Land classification for ecological applications: Ecological Site Descriptions

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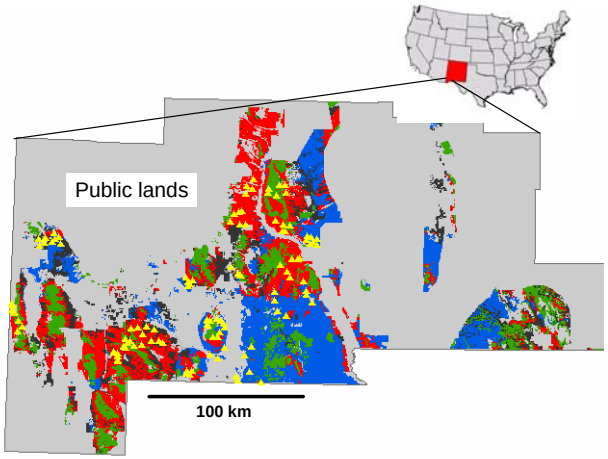
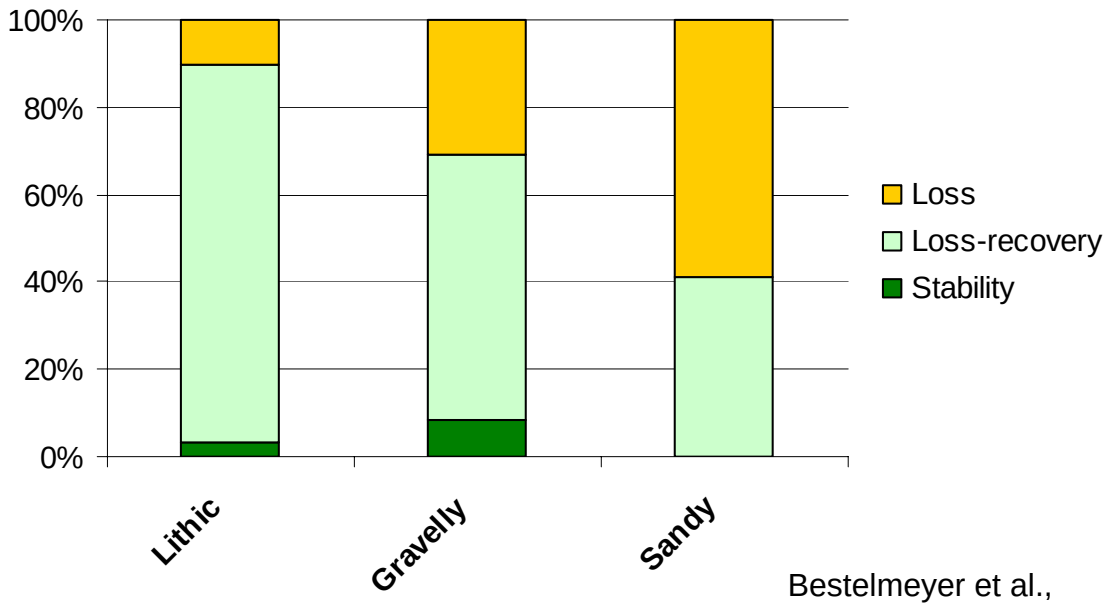
Why is grassland degradation so spatially variable? How should our management targets vary across space?

Subtle soil variation governs vegetation potential and desertification likelihood

Regional patterns of degradation on different geomorphic units



Grass dynamics in 123
trend plots: ca. 1970-2003



Bestelmeyer et al.,
J. Arid Env., 2006

Dynamics differ predictably on different soils

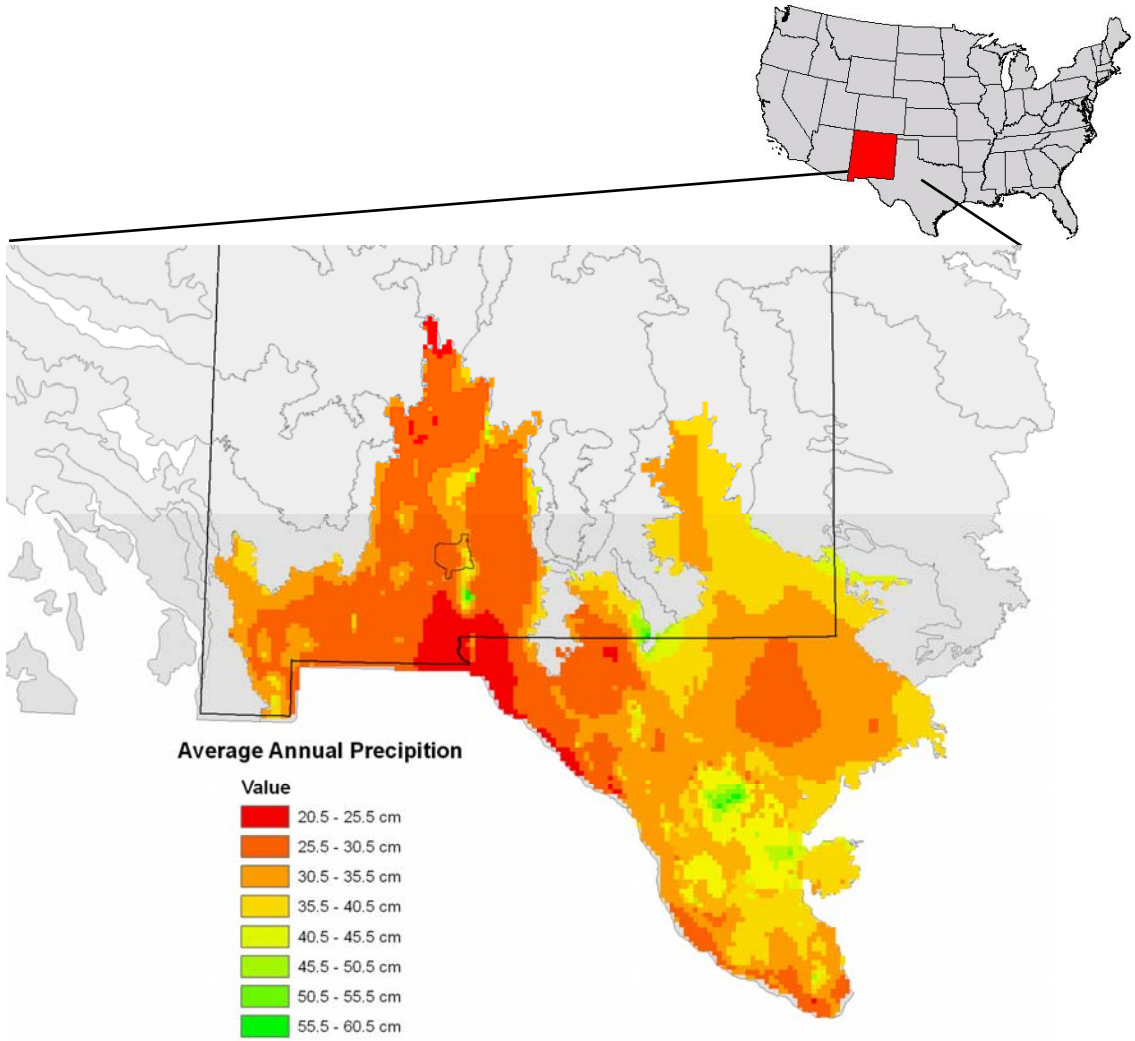
Geomorphic position conditions vegetation dynamics:

Erosion and deposition processes depend on landscape context

Active alluvial fan (gravelly soils)

Relict, dissected alluvial fan (gravelly soils)

Ecological site classification: climate zones

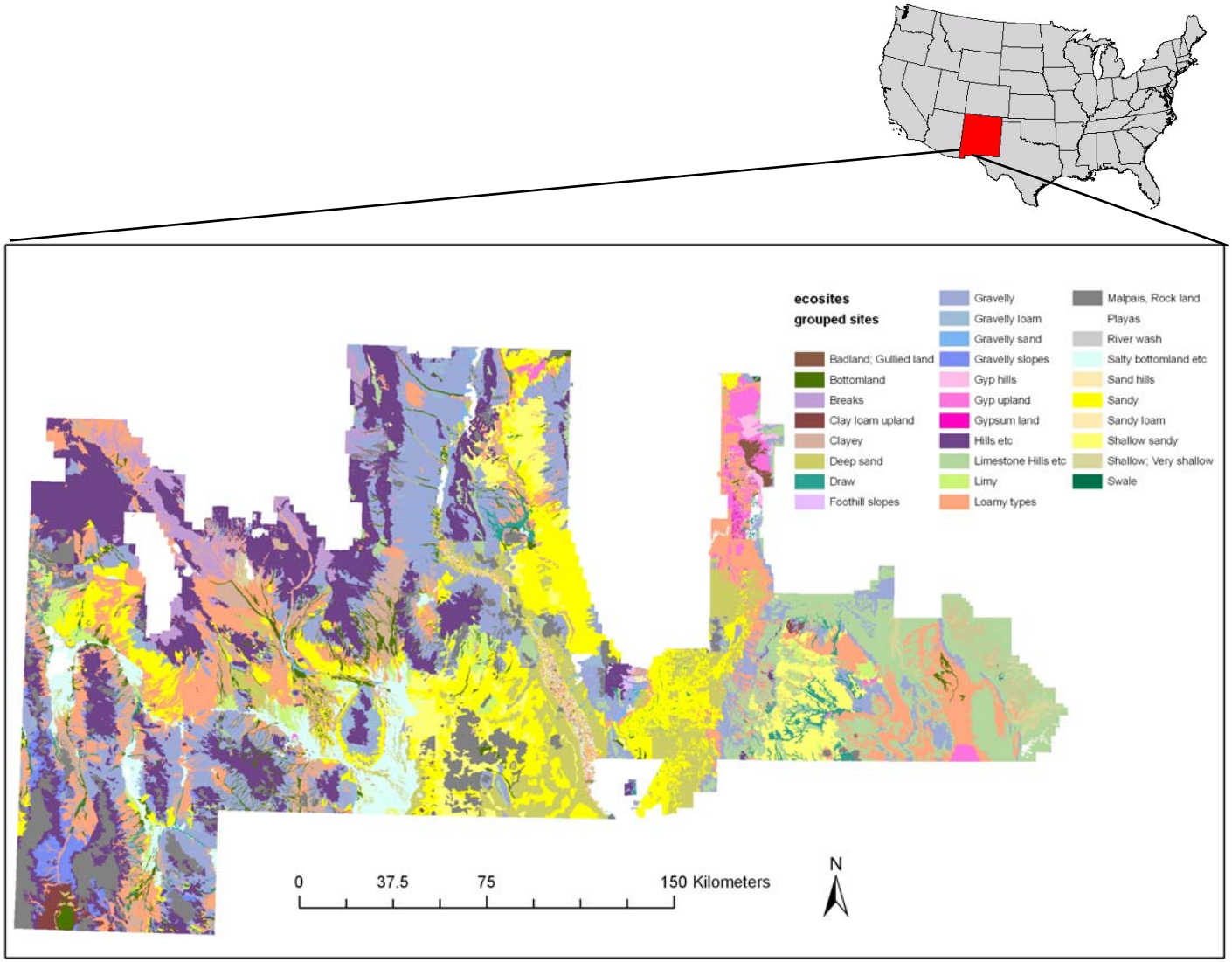


In general, 5 cm increments of mean annual precipitation alter degradation frequency

Ecological site classification: soil variables within climate zones

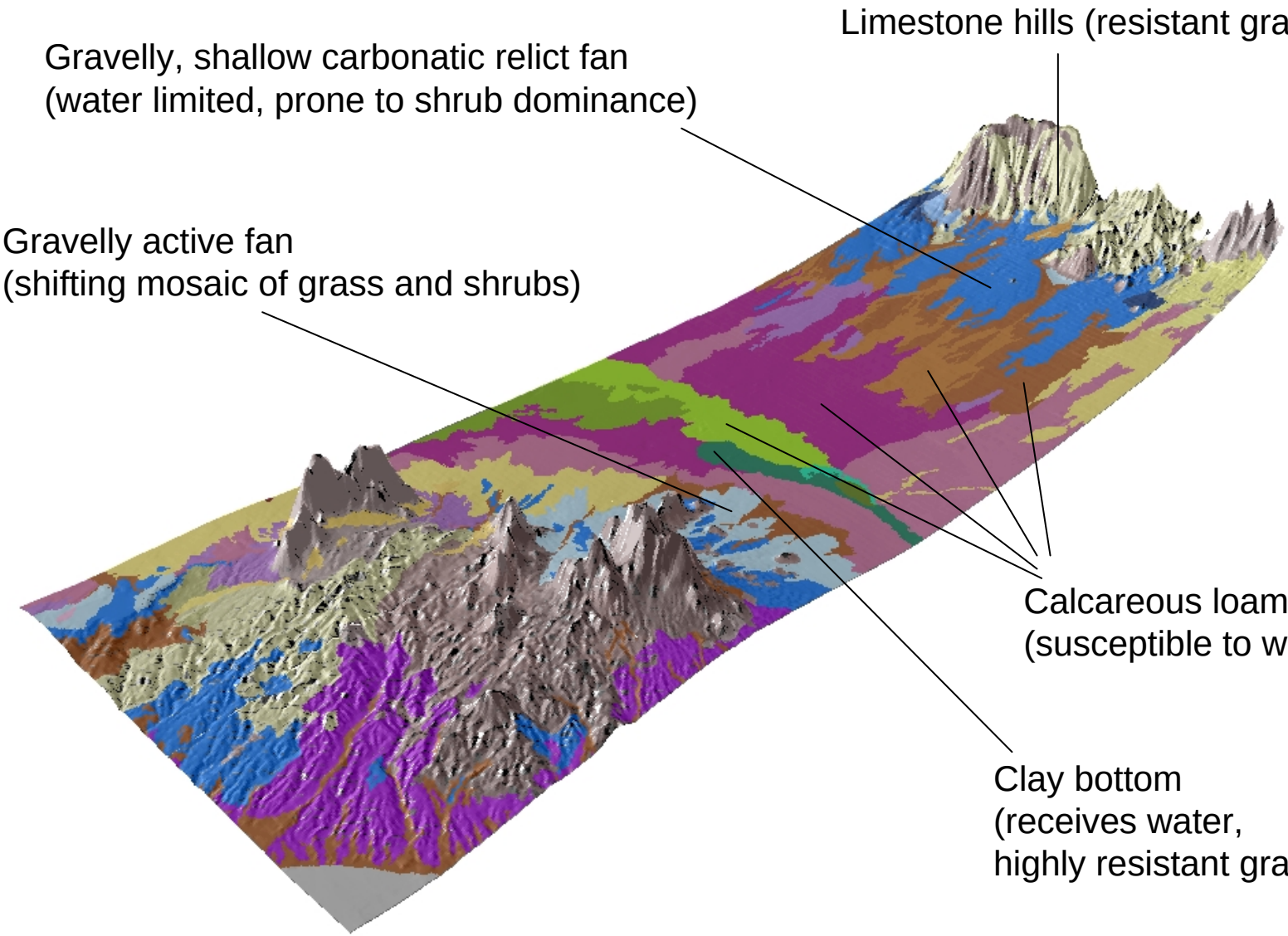
Type	*Variable*	*Example contrast*
Hydrology		
	Water table depth (ft.)	Salt meadow vs Salt flats
	Flooding duration (days)	Bottomland vs. Draw
Soil physical properties		
	Soil texture of surface (class)	Clay loam vs. Clayey upland
	Fragment content (%)	Gravelly loam vs. Loamy
	Argillic horizon development (class)	Loamy sand vs. Sandy loam
	Soil depth to restrictive layer (cm)	Sandy vs. Shallow sandy
Lithology/geology		
	Bedrock type (class)	Limestone Hills vs. Igneous
Topography/landform		
	Landscape position (class)	Limy upland vs. Limy slopes
Chemistry		
	Soil salinity/sodicity (mmhos)	Salt flats vs. Loamy
	Soil gypsum content/distribution in profile (%/cm)	Gyp Upland vs. Loamy
	Soil carbonate content/distribution in profile (%/cm)	Limy vs. Loamy

Region-scale Ecological Site heterogeneity in the NM Chihuahuan Desert



Prediction of degradation and restoration requires location-specific data

Ecological sites comprise a functional landscape mosaic



Mosaic organization repeats across physiographic regions

Three kinds of vegetation/soil dynamics

"Resilient variation within states"

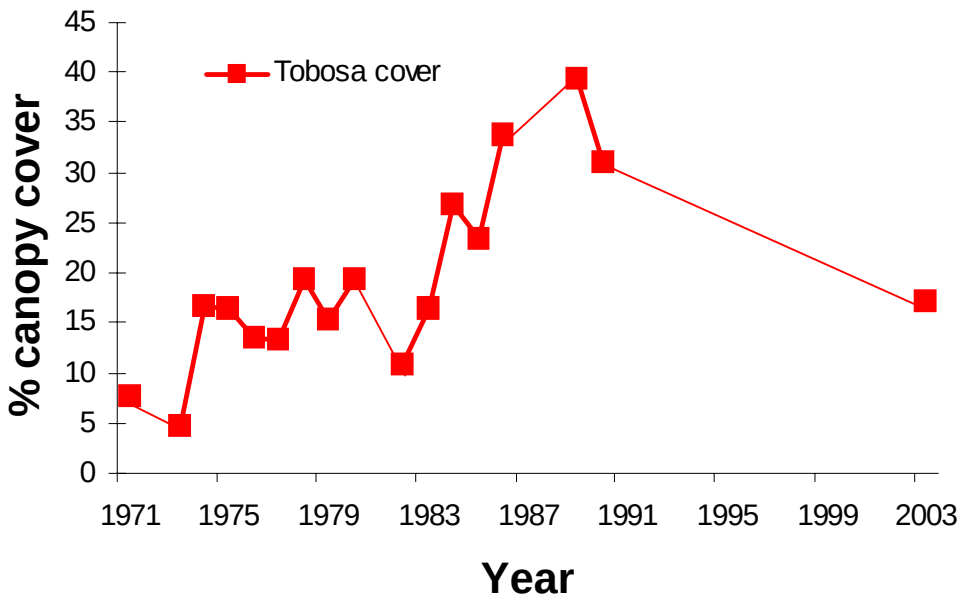
A. Reversible changes in plant abundance with changes in rainfall or disturbance pattern (grazing, fire) ~ patch dynamics

"Transition between states"

B. Changes in plant abundance that cannot be reversed until competitors or fire-adapted species are removed

C. Changes in plant abundance that cannot be reversed until erosion is stabilized and soil fertility, soil physical properties, or previous hydrology is restored.

Resilience = cover oscillation, loss and recovery

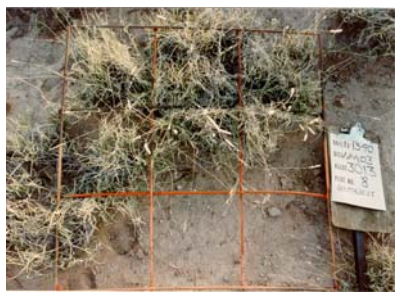


Basin floor
Clayey ecological site

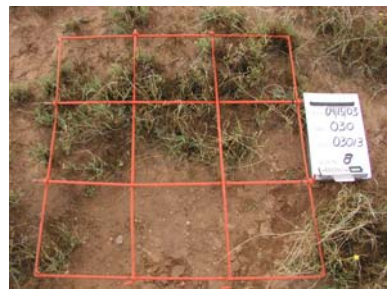
- **Recovery possible even at very low grass cover values**
- **System resistant to soil degradation**
- **System resistant to invasion**
- **Locally-driven dynamics**

1971

1980

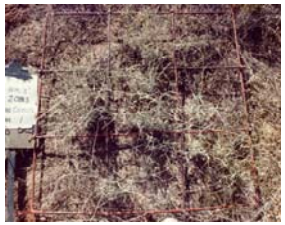


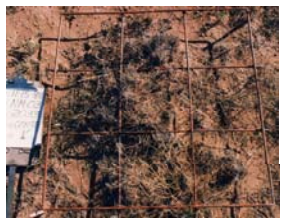
1990



2003

Transition: sediment deposition and landscape context

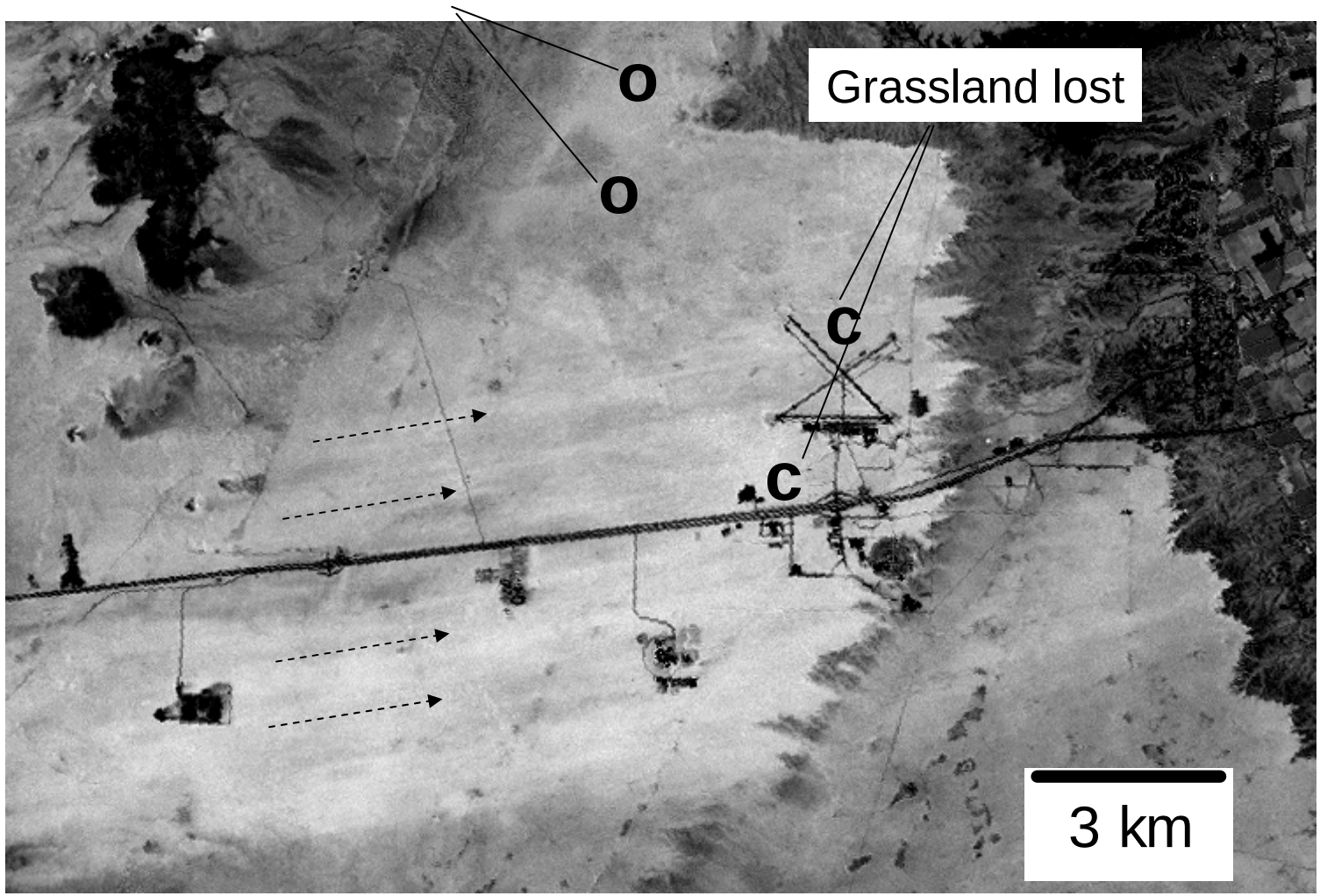




Basin floor: Loamy site adjacent to degrading loamy sand site

- **25 cm of fine sand accumulation abrading and burying tobosa**
- **Landscape-driven dynamics**

Geographic position may override local properties



Detecting thresholds: surface soil tells a story

Gravelly land units

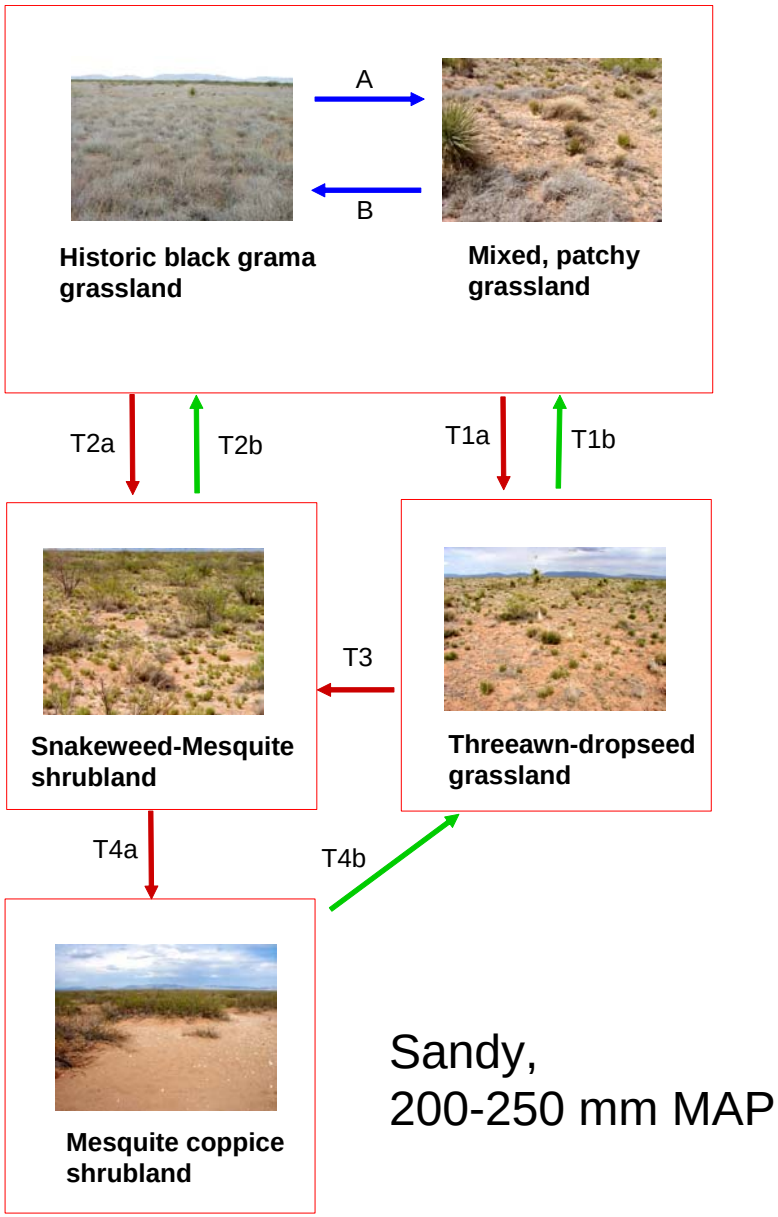
- Recent grassland loss
- Crossed a biotic threshold, soils not yet degraded
- Recovery possible

Dark A Light A

- Grassland absent for decades
- Crossed a soil degradation threshold
- Recovery improbable

The dynamic relationship between soil and vegetation is key to defining thresholds

Synthesize and communicate mechanisms in state-and-transition models



Sandy,
200-250 mm MAP

Succession/disturbance

Threshold/transition

Restoration/remediation

Key to arrows

A. Continuous grazing or drought, recovery with prescribed grazing (**B**).

T1a. Continued grazing causes black grama loss. Restoration with plantings and 2 consecutive summers of above-average rainfall (**T1b**).

T2a. Continuous grazing, winter rain, plus lack of fire leads to mesquite proliferation and black grama extinction. Restoration with shrub control, plantings, summer rain, and fire management (**T2b**).

T3. Mesquite spread with high winter rain

T4a. Inappropriate stocking during drought with soil disturbance leads to high soil erosion rates in shrub interspaces. Restoration of some grass cover with bulldozing, seeding and summer rain (**T4b**.)

Ecological site training, participatory model development and linkage to rangeland health indicators

Ulan Baatar, Mongolia

New Mexico, USA

Zacatecas, Mexico