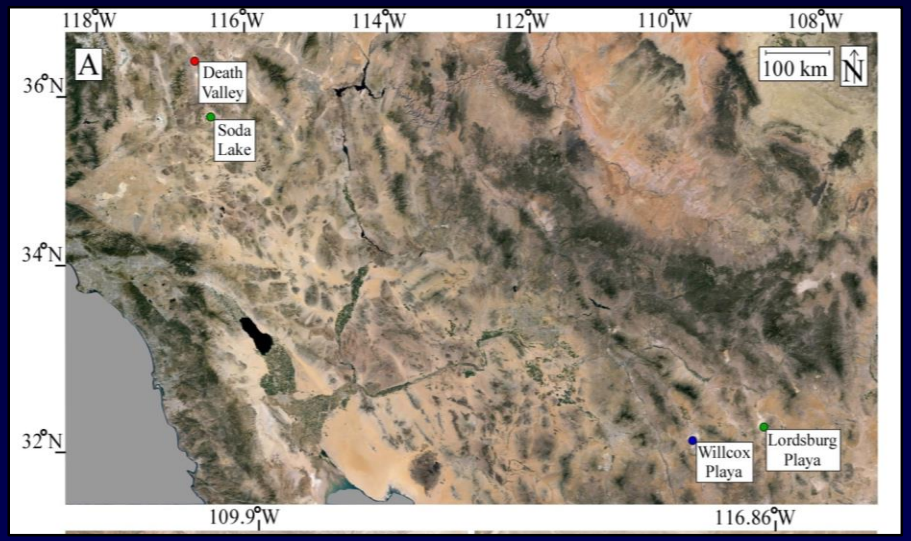
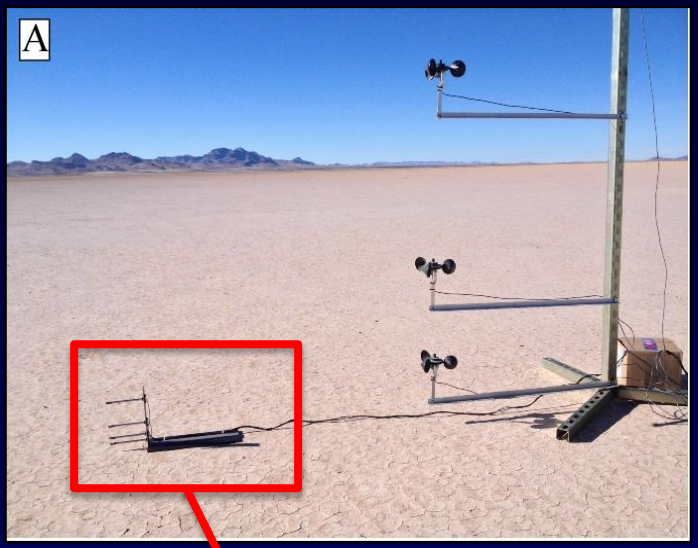
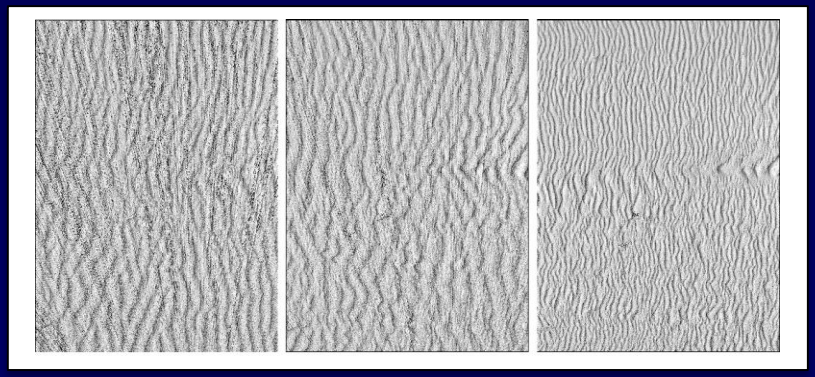


Dust Emission Hot Spots: Playas







Pelletier and Field 2015

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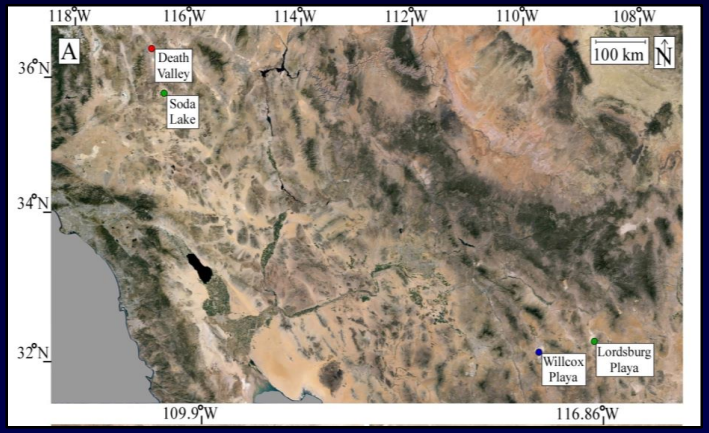
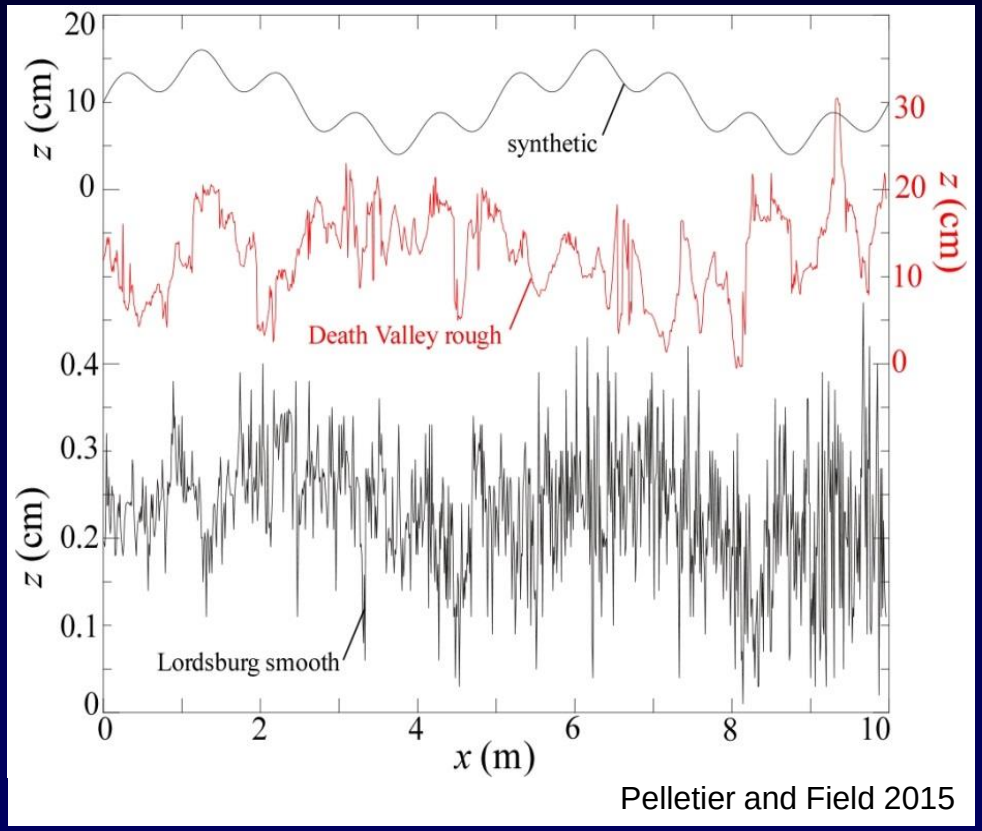




Pelletier and Field 2015

Law of the Wall

$$u(z) = \frac{u_*}{\kappa} \ln\left(\frac{z}{z_0}\right)$$

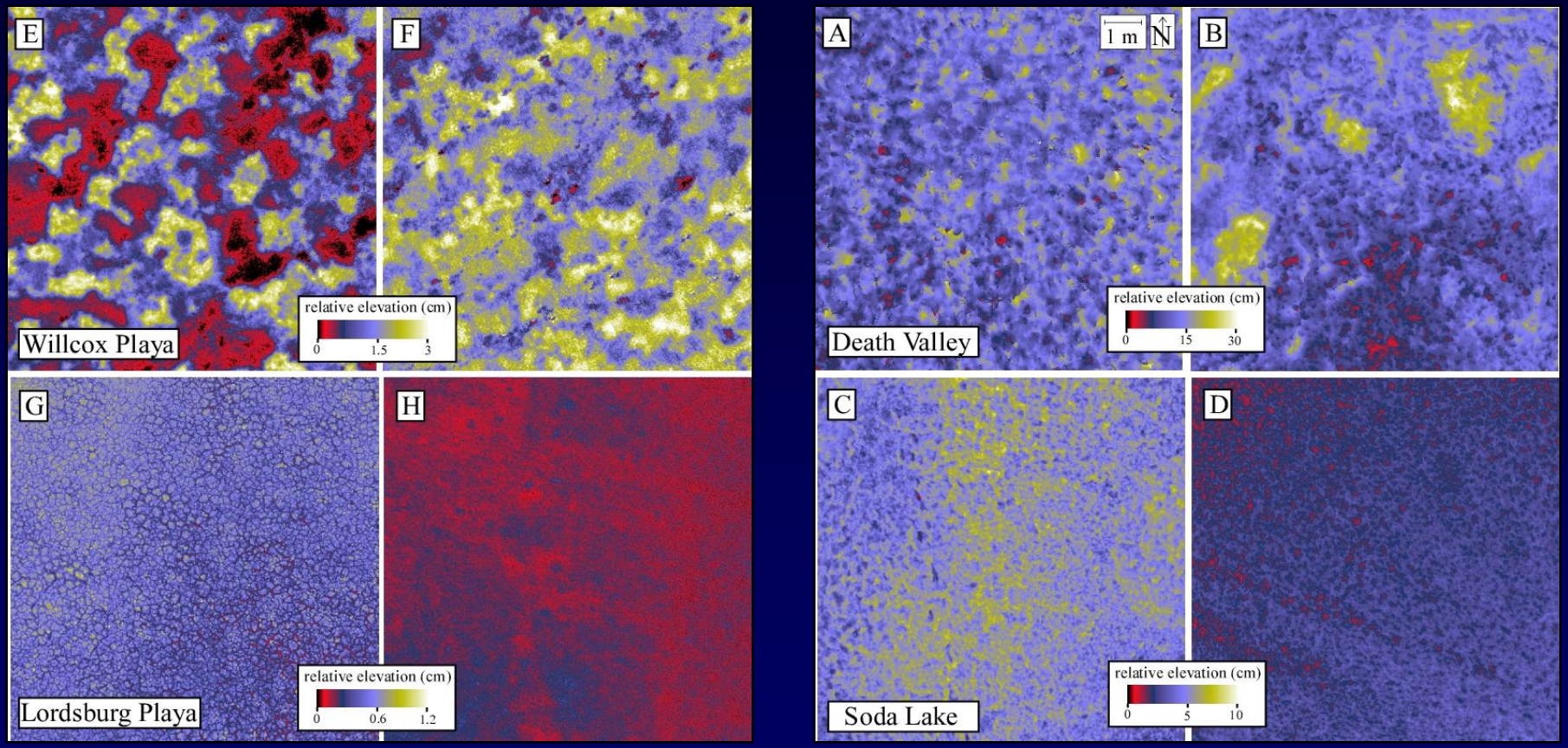
***u*(z)** = fluid velocity at height z above the bed

u_* = shear velocity

κ = von Kármán constant (0.41)

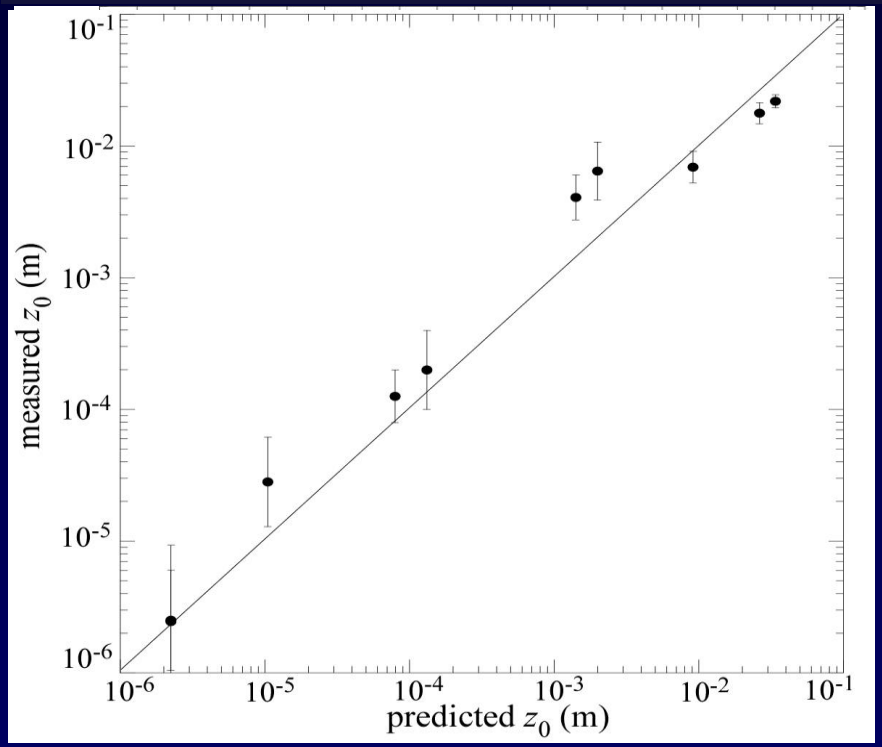
z_0 = roughness length

Dust Emission Hot Spots: Playas



Predicting Sediment Transport: Dust Models

Measured z_0 values vs. predicted



Law of the Wall

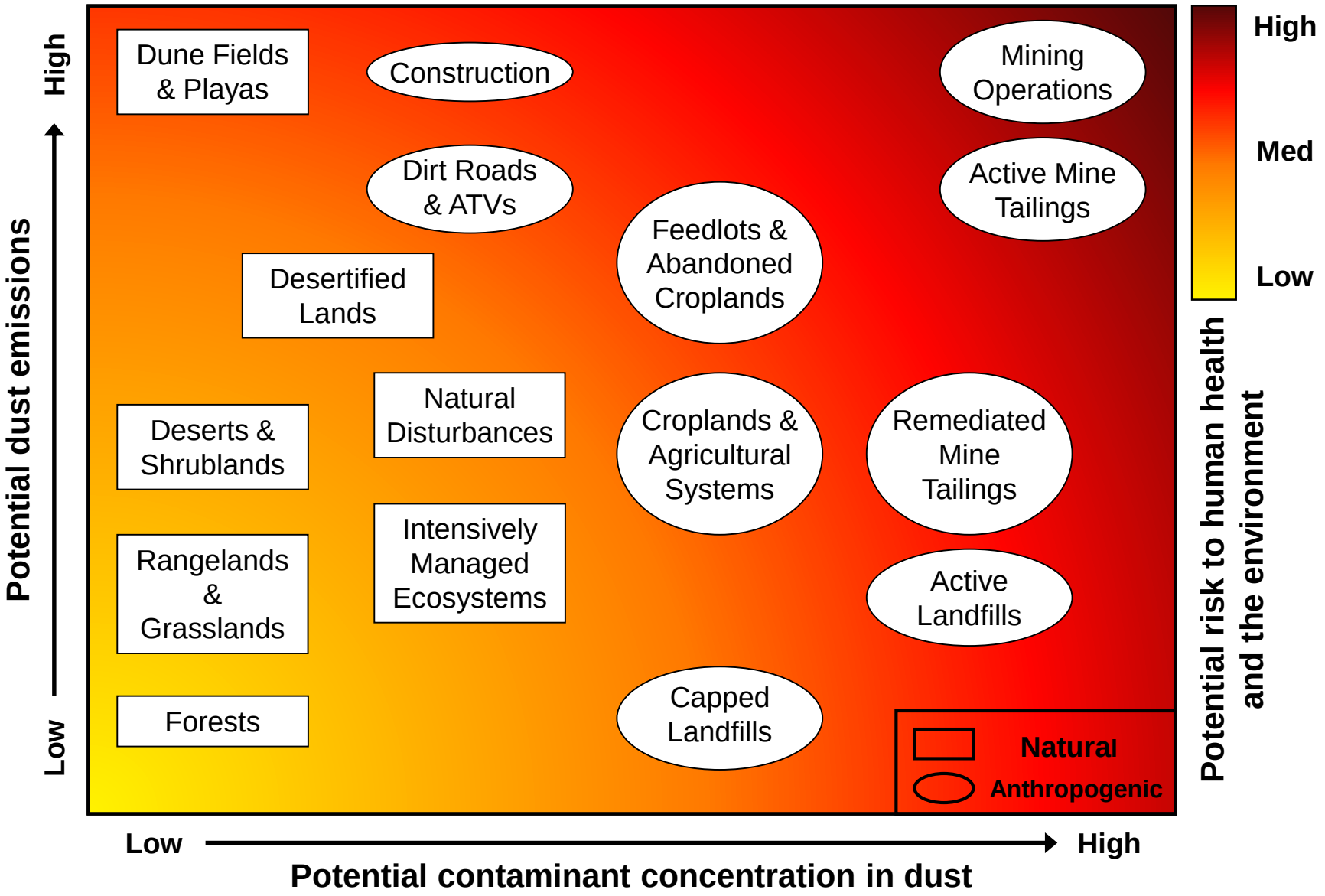
$$u(z) = \frac{u_*}{\kappa} \ln\left(\frac{z}{z_0}\right)$$

New equation for predicting *Roughness Length* (z_0) over multi-scale topography

$$z_0 = z_{0g} + \frac{c_1 a}{1 + (c_2 / S)^{c_3}}$$

Pelletier and Field 2015

Natural and Anthropogenic Sources of Dust



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