Strategies for assessment and monitoring design in landscapes

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Assessment and monitoring…for what and where exactly?

- **Assessment**: Comparing focal area to a standard/benchmark

"This is a degraded community, it used to be black grama grassland"

- **Monitoring**: Detecting change and the precursors of thresholds

"If this community is degrading, then we will see declines in black grama"

Outline of a general strategy

1) **Domain of inference** — define the extent about which you want to make a statement (your pasture? your ranch? your MLRA?)

2) **Conceptual models of change** --- formally define the relationships of attributes, patterns, and processes; what do you expect to happen and why?

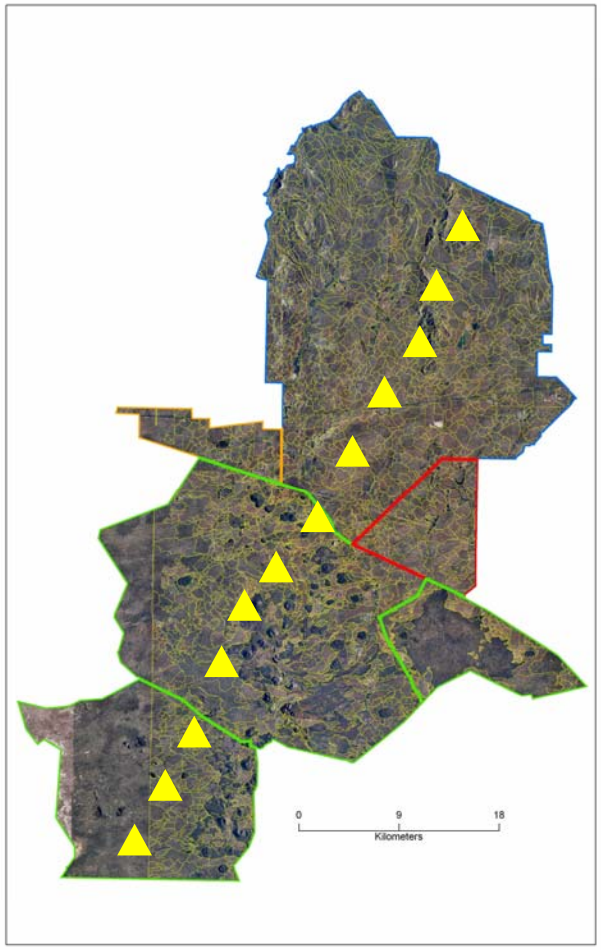
3) **Patterns, processes, and scales** --- specify the focal patterns within strata that you care about, the processes causing change in them, and the appropriate scale to measure them, choose indicators

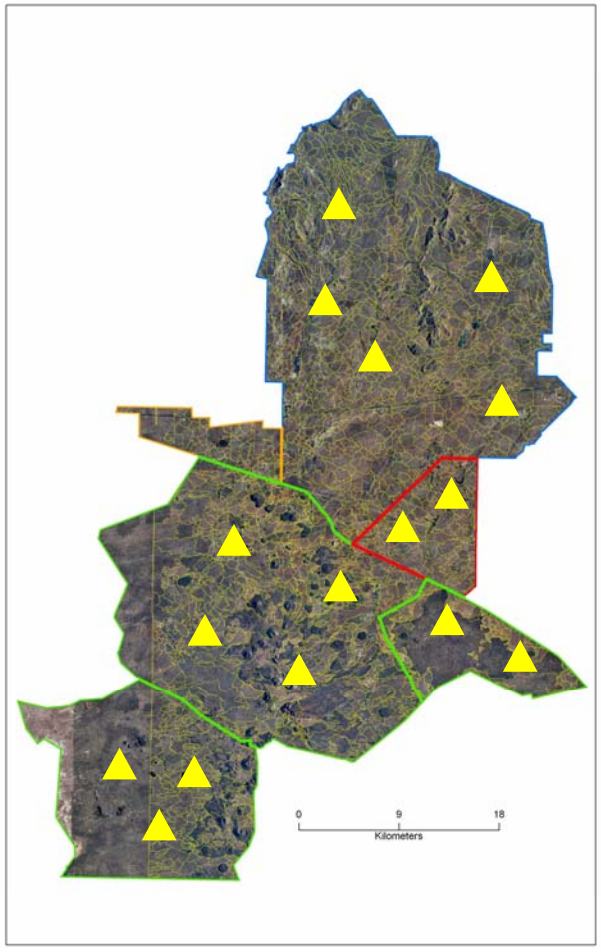
4) **Stratification** --- subdivide the extent based on the distinct factors and types of ecological dynamics occurring different land areas

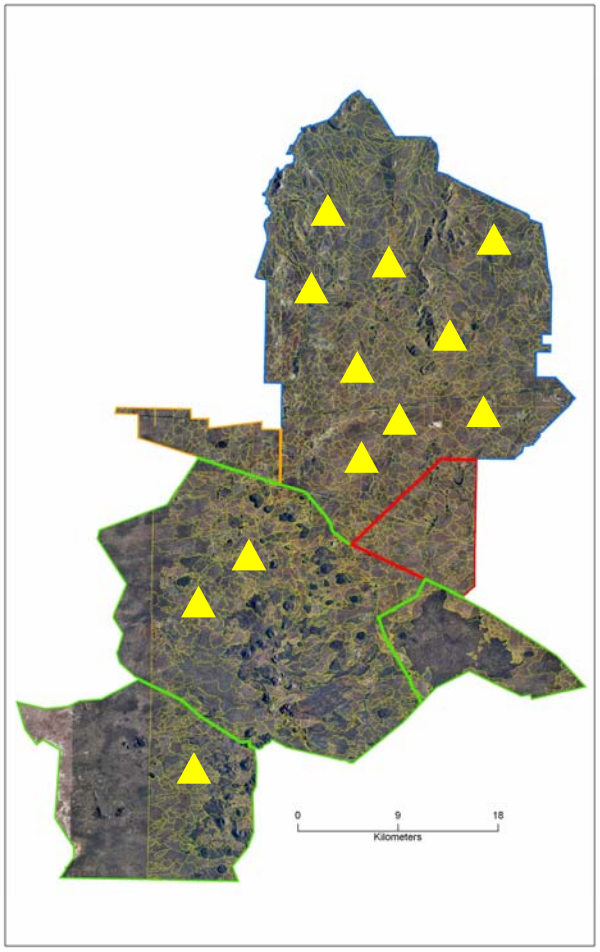
5) **Sample and interpret indicators** --- interpretation of a given indicator based on conceptual model and domain of inference

1. Domain of inference

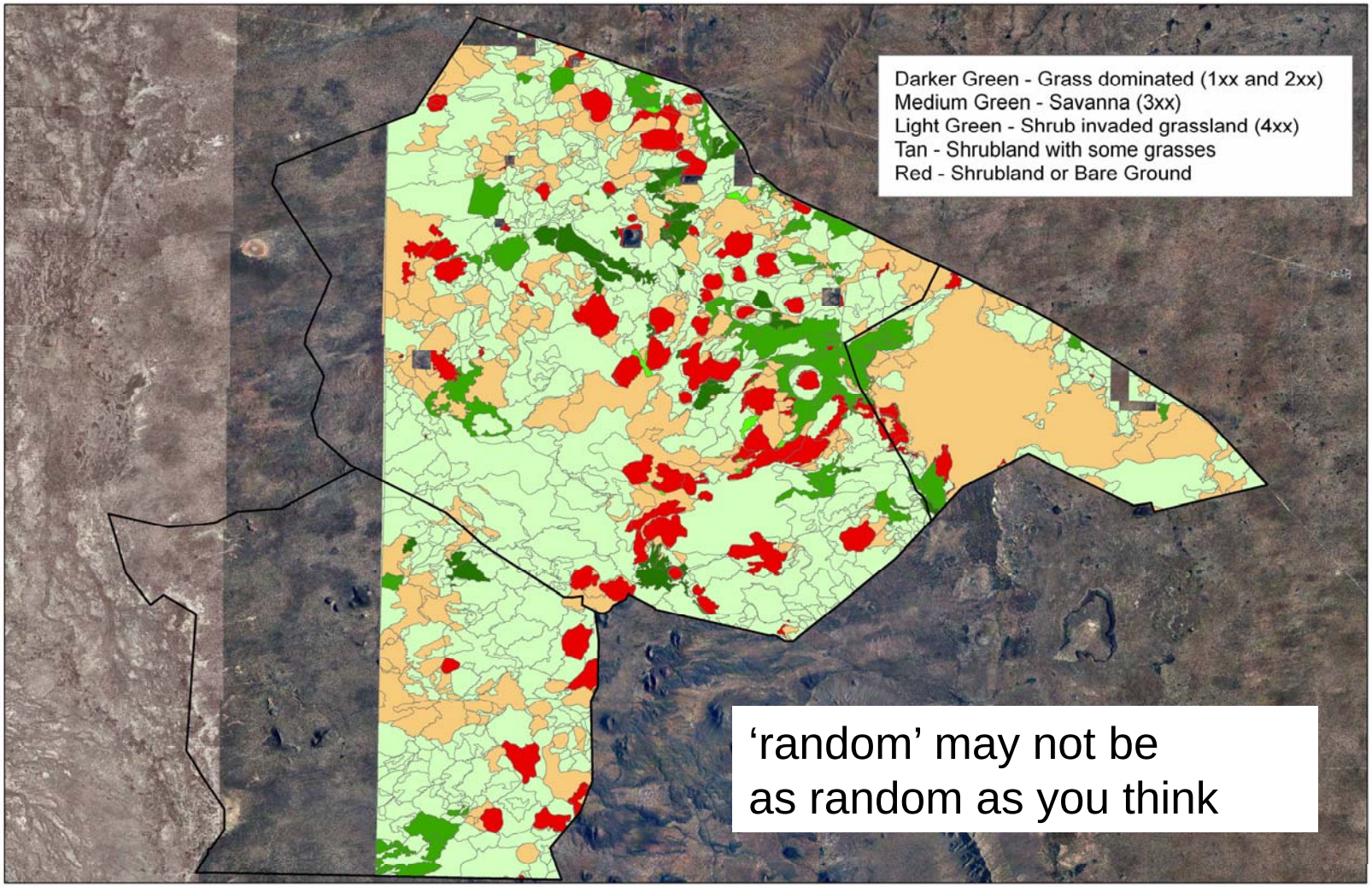
Resource: common sense, but…..



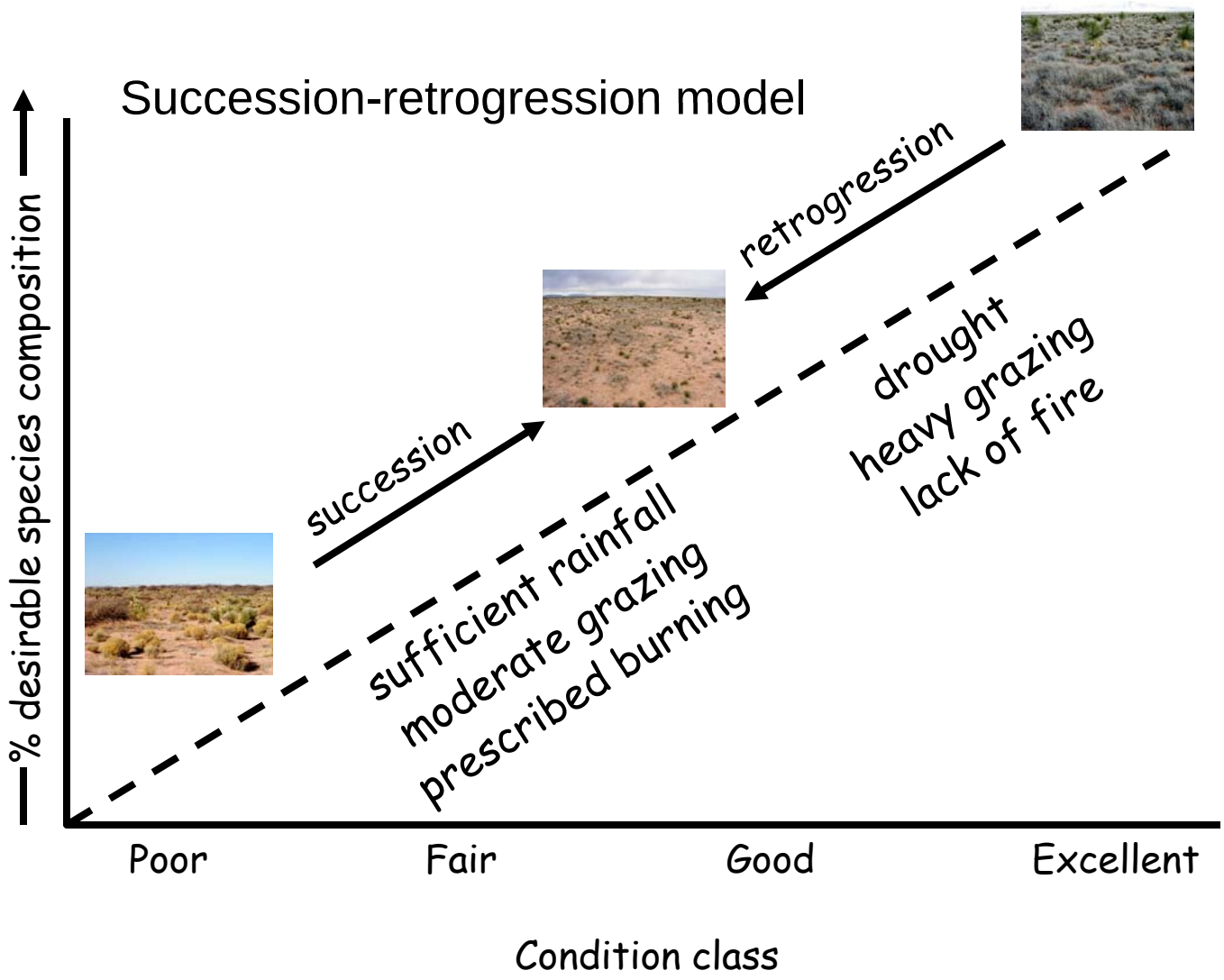




1. Domain of inference: rangelands are heterogeneous

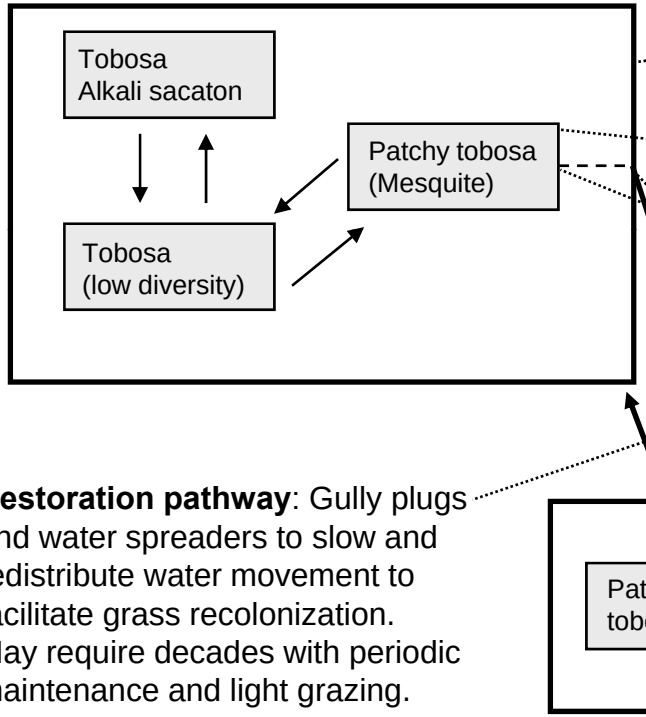


2. **Conceptual model**: a formal description used to help visualize relationships among patterns and processes that cannot be directly observed



2. **The state-and-transition model**: types of change, processes, indicators

Draw ecological site, MLRA 42.2



Reference State
Indicators: High perennial grass cover, minimal soil movement, bare patches small and unconnected.
Feedbacks: Perennial grasses minimize soil, nutrient and water movement from high-intensity storms.

At-risk Community Phase: Perennial grass cover low, patchy, with decadent tobosa plants and large interconnected areas of bare ground in response to intensive grazing and drought.

Trigger: Heavy grazing/drought followed by an intense rainfall event to initiate gully formation.

Threshold: Gully development channels water and nutrients away from grasses, initiates soil erosion, and leads to additional grass loss.

Restoration pathway: Gully plugs and water spreaders to slow and redistribute water movement to facilitate grass recolonization.
May require decades with periodic maintenance and light grazing.

Alternative State
Indicators: Major soil and water movement, gullies that continue to deepen, high composition of short-statured, drought-tolerant grass species.
Feedbacks: Few perennial grasses and continued water, soil and nutrient losses with rain storms that lead to additional grass loss.

2. The state-and-transition model: 3 general classes of indicated conditions

Sandy ecological site, MLRA 42.2

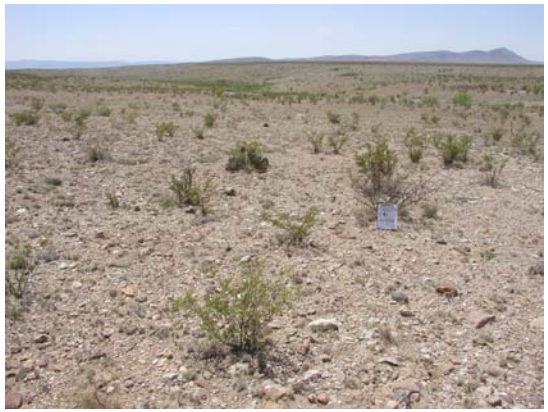
Pre-threshold state, resilient condition, at potential

Pre-threshold state, reduced resilience, at-risk

Post-threshold state

2. The state-and-transition model: focal attributes vary among ecological sites and states

Gravelly ecological site, MLRA 42.2



High bare ground, but high organic matter may allow recovery

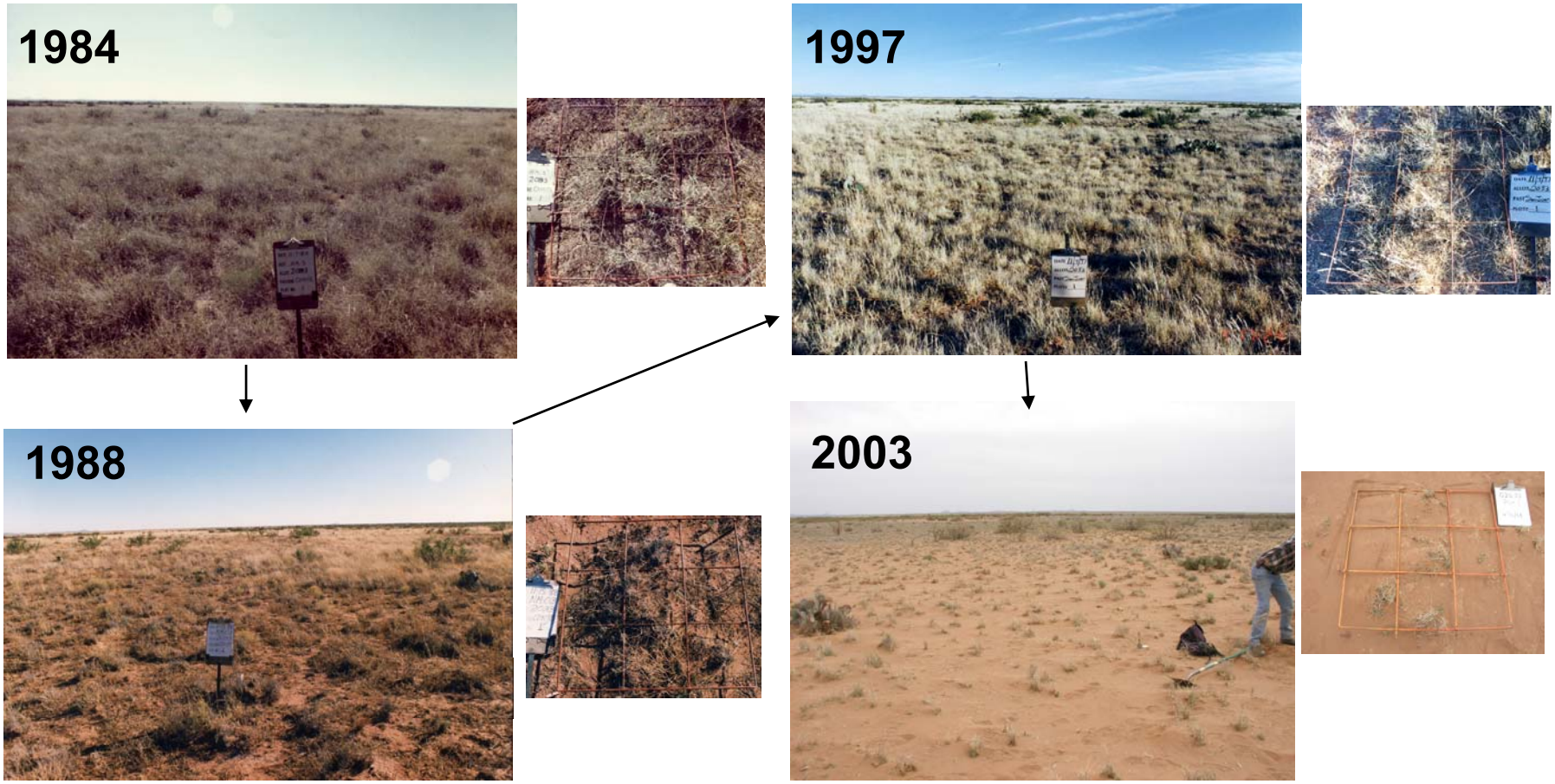
Dark A

Light A

High bare gound, mature shrubs, low organic matter may preclude recovery

2. The state-and-transition model: landscape processes may be important

Loamy ecological site, MLRA 42.2



Site-based models and indicators may not tell you everything you need to know

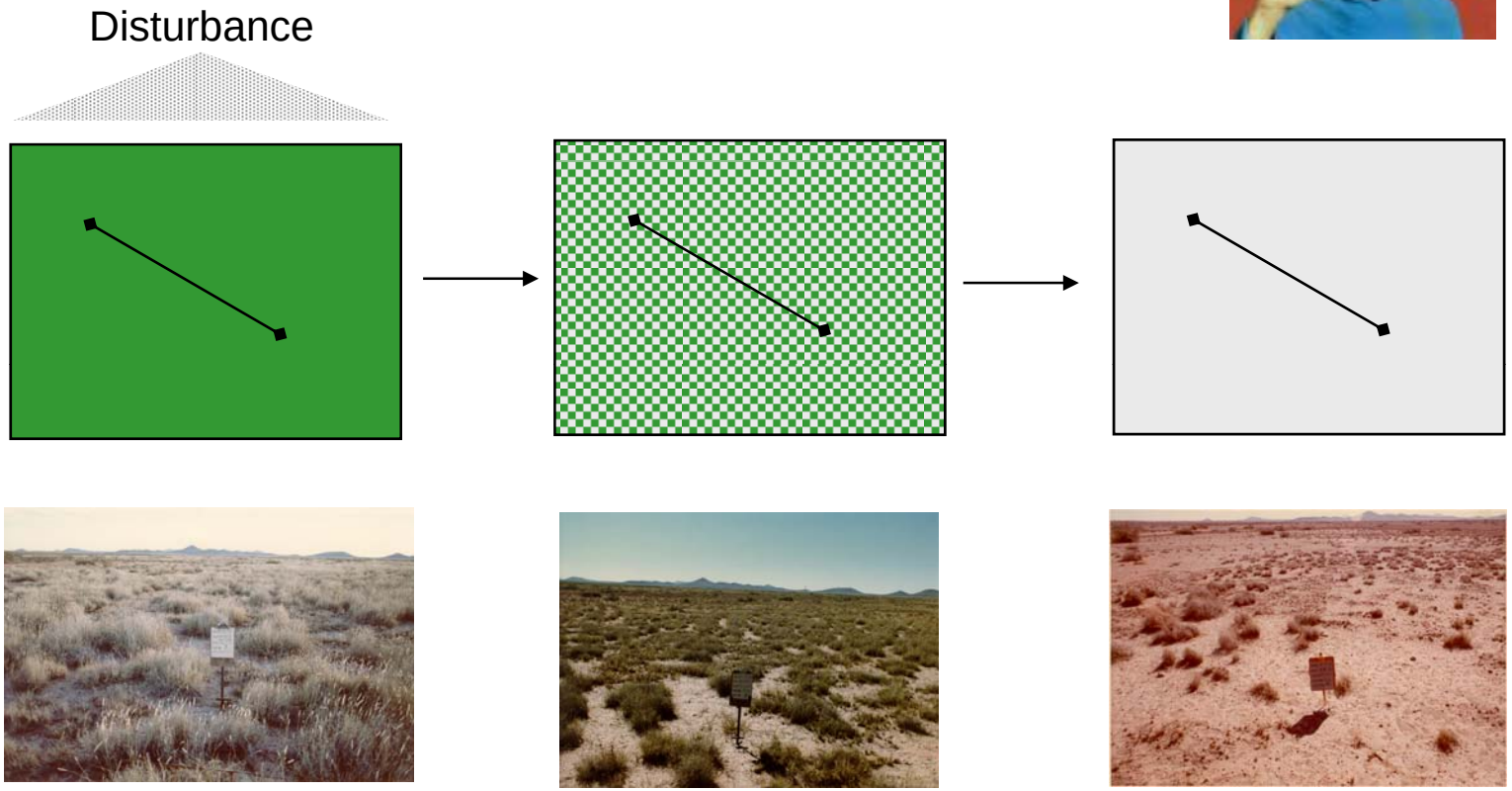
3. **Patterns, processes, and scales:** how do you measure?

Pattern: amount and configuration of something, such as grass patches

Process: a continuing activity or function, such as infiltration or erosion

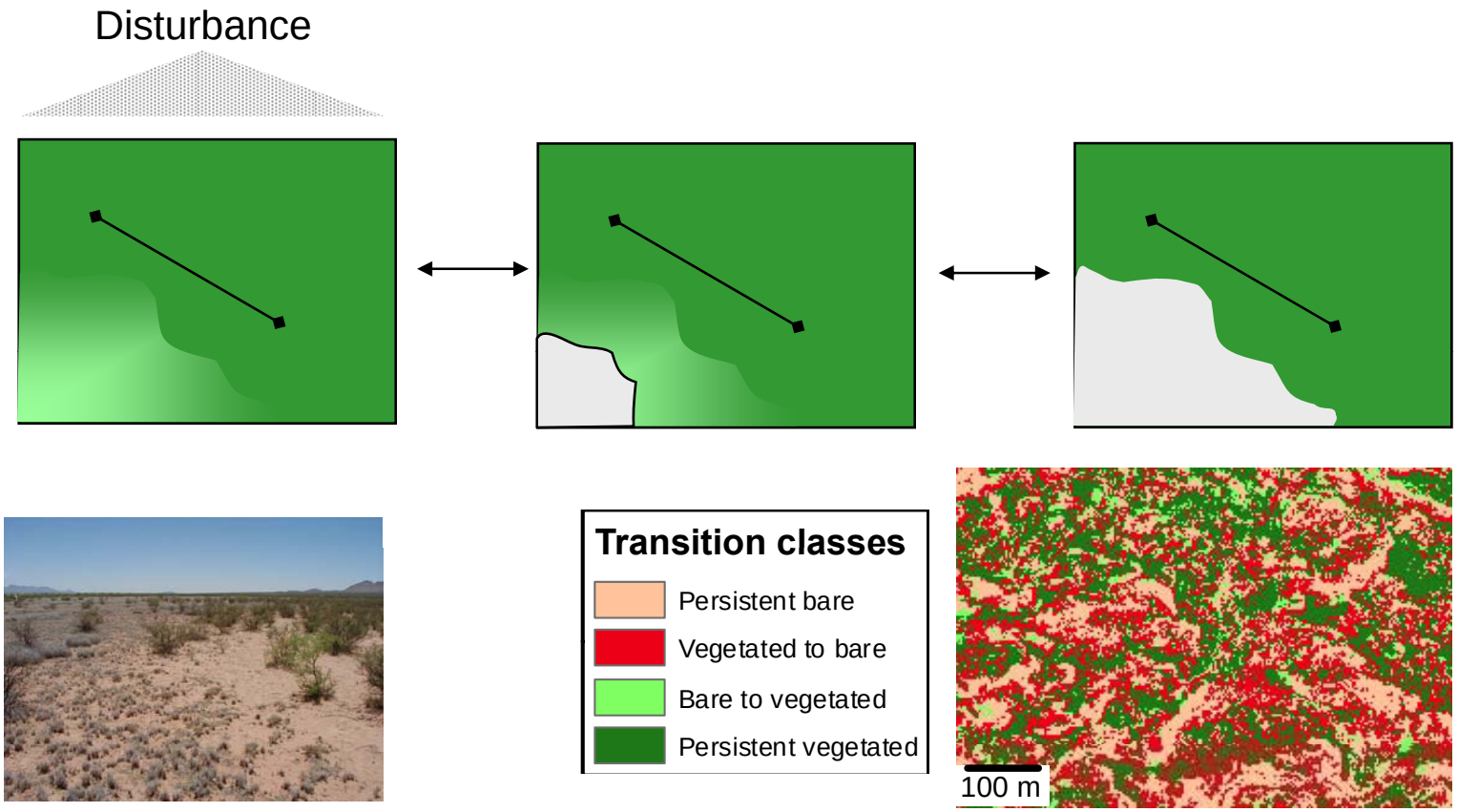
Scale-dependence: characteristic patterns, processes, relationships differ depending upon the scale of observation

3. What is the spatial pattern of change (SPOC)?



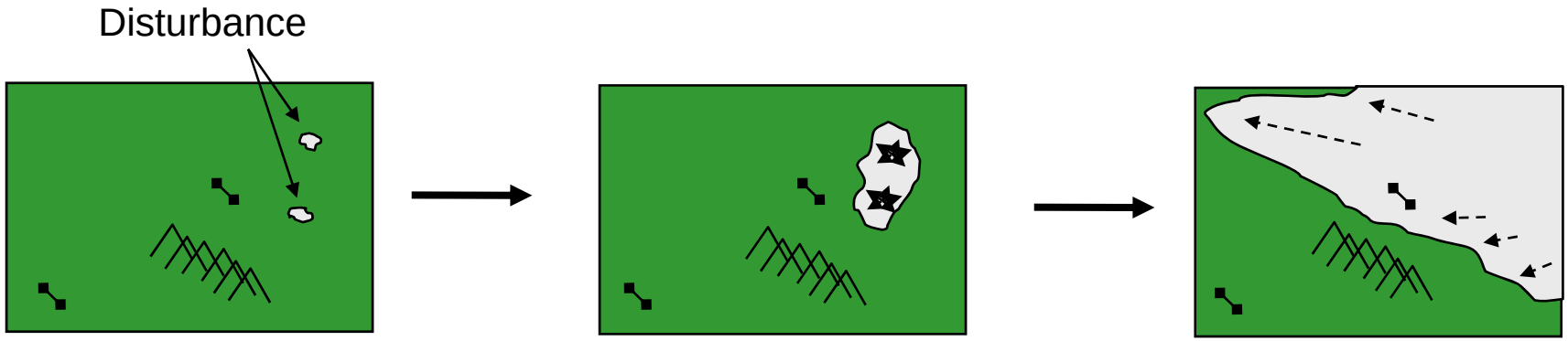
Vegetation cover and pattern of change are more or less uniform, change is driven by local, evenly-distributed processes

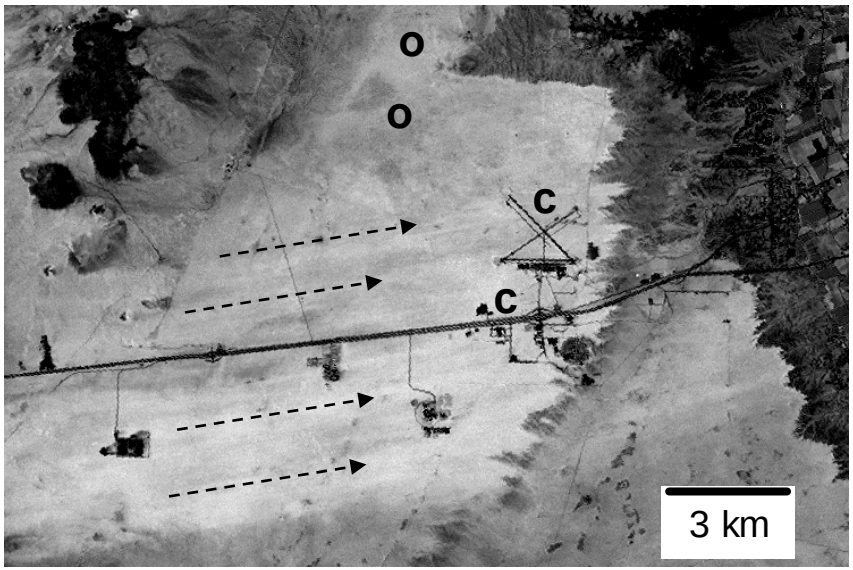
3. Change may be patchy at scales larger than evaluation areas



Pattern of change is patchy due to soil or hydrological interactions among patch types

3. Change may be unpredictable using local-scale data

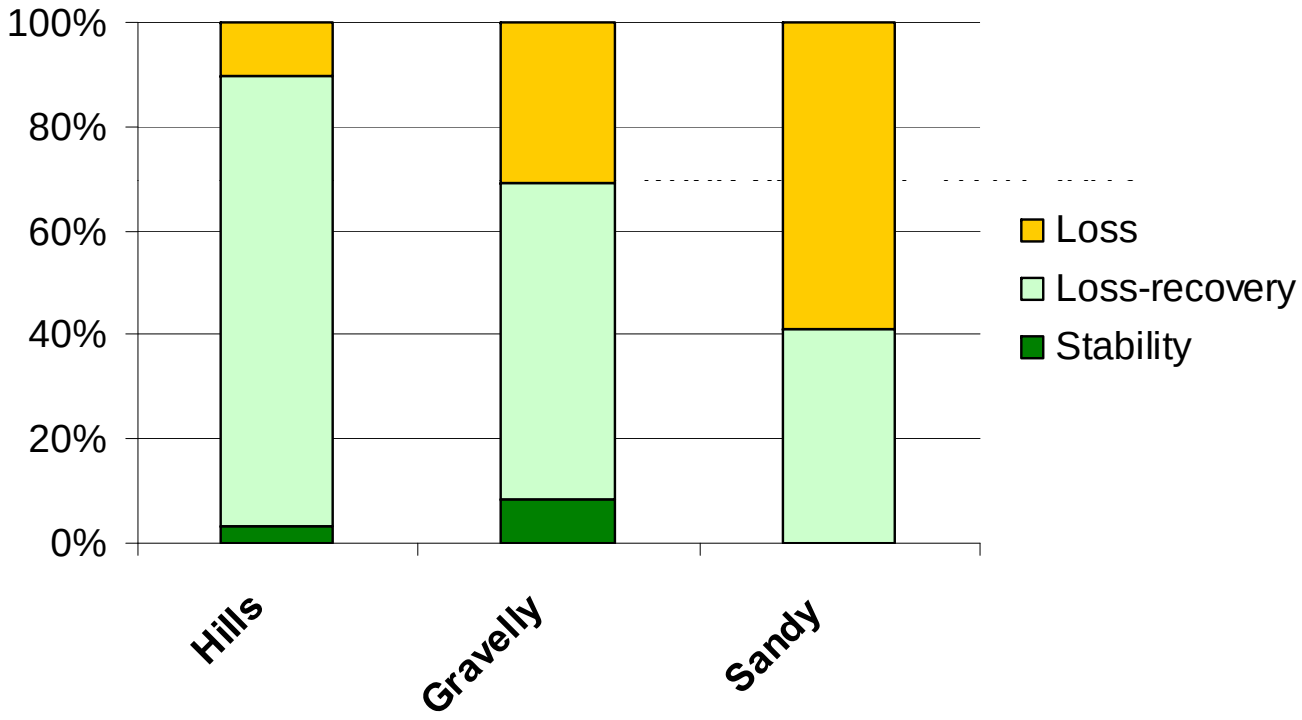




Pattern of change contagious at large scales, driven by broad-scale processes and constrained by landscape structure. Need landscape indicators!

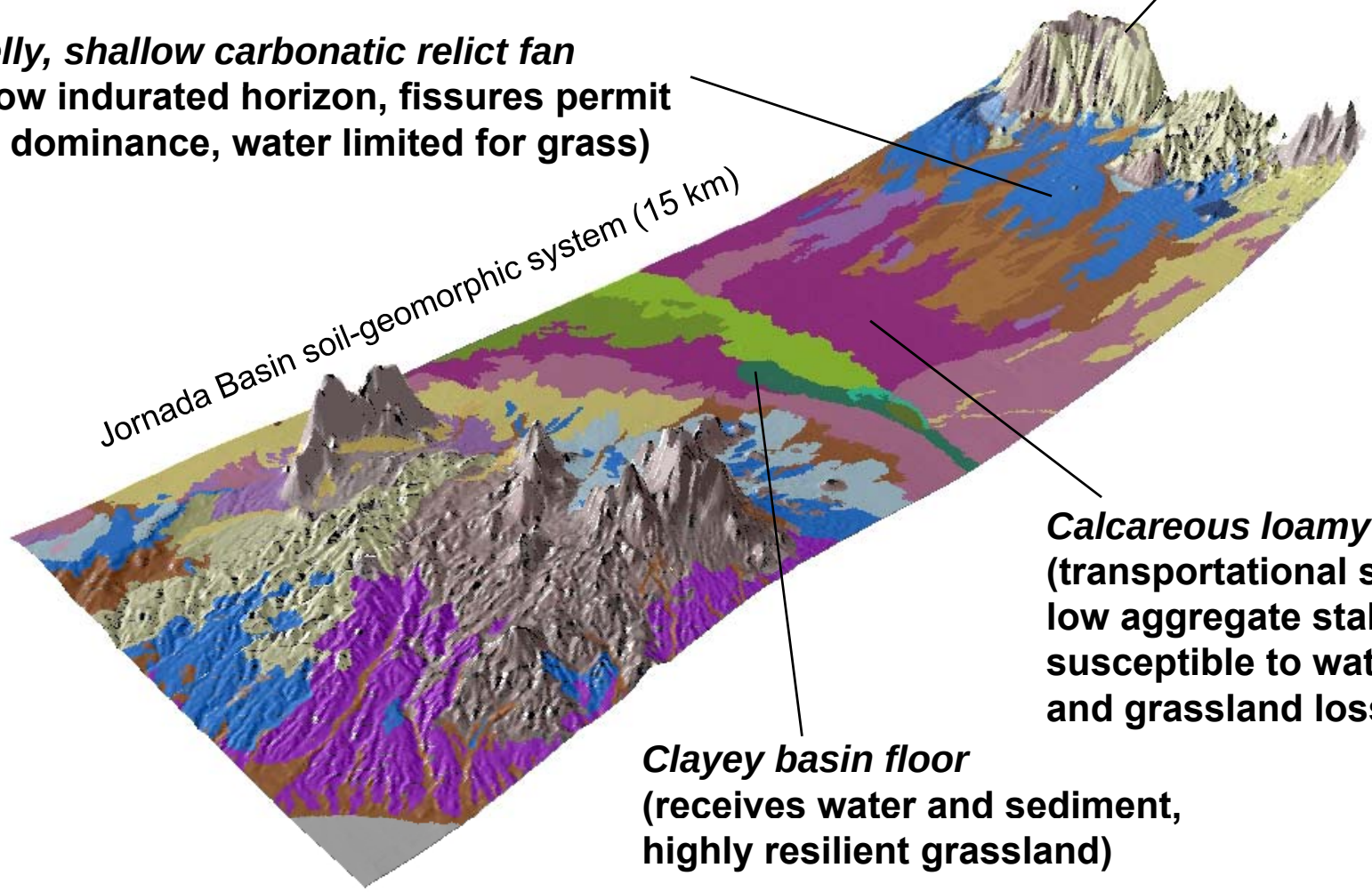
4. Stratification: how can you apply the concepts in rangeland health?

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



Ecological sites differ in resilience and SPOC, obvious strata

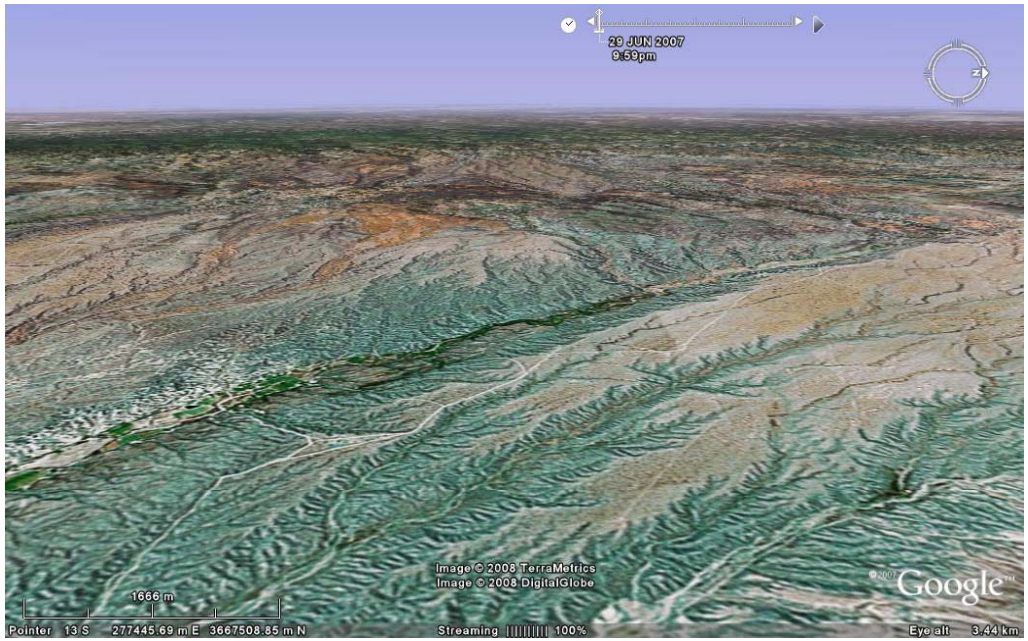
4. Stratification: juxtaposition of sites matters too: the soil-geomorphic system



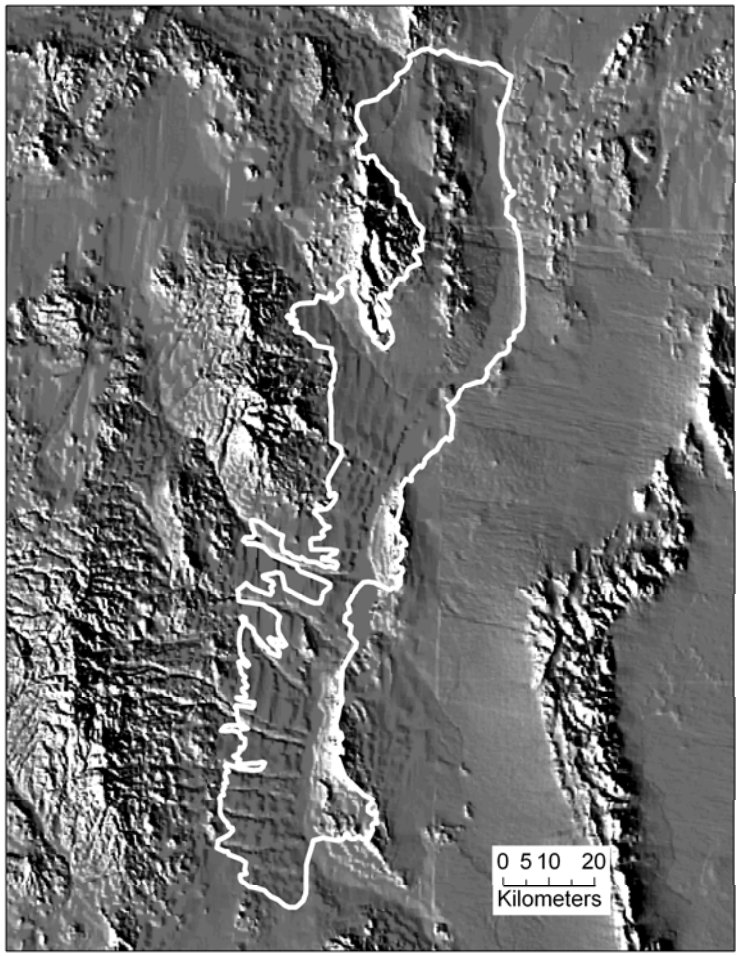
Soil-geomorphic system: a characteristic arrangement of ecological sites that are linked by fluxes of materials, pedogenic processes, and ecological processes

4. Mapping soil-geomorphic systems: can define a reasonable extent

Valley-border ballena soil-geomorphic system

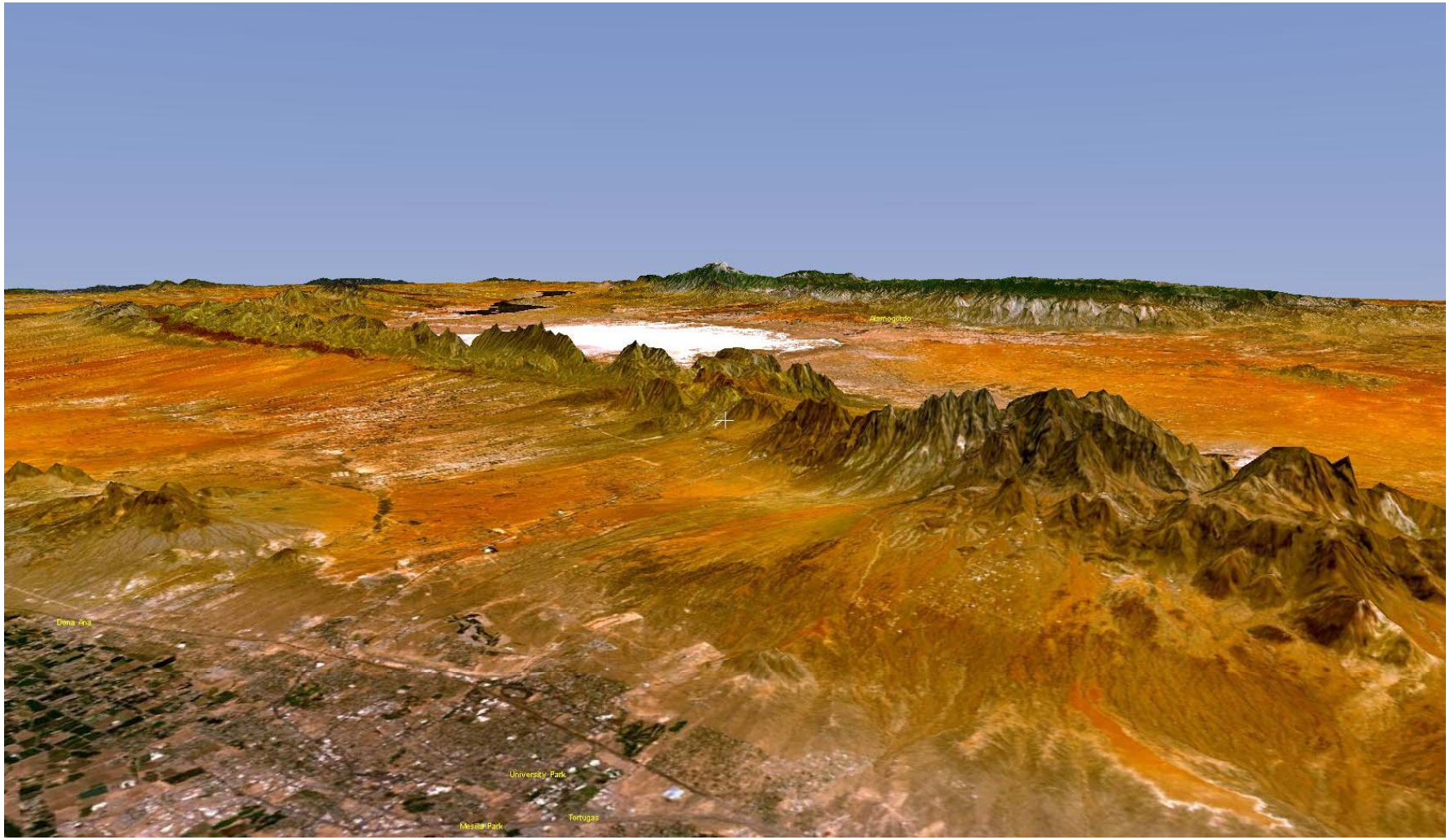


Google Earth



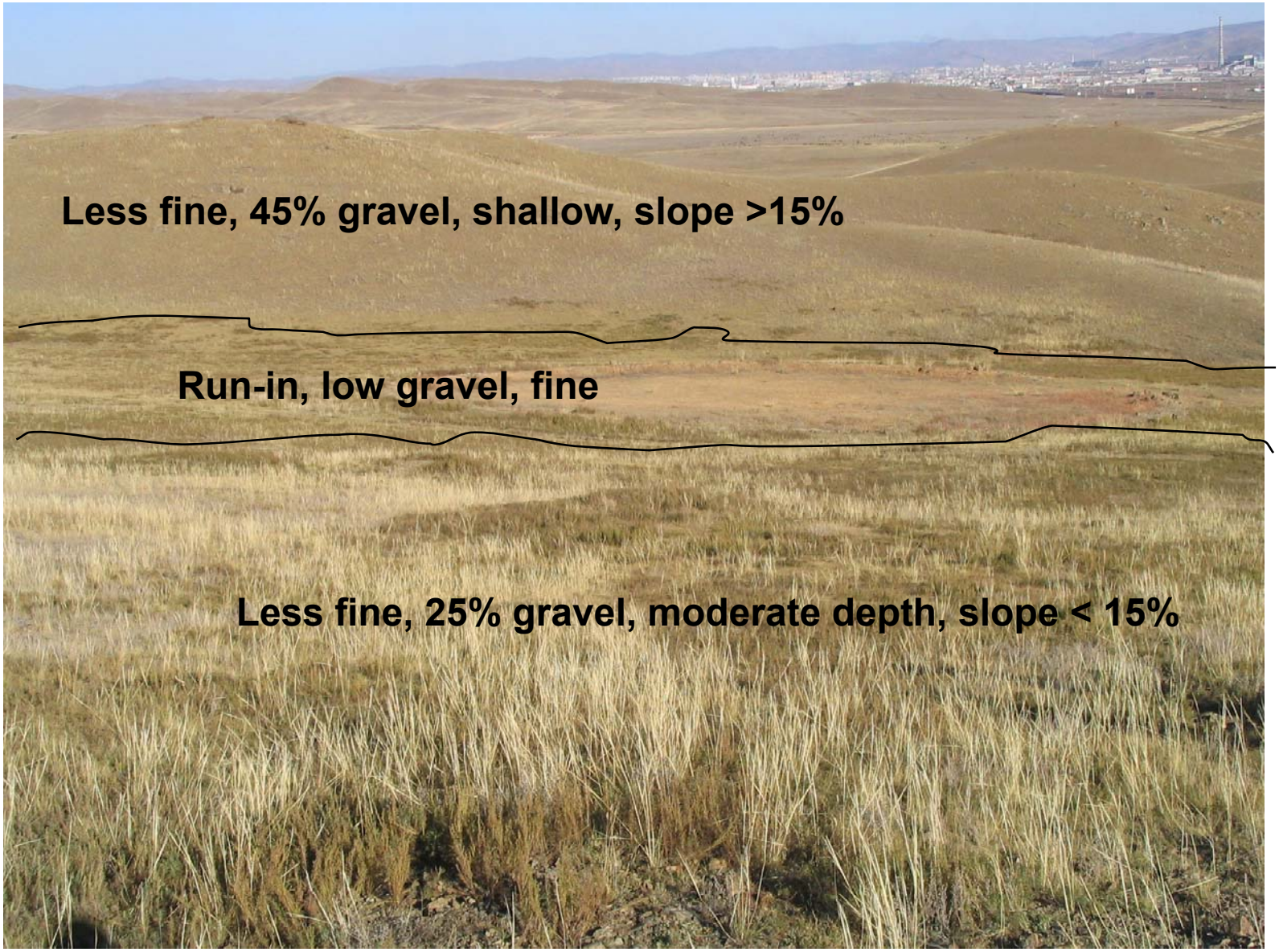
DOQQ

4. Mapping ecological sites within soil-geomorphic systems



NASA Worldwind, exaggerated DEM, LandSat 7 visible color

4. Mapping ecological sites within soil-geomorphic systems



4. Mapping ecological sites: properties affecting potential and resilience

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 (in.)	Sandy vs. Shallow sandy
Lithology/geology		
	Bedrock type (class)	Limestone vs. Igneous Hills
	Slope (%)	Limy upland vs. Limy slopes
Chemistry		
	Soil salinity/sodicity (mmhos)	Salt flats vs. Loamy
	Soil gypsum content/distribution in profile (%/in.)	Gyp Upland vs. Loamy
	Soil carbonate content/distribution in profile (%/in.)	Limy vs. Loamy

4. Mapping states within ecological sites: Cadillac version

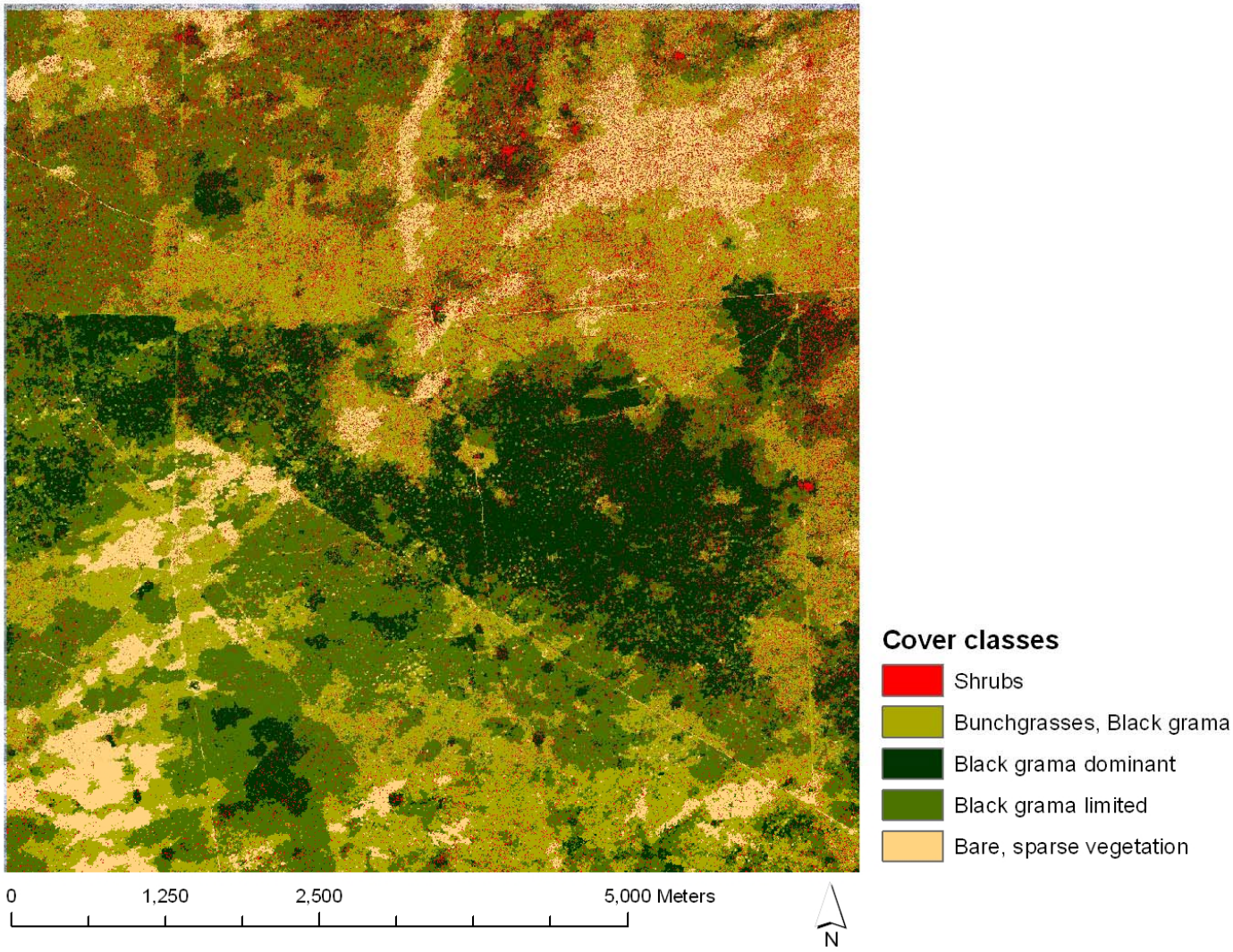
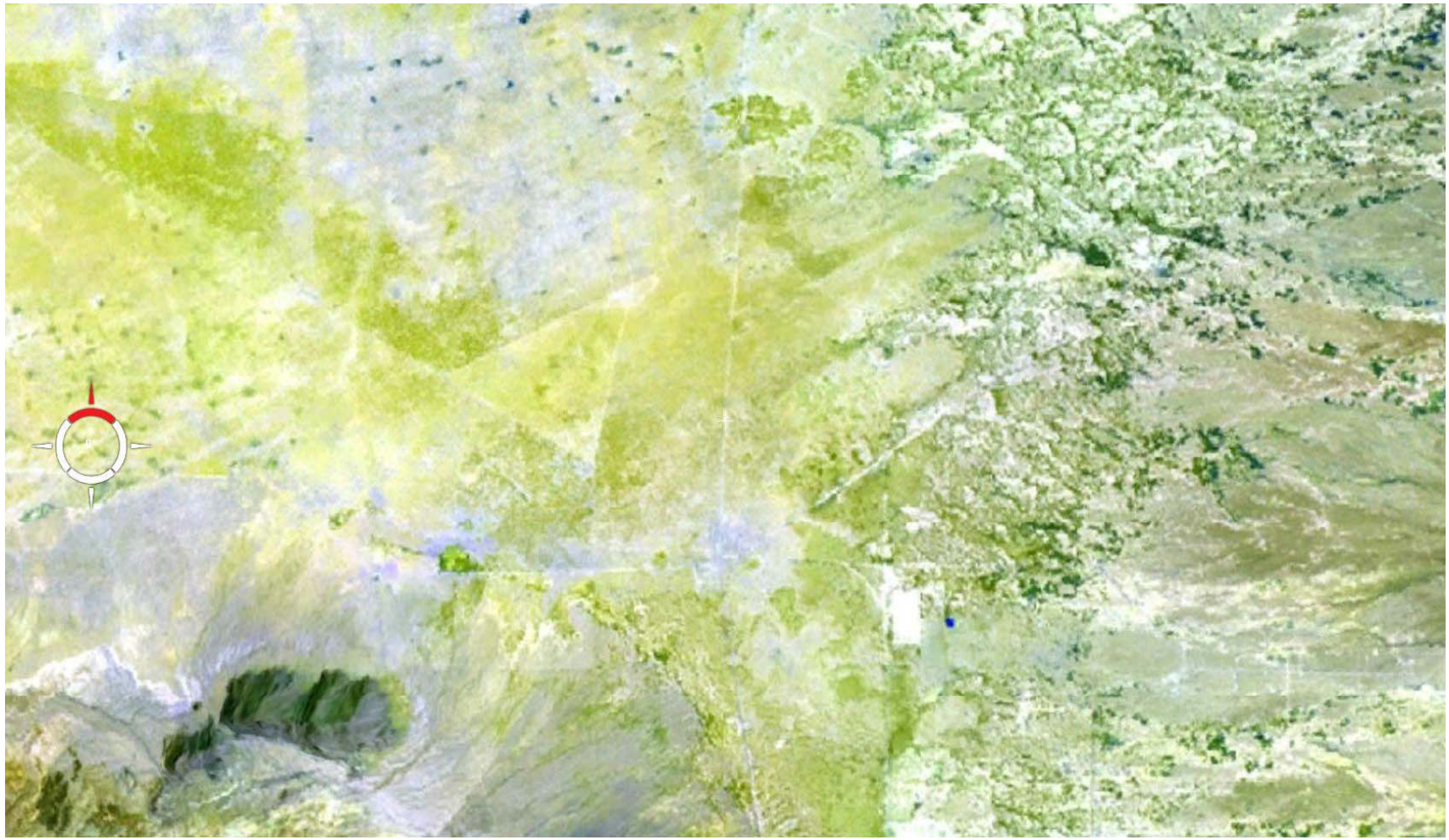


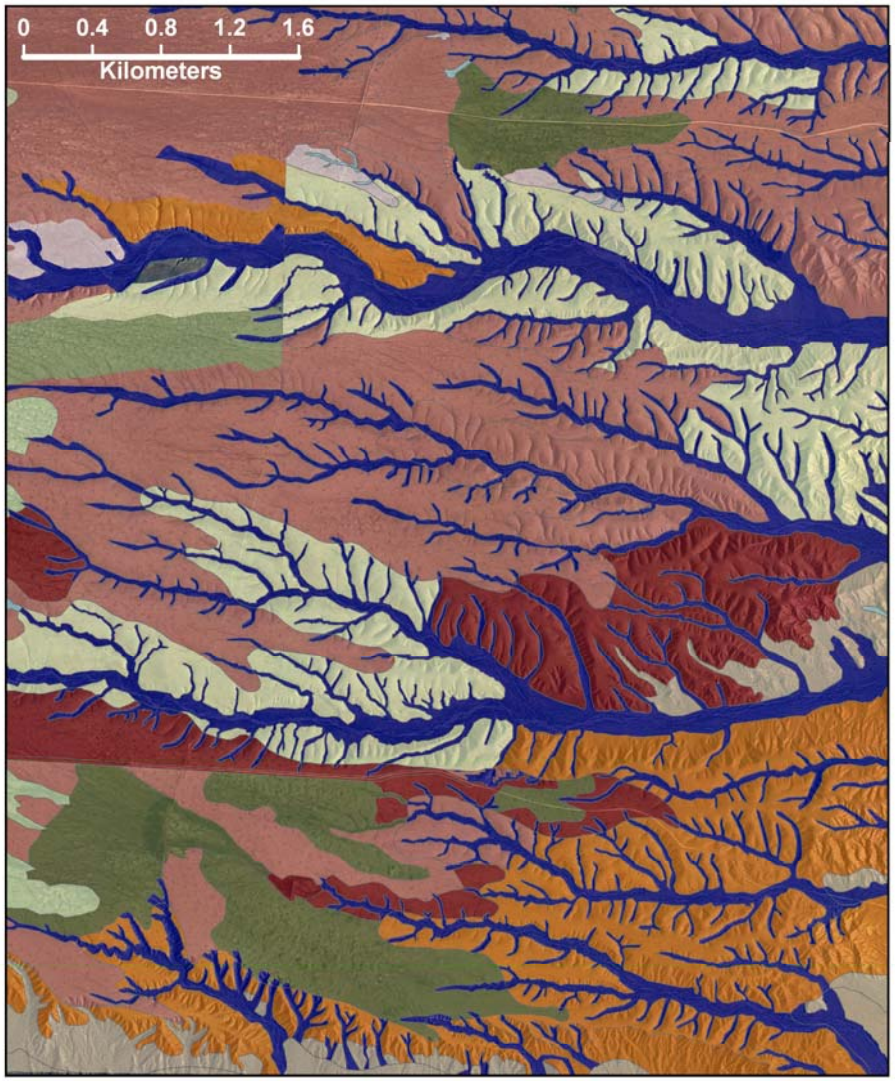
Image classification coupled to rapid inventory and based on state criteria (ENVI Feature Extraction module, Quickbird imagery)

4. Mapping states within ecological sites: Yugo version



NASA Worldwind, LandSat 7 pseudo color

4. Ecological sites with state classes nested: a sampling and interpretation frame



Ecological Sites and States

Shallow Sandy
- Shrub-invaded Grassland
- Shrub-dominated
- Shrubland

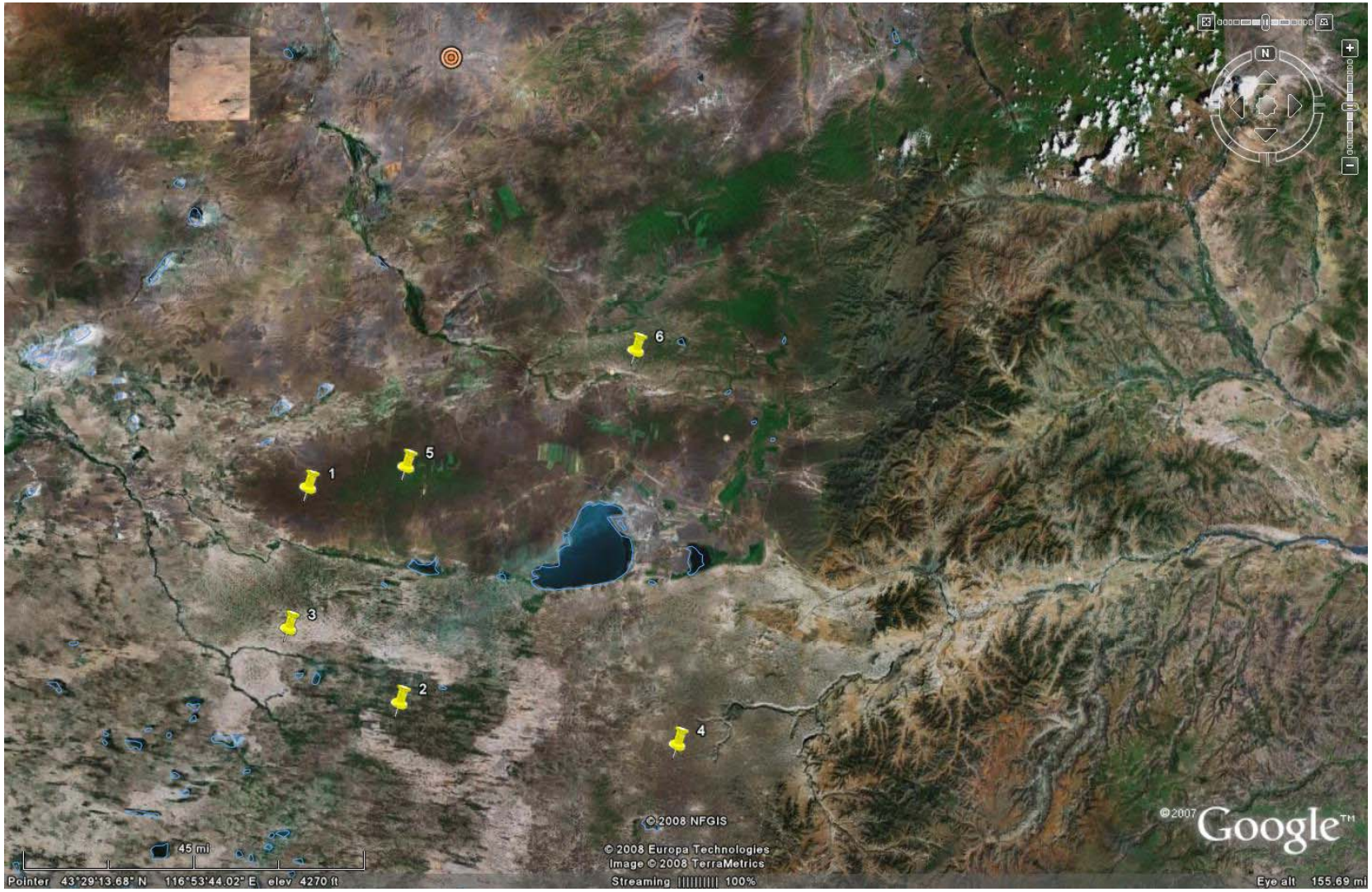
Gravelly
- Grass/Shrub mix
- Shrub-dominated
- Shrubland

Gravelly sand
- Shrubland

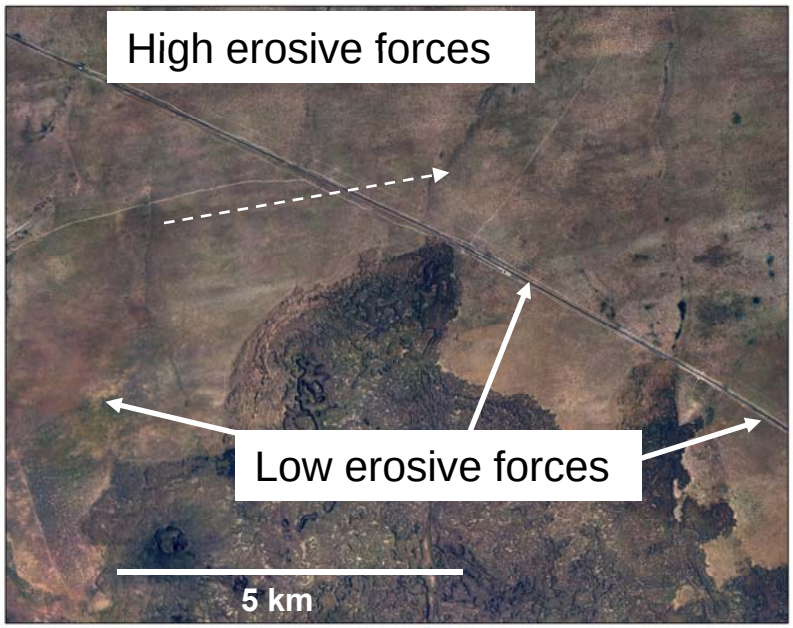
Gravelly loam
- Shrub-invaded Grassland
- Shrub-dominated
- Shrubland

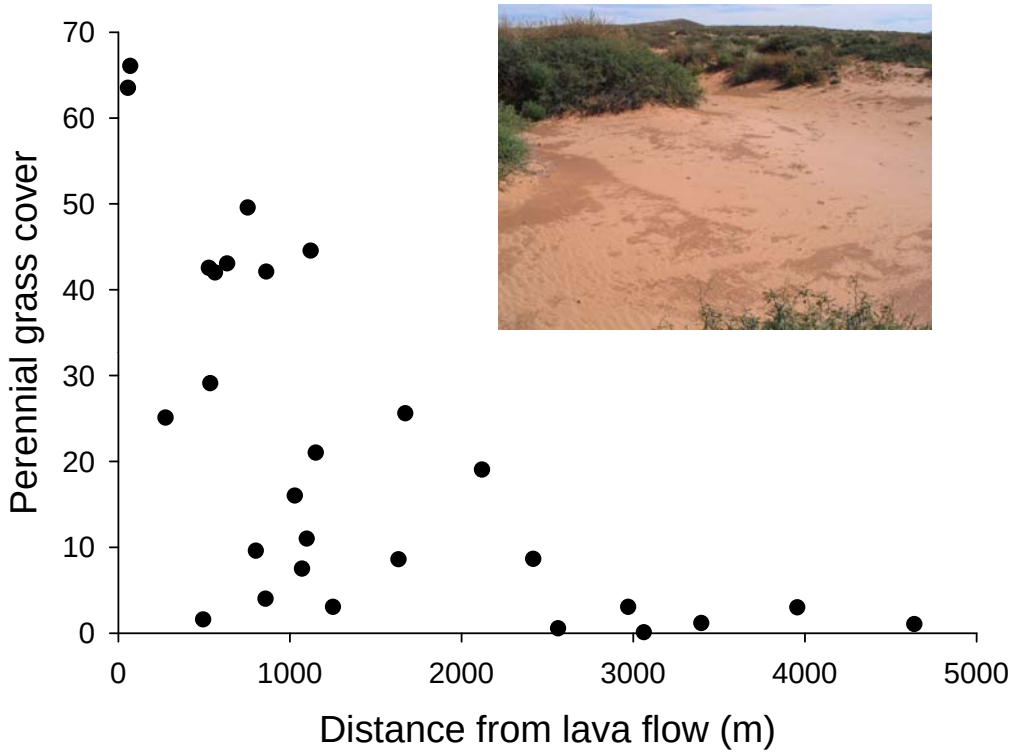
Draw
- Shrub-invaded Grassland
- Shrubland

5. Sample selection: .kml → .gpx (e.g., DNR Garmin software)



5. Analysis and interpretation: the value of many points





In the Potrillos SGS, occurrence of remnant grasslands depends on protection from sand movement, but *not* properties of the soil profile

The rules determining resilience change among soil-geomorphic systems

Take home messages

1) Start with conceptual models of resilience and change

2) Where, what, and how to assess and monitor:

   --different attributes and spatial positions (e.g., edges of remnant grass patches) can serve as ‘early-warning’ in different ecological sites and states

3) Stratify samples, many samples, look for patterns in data

4) Use maps and models to create spatially-explicit interpretations and area-weighted conclusions