Unpacking the term "Transboundary Dryland Border Region"

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and

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What is meant by the term?

What areas and populations are included in the definition?

Why is it important to consider the region as a whole?

What is meant by the term?

What are Drylands (over 300 definitions)?

Accounting for the World's Rangelands

By H. Gyde Lund

How much rangeland do we have? Globally we do not know. I suspect the same can be said nationally. If we do not know what we have, how can we monitor it and develop a strategy for management? Existing statistics and definitions for rangelands or grasslands vary widely. In addition, definitions of various land classes such as rangeland and forest overlap. Not only is the definition important for accounting purposes, how one classifies lands could dictate who will administer the lands and how they will be managed.

To help resolve the problem, I offer a definition for rangelands that one can use to objectively inventory and report on rangelands at the national and international level. The intended audience is anyone who has to account for and report on the area of rangelands.

Why Are Rangelands Important?

Rangelands (including grasslands, shrublands, and tundra) are found throughout the world from the outback of Australia, to the muskegs and tundra of the Arctic, to the savannahs of Africa, to the cerrados of Brazil, to the plains of Mongolia, and to the sagebrush lands of the United States. As any range manager knows, rangelands are of key importance globally, nationally, and locally, both in terms of extent and socio-economic impact.

Properly managed rangelands can provide food security and poverty alleviation to millions of people. Rangelands are the main feed resource for traditional livestock rearing systems in many parts of the world. They provide about 70 percent of the feed for domestic ruminants.[1] Rangelands are of great economic and social importance, because they offer a livelihood to millions of people. Traditional animal production provides people in developing countries with food (milk, meat, and blood), manure (for fuel and fertilizer), wool, hides, draft power, transportation, added security, and the possibility to accumulate capital. Livestock are also important in association with arable agriculture, because livestock provide the power for cultivation and manure for increased fertility. Livestock also consume crop residues, which often have no or little other value, except that straw can be used as roofing material or made into baskets.[2]

In addition, rangelands are vital for the ecological, environmental, and economic functions they provide. The multiple uses of rangelands, as with forests, are of great ecological significance because both vegetation types protect often-fragile soil profiles, store carbon, provide habitat for wild fauna and flora, and act as catchments or watersheds for large river systems.

Environmentally, rangelands provide biological diversity and ecological functions. They provide local, regional, and global values and regulatory and buffering services (for instance, corals reefs in the Caribbean are declining due to desertification in the Sahel;[3] deforestation of the cerrados in Brazil affects the water balance in the whole of Amazon as well as the regional climate, etc.; all of these have major long-term impacts).

Economically, forests and rangelands provide us with essential goods and services. Both vegetation types contain medicinal plants, timber, germplasm for new and wild relatives of existing crop and pasture plants, and recreational opportunities. Furthermore, rangelands provide designated reserves.[2]

The economic importance of rangelands varies significantly according to the socio-economic system in which they are embedded. In developed economies, such as Australia and

Lund, H.G. 2007. Accounting for the World's rangelands. Rangeland 3-

A part of this uncertainty relates to the Definition of Drylands

10 – 80% Degraded

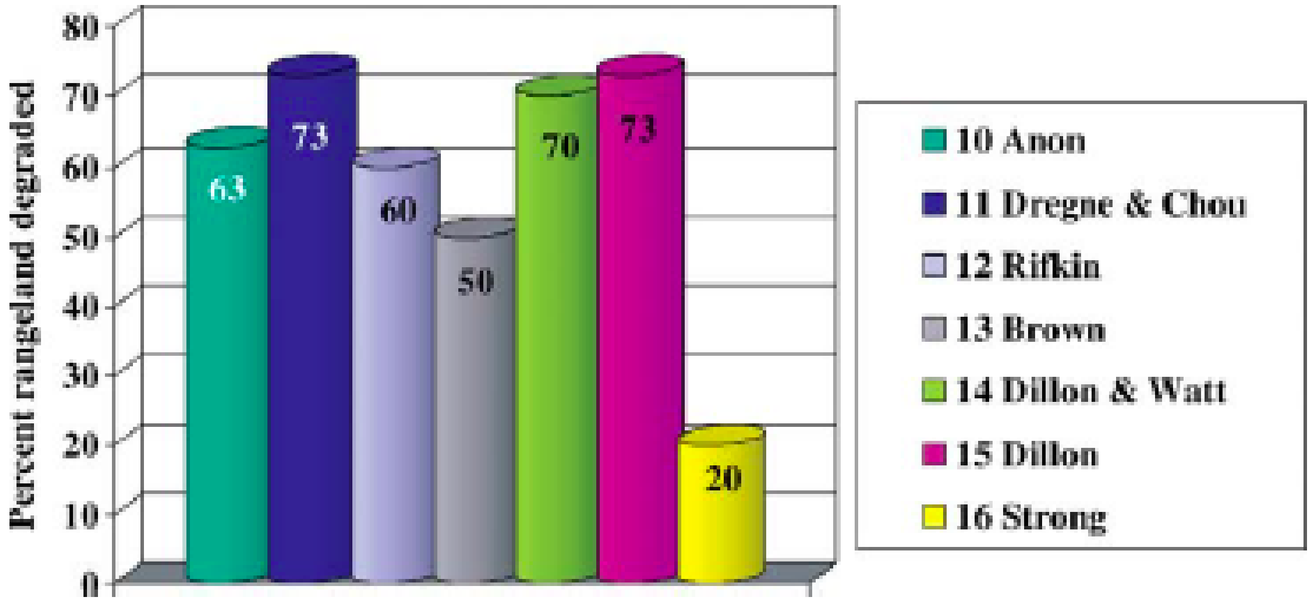


Figure 1. Recent estimates of percent of world's rangelands that are degraded.

Lund, H.G. 2007. Accounting for the World's rangelands. Rangelands 29:3-10.

Land Use? Grazing of Forests

Hungry Goats Atop a Tree, Doing Their Bit for Epicures

Land Cover? Grazing of Forests

Hungry Goats Atop a Tree, Doing Their Bit for Epicures

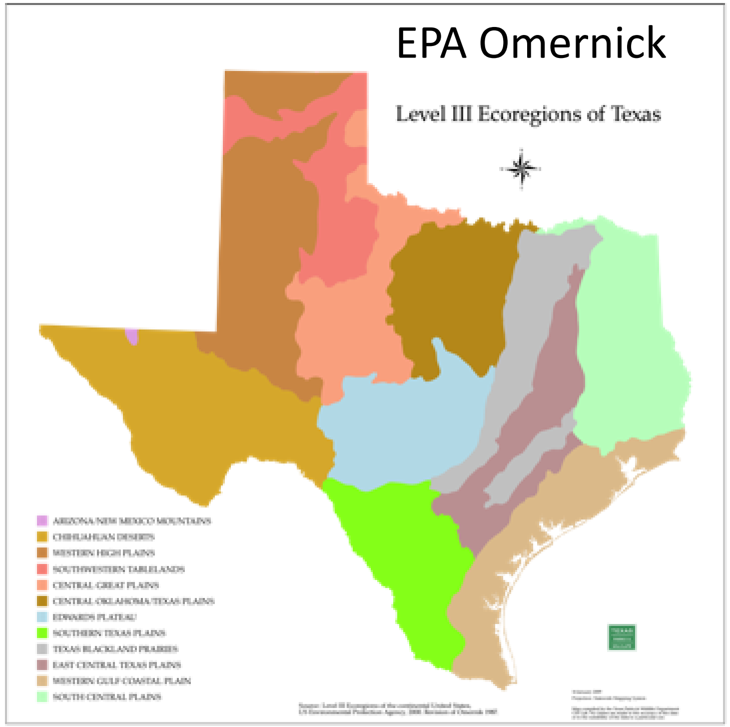
Watersheds

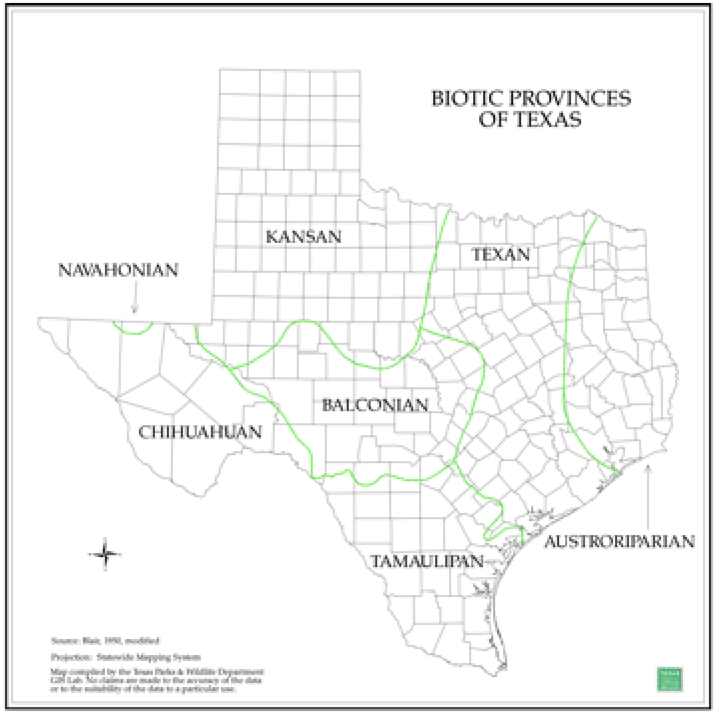
Ecoregions

Division = *F*{CL (P &T),R, time}

Biogeographic Provinces

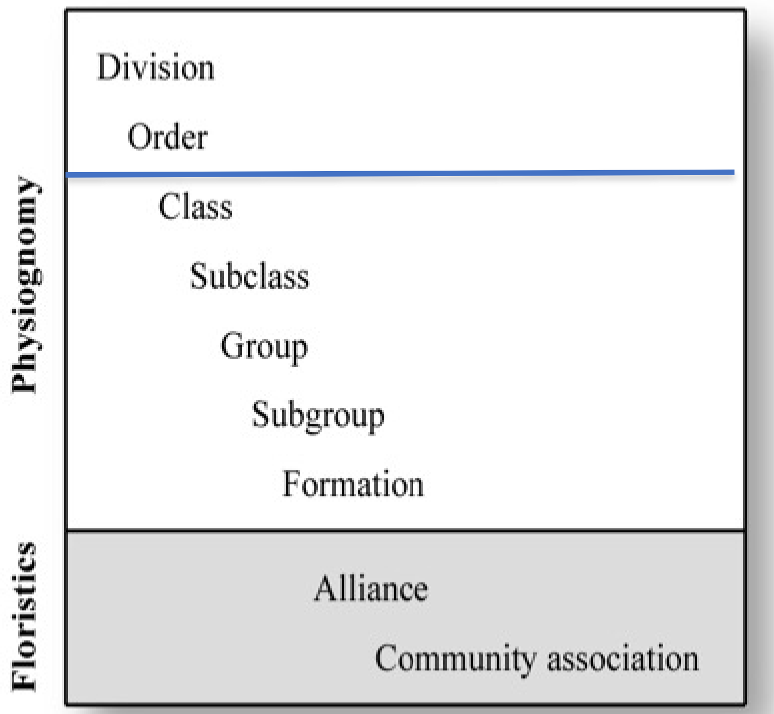
geographic distributions of related species, genera, & families





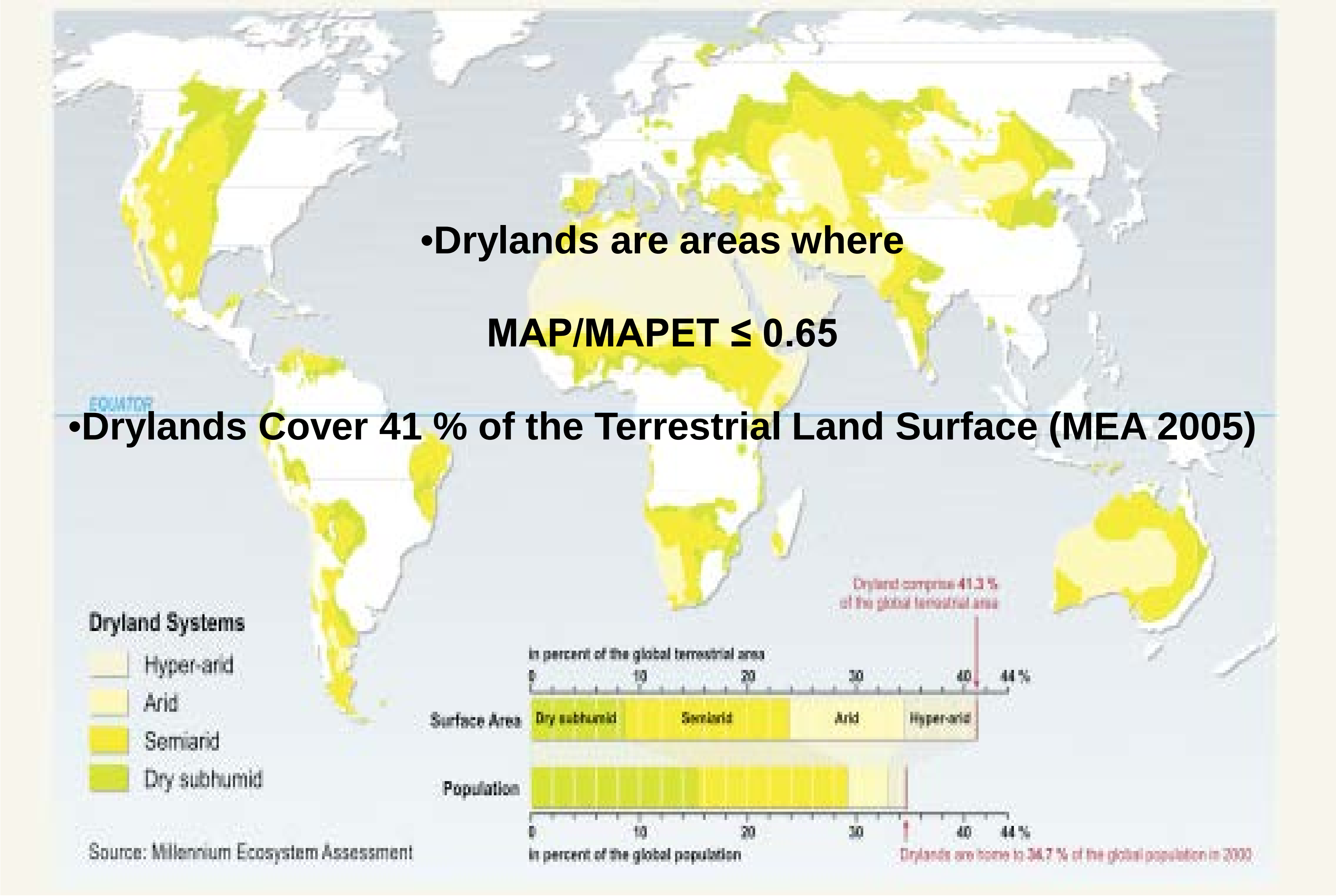
Hierarchical Classifications: Land Cover

U.S. *National Vegetation Classification System*



The Vegetation Subcommittee of the Federal Geographic Data Committee has endorsed the *National Vegetation Classification System* (NVCS) which produces uniform vegetation resource data at the national level. The NVCS uses a systematic approach to classifying a continuum of natural, existing vegetation. The combined physiognomic-floristic hierarchy uses both qualitative and quantitative data appropriate for conservation and mapping at various scales. Physiognomic characteristics include the more general and less precise levels of taxonomy, whereas the floristic characteristics are found in the more specific levels of taxonomy.

Source: **John R. Jensen. 2007. Remote Sensing of the Environment:** **[An Earth Resource Perspective (2nd Edition)]**. **Pearson Prentice Hall, N.J.**

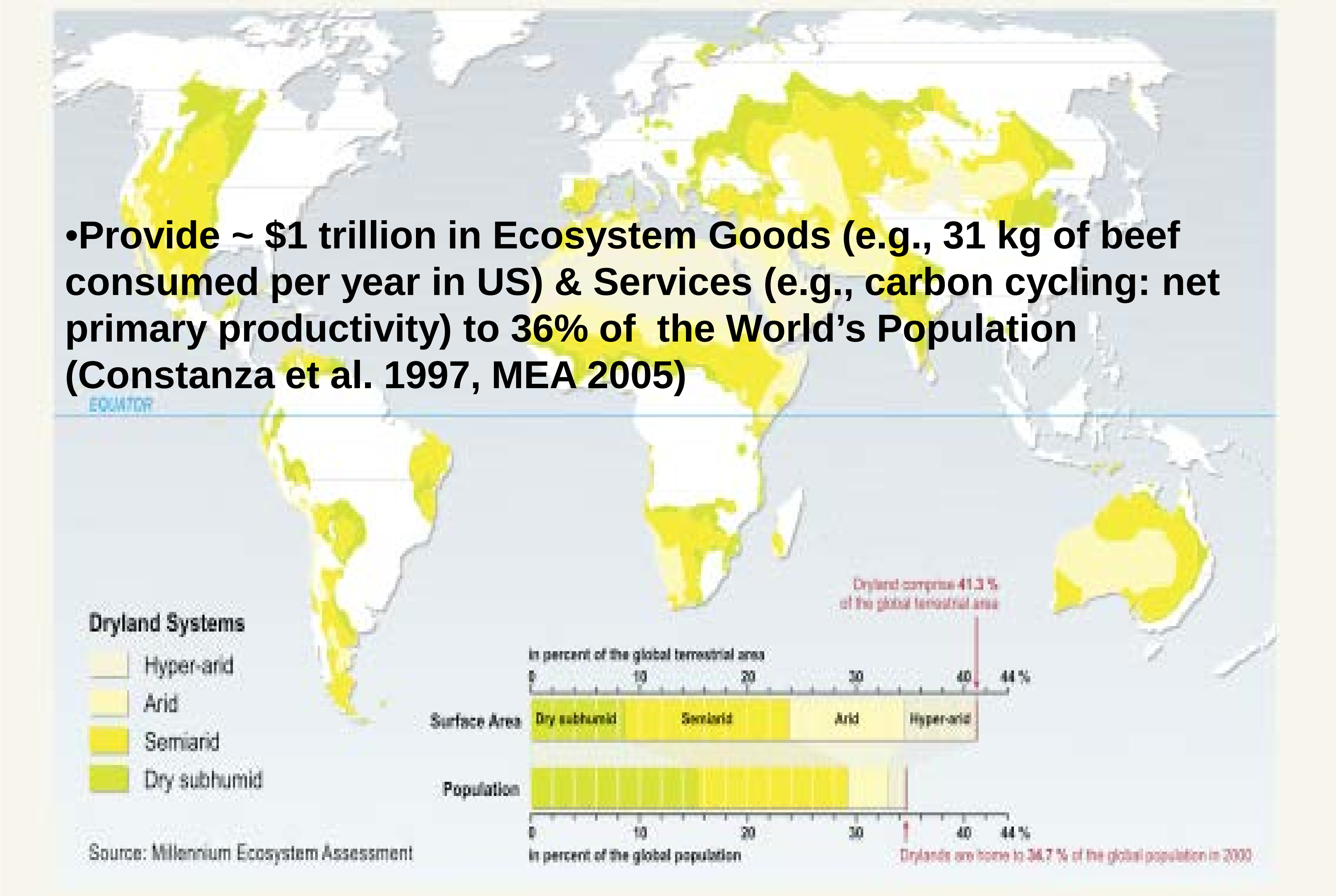


•**Drylands are areas where**

MAP/MAPET ≤ 0.65

•**Drylands Cover 41 % of the Terrestrial Land Surface (MEA 2005)**

•**Provide ~ $1 trillion in Ecosystem Goods (e.g., 31 kg of beef consumed per year in US) & Services (e.g., carbon cycling: net primary productivity) to 36% of the World's Population (Constanza et al. 1997, MEA 2005)**



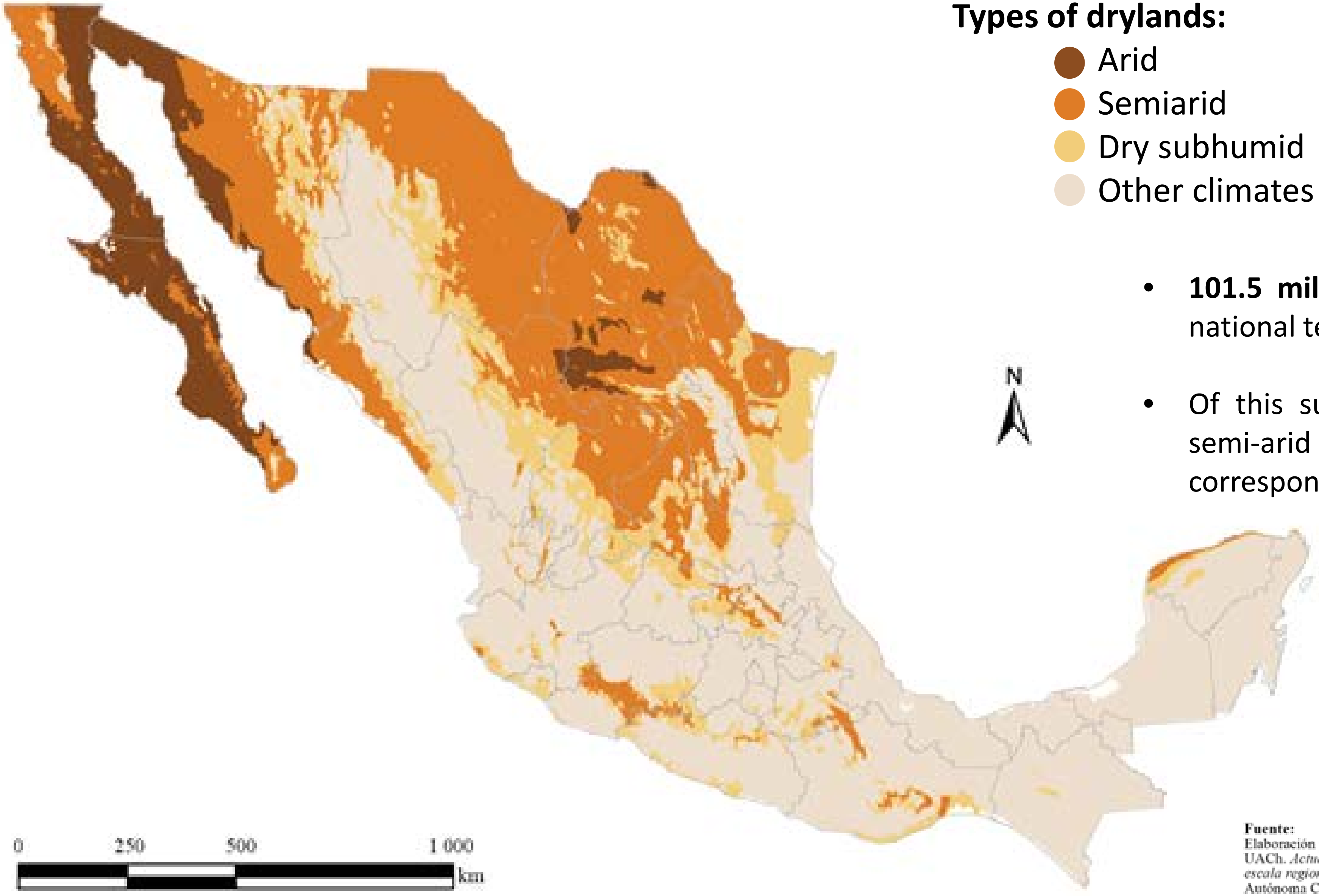
What are Drylands (over 300 definitions)?

~ 45 % of the USA is Drylands (UNCCD definition)

and in México, drylands make up 65% of the territory, or 1,280,494 km^2 (Verbist *et al*., 2010)

Verbist K., Santibañez F., Gabriels D, Soto, G. (2010). Atlas de Zonas Áridas de América Latina y El Caribe. CAZALAC. Documentos Técnicos del PHI-LAC.

DISTRIBUTION OF DRYLANDS: CLIMATE PERSPECTIVE



Types of drylands:

- Arid
- Semiarid
- Dry subhumid
- Other climates

- **101.5 million hectares**, just over half of the national territory.
- Of this surface, arid zones represent 15.7%, semi-arid zones 58% and the remaining 26.3% correspond to dry sub-humid zones

Fuente:
Elaboración propia con datos de:
UACh. *Actualización de la delimitación de zonas áridas, semiáridas y subhúmedas de México, a escala regional.* Reporte final de proyecto de investigación. Departamento de Suelos, Universidad Autónoma Chapingo. México. 2011.

Six Main Uses of Drylands

- Plant products
  - forage, energy, timber
- Livestock production
  - meat, hides, fiber, milk, energy (manure), construction (adobe)
- Wildlife habitat management
  - meat, hides, recreation
- Water catchments
  - water supplies
- Open space for recreation
  - camping, hunting, fishing, photography, wind farming
- Lumber and mineral production

Land Use Distribution within Drylands

Zone	Precipitation	Land Use
Dry sub-humid	600 - 1200 mm	Cropping
Semi-arid	250 - 600 mm	Dryland Farming/Rangeland
Arid	100 - 250 mm	Rangeland (livestock grazing)
Hyper-arid	60 - 100 mm	Marginal livestock

- 88% of Dryland is used for Rangelands
- 3% is used for irrigated croplands
- 9% for rainfed agriculture

Complex System Dynamics

CLIMATE

Drylands in the Earth System

A study of one of the world's driest forests elucidates the climatic effects of drylands.

David S. Schimel

22 JANUARY 2010 VOL 327 SCIENCE www.sciencemag.org

The Yatir Forest from space. The dark color of the forest contrasts with the surrounding, desertified landscapes. The Yatir, which covers about 30 km², warms its local environment by absorbing incoming solar radiation, whereas the surrounding bright desert landscapes reflect more of the incoming radiation to space. Today, the Yatir shows up as a green anomaly in a vast desert landscape, but in biblical times, this entire region was forested.

Contribution of Semi-Arid Forests to the Climate System

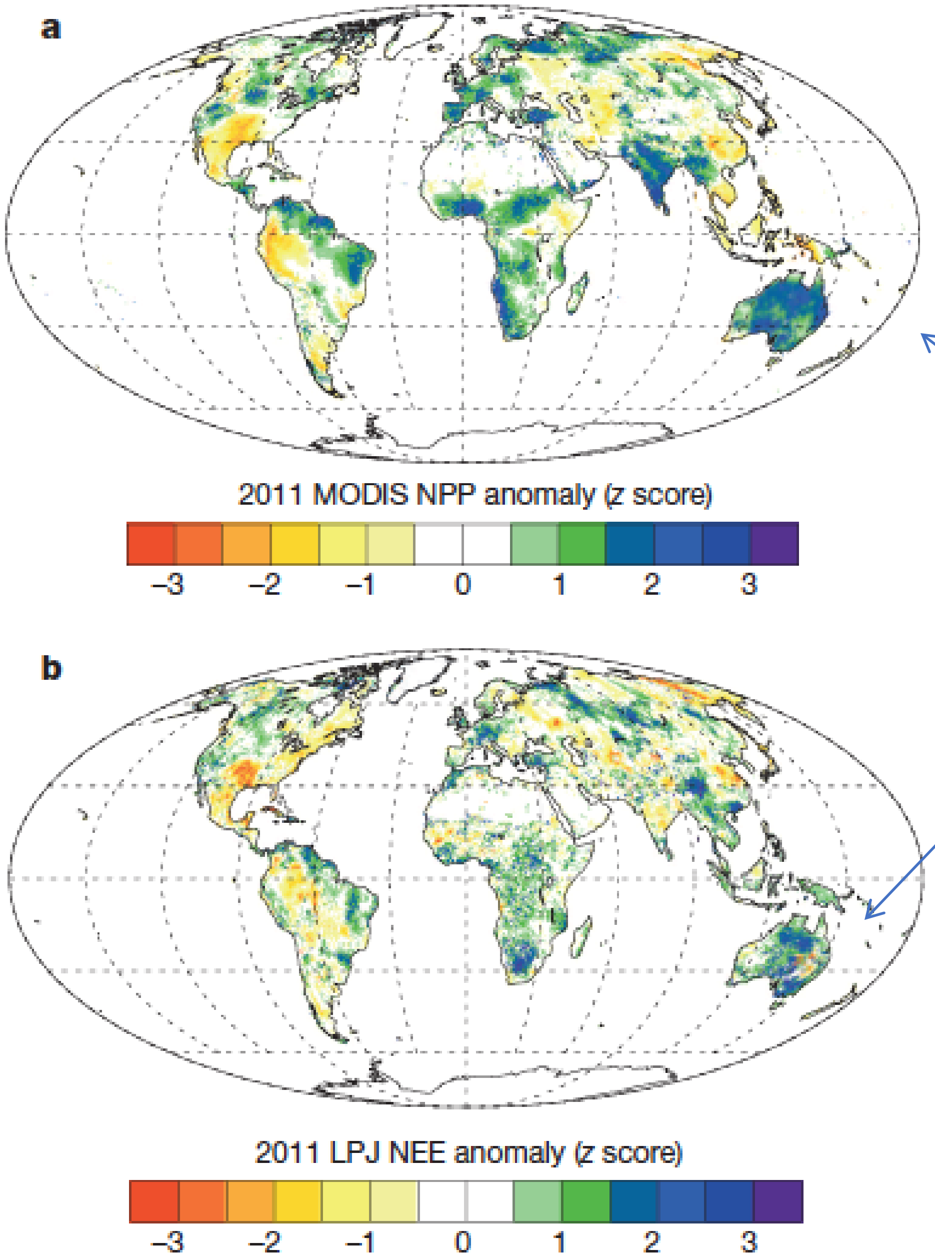
Eyal Rotenberg and Dan Yakir*

Forests both take up CO_2 and enhance absorption of solar radiation, with contrasting effects on global temperature. Based on a 9-year study in the forests' dry timberline, we show that substantial carbon sequestration (cooling effect) is maintained in the large dry transition zone (precipitation from 200 to 600 millimeters) by shifts in peak photosynthetic activities from summer to early spring, and this is counteracted by longwave radiation (*L*) suppression (warming effect), doubling the forestation shortwave (*S*) albedo effect. Several decades of carbon accumulation are required to balance the twofold $S + L$ effect. Desertification over the past several decades, however, contributed negative forcing at Earth's surface equivalent to ~20% of the global anthropogenic CO_2 effect over the same period, moderating warming trends.

Table 1. Indicators of carbon use efficiency in pine forests: *GPP*, R_e, and *NEE* of carbon for the 12 European pine forest sites [62 data years (*36*)], for the entire global Fluxnet network (*43*), and for semi-arid forest [Yatir (*44*)].

Pine forest	*GPP*	R_e	*NEE*	*NEE/GPP*
European (Carboeurope)	1142	944	200	0.17
Global (FluxNet)	1540	1280	260	0.17
Semi-arid (Yatir)	820	600	220	0.27

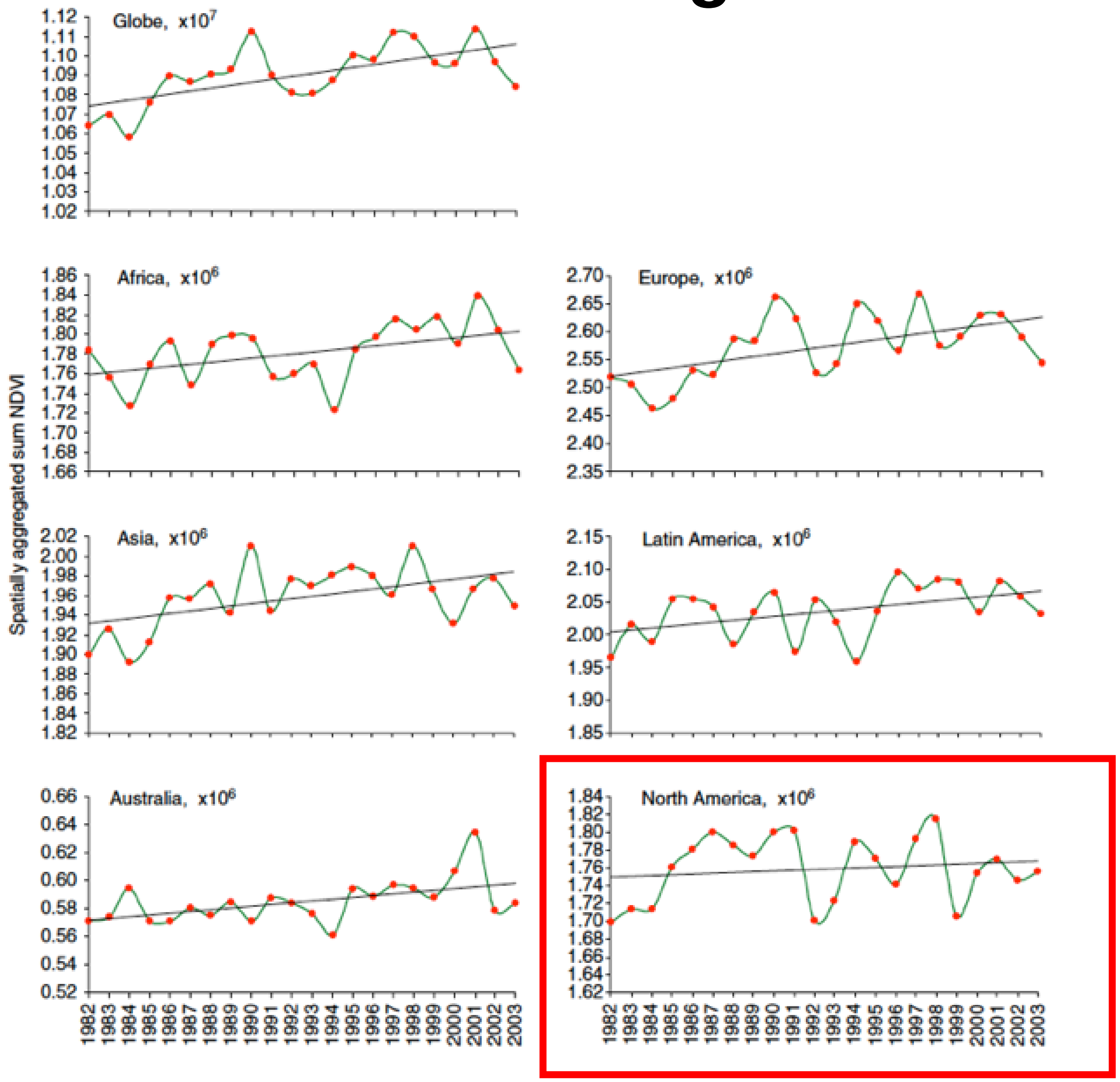
New Finding: Drylands Largest Carbon Sink in the World in 2011



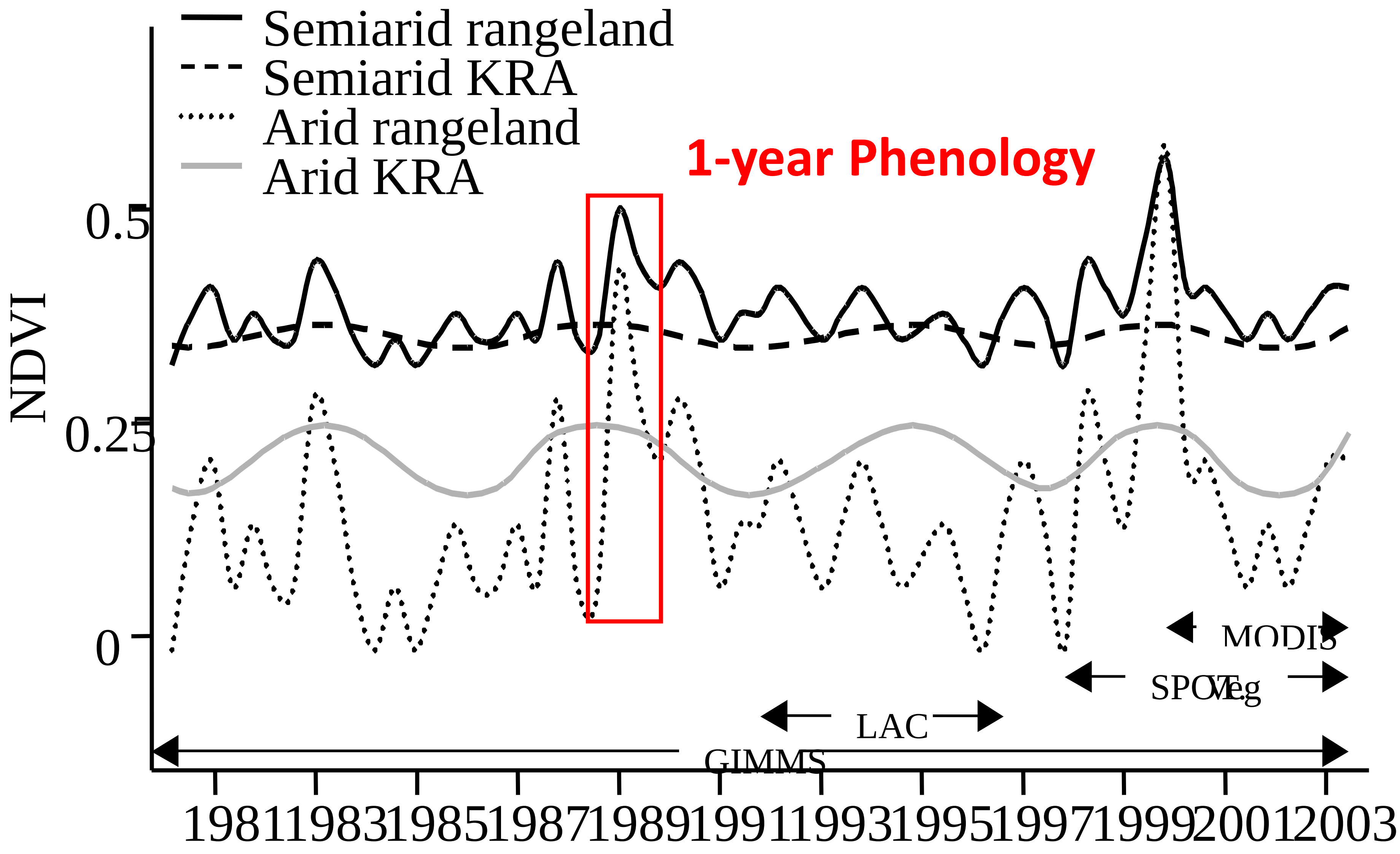
57% of Carbon in Australia

Poulter et al. (2014). Nature DOI: 10.1038/nature13376

Global Greening Trend

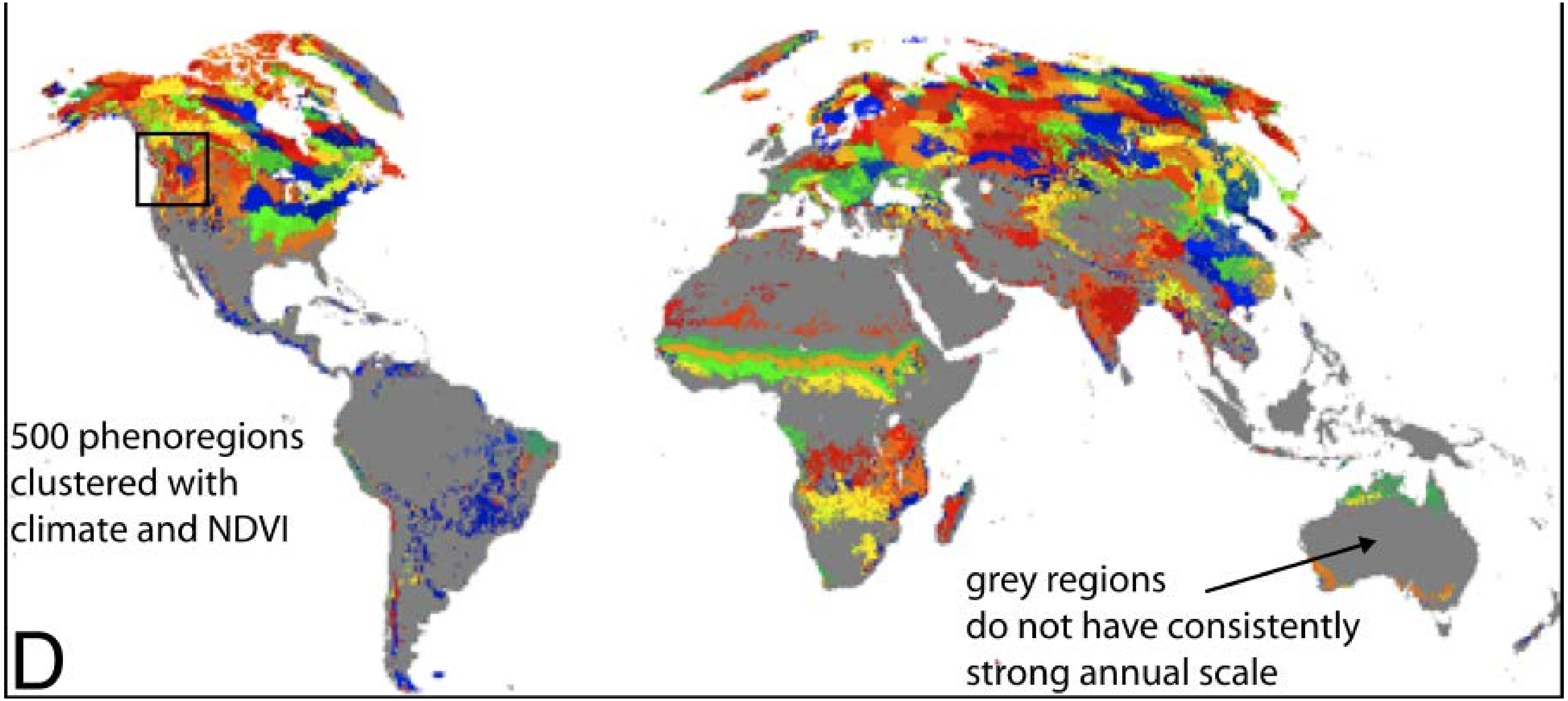


Bai et al.2008. Proxy global assessment of land degradation. Soil Use and management 24: 223-234

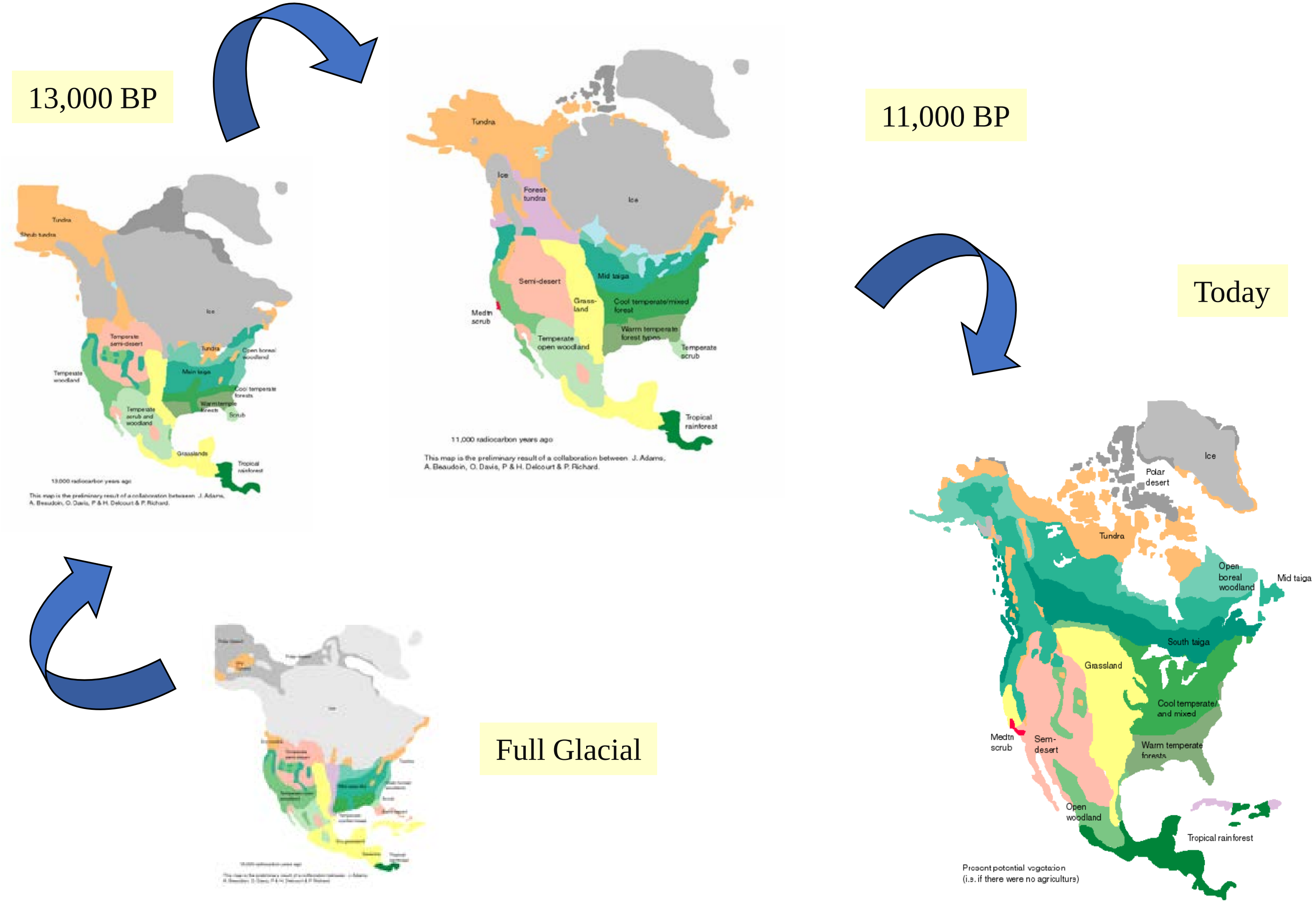


www.nrel.colostate.edu/projects/ agecosys/pres/files/26_pres.ppt

Drylands are Regions with Unstable Plant Growth intra-annually and interannually



White et al. 2004. A global framework for monitoring phenological responses to climate change. Geophysical Research Letters, vol. 32, l04705



North American Vegetation Changes

JM Adams & H. Faure. 1998. A new estimate of changing carbon storage on land since the last glacial maximum, based on global land ecosystem reconstruction Global and Planetary Change **16-17: 3-24.**

Climate Change is Projected to Expand North American Drylands

Is Dryland climate changing?

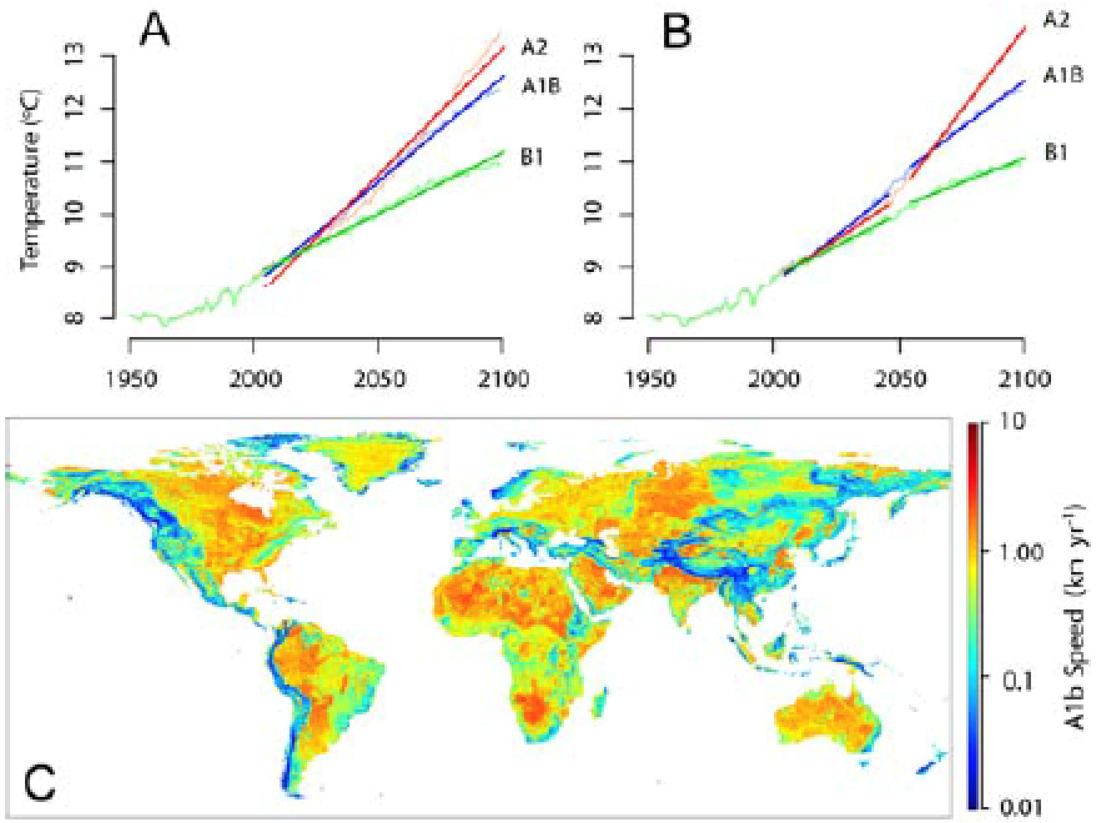


Figure 2| The velocity of temperature change globally. a, Temporal gradients calculated from 2000 through 2100 across three emissions scenarios. **b**, Temporal gradients calculated from 2000 – 2050 and 2050 – 2100 across three emissions scenarios. Trends plotted here are the average of the global land surface. **c**, A global map of climate velocity calculated using the 2050 – 2100 SRES A1B emissions scenario temporal gradient.

Loarie, S.R. , P.H. Duffy, H. Hamilton, G.P. Asner, C.B. Field, D.D. Ackerly. 2009. The velocity of climate change. Nature 462:1052-1055.

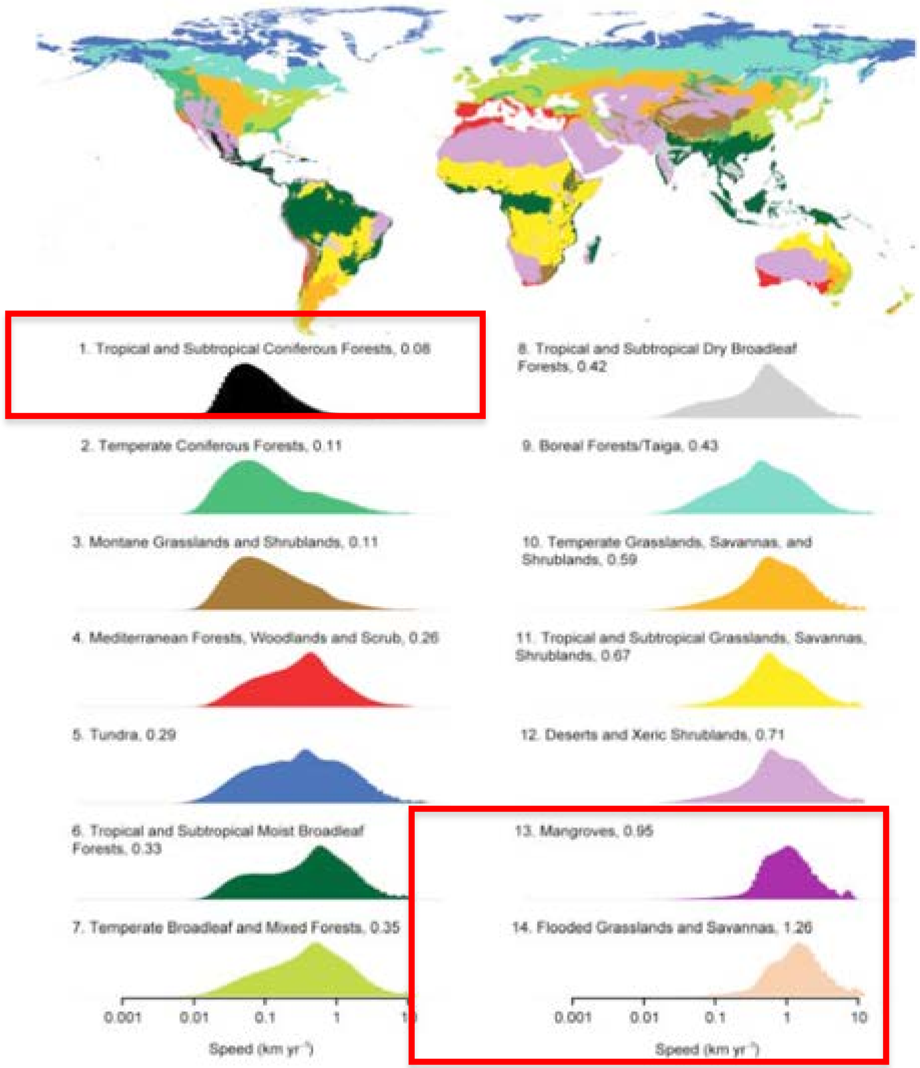


Figure 3| The velocity of temperature change by biome. A map of biomes and histograms of the speed of temperature change within each biome. Histograms are ordered by increasing velocity according to their geometric means.

Loarie, S.R. , P.H. Duffy, H. Hamilton, G.P. Asner, C.B. Field, D.D. Ackerly. 2009. The velocity of climate change. Nature 462:1052-1055.

Diameter Protected Area (km) / climate velocity (km/hr)

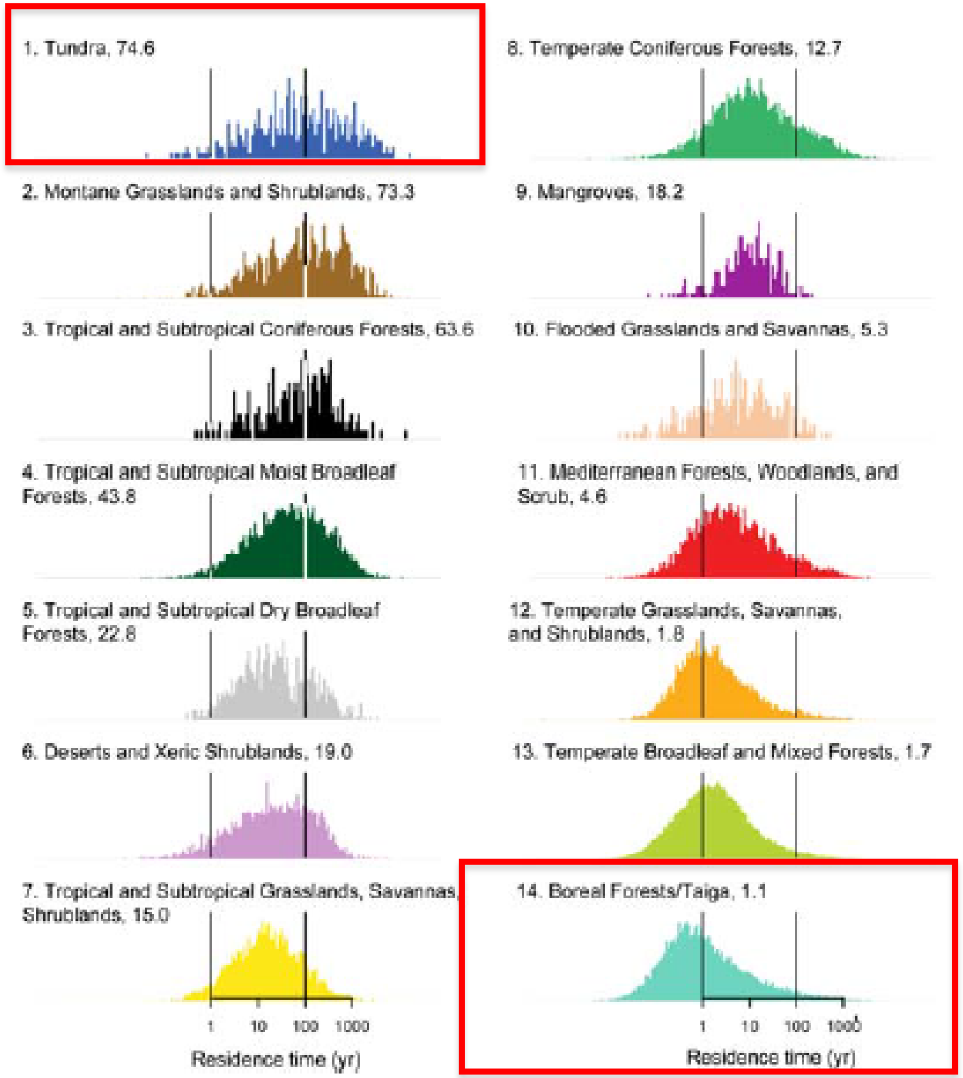


Figure 4| Climate residence time (yr) in protected areas. Histograms represent the ratio of protected area diameter (km) to climate velocity (km/hr), and are ordered by decreasing mean residence time across biomes. The vertical bar indicates 1 and 100 years.

Loarie, S.R. , P.H. Duffy, H. Hamilton, G.P. Asner, C.B. Field, D.D. Ackerly. 2009. The velocity of climate change. Nature 462:1052-1055.

Jun/Jul/Aug

Departures from average

1895-2011

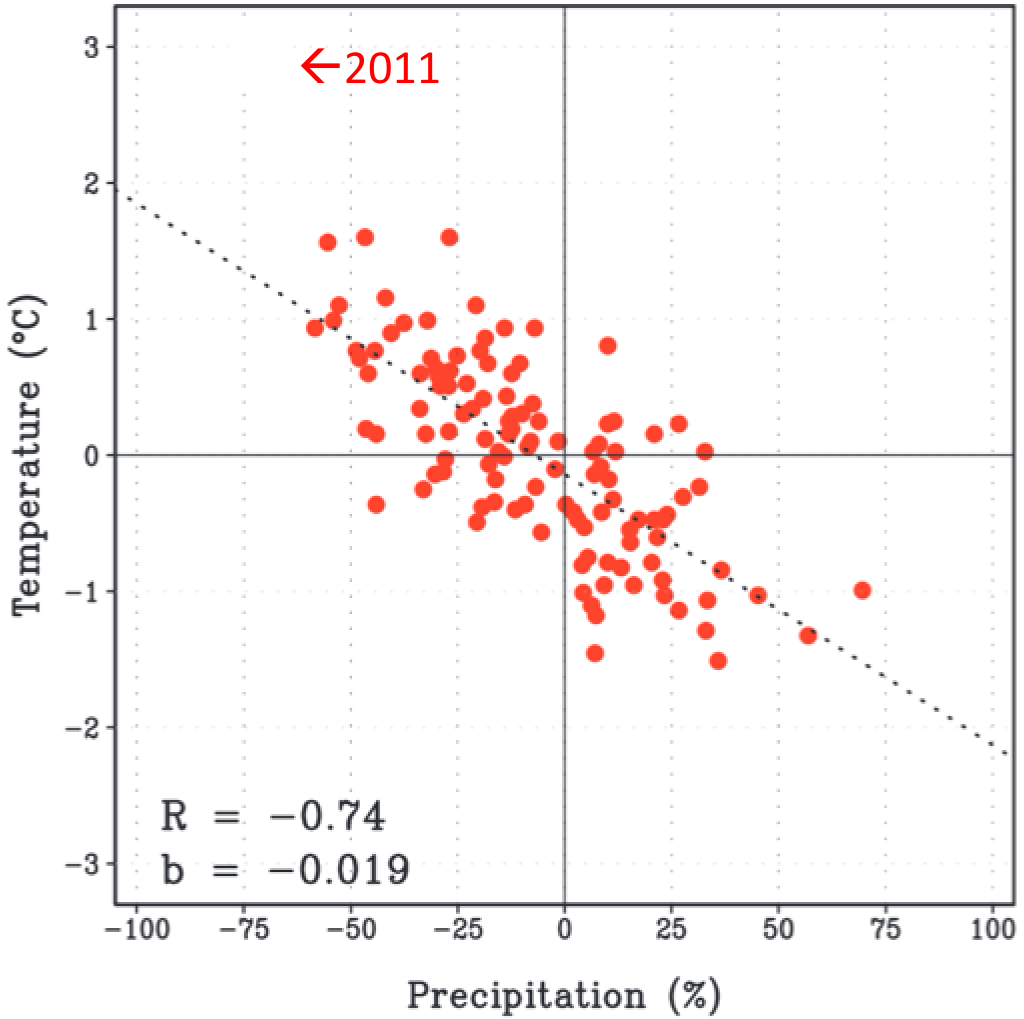


FIG. 5. The historical relationship between JJA Texas averaged rainfall departures (% of climatology) and surface temperature departures (°C). Each dot corresponds to a summer during 1895–2010, and the 2011 value is indicated by the blue wagon wheel. Inset values are for the correlation *R* and the slope of the linear fit expressed as degree Celsius per percent precipitation departure.

Source: Hoerling, M. et al., 2013: Anatomy of an Extreme Event. *J. Climate*, **26**, 2811–2832.

Ecological Applications, 26(2), 2016, pp. 602–611

Tree mortality from an exceptional drought spanning mesic to semiarid ecoregions

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[3]*Department of Geography, University of Tennessee, Knoxville, Tennessee 37990-0925 USA*

Abstract. Significant areas of the southern USA periodically experience intense drought that can lead to episodic tree mortality events. Because drought tolerance varies among species and size of trees, such events can alter the structure and function of terrestrial ecosystem in ways that are difficult to detect with local data sets or solely with remote-sensing platforms. We investigated a widespread tree mortality event that resulted from the worst 1-year drought on record for the state of Texas, USA. The drought affected ecoregions spanning mesic to semiarid climate zones and provided a unique opportunity to test hypotheses related to how trees of varying genus and size were affected. The study was based on an extensive set of 599 distributed plots, each 0.16 ha, surveyed in the summer following the drought. In each plot, dead trees larger than 12.7 cm in diameter were counted, sized, and identified to the genus level. Estimates of total mortality were obtained for each of 10 regions using a combination of design-based estimators and calibrated remote sensing using MODIS 1-yr change in normalized difference vegetation index products developed by the U.S. Forest Service. As compared with most of the publicized extreme die-off events, this study documents relatively low rates of mortality occurring over a very large area. However, statewide, regional tree mortality was massive, with an estimated 6.2% of the live trees perishing, nearly nine times greater than normal annual mortality. Dead tree diameters averaged larger than the live trees for most ecoregions, and this trend was most pronounced in the wetter climate zones, suggesting a potential re-ordering of species dominance and downward trend in tree size that was specific to climatic regions. The net effect on carbon storage was estimated to be a redistribution of 24–30 Tg C from the live tree to dead tree carbon pool. The dead tree survey documented drought mortality in more than 29 genera across all regions, and surprisingly, drought resistant and sensitive species fared similarly in some regions. Both angiosperms and gymnosperms were affected. These results highlight that drought-driven mortality alters forest structure differently across climatic regions and genera.

Key words: *acute drought impact; Central North America; dead carbon pool; forest structure; Texas, USA; tree death.*

What areas and populations are included in the definition?

A Question of Space & Time Scale Perspectives

Grain

AVHRR 1km

MODIS 250m

TM 30m

TM 15m

IKONOS 4m

DOQ 1m

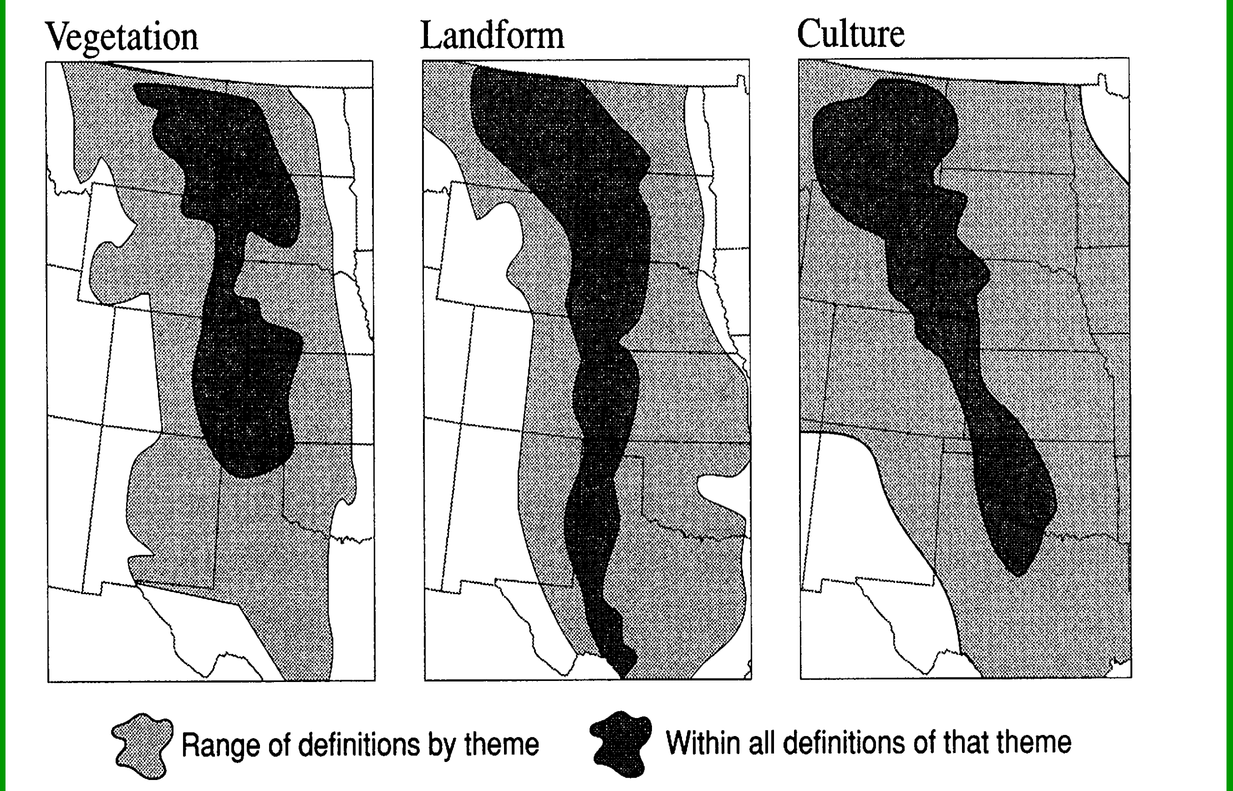
- Grain is the raster equivalent of the term scale and refers to the resolution of a particular raster based database.
- This application of "scale" often confuses people.

Extent: **J Harlen Bretz 1923 Hypothesis: The channeled scablands had been formed catastrophically by a single gigantic flood of glacial meltwater.**

Confirmed in the 1970’s

Stephen J. Gould. 1980. The Great Scablands Debate pp194 - 203 in The Panda’s Thumb. W.W. Norton & Company, N.Y.

Alternative Definitions of the "Great Plains" using different bases



Though the Extent of Drylands is not Clear, The Administrative Border is more clearly defined

The Present Fence/Wall

Source: Center for Investigative Reporting and OpenStreetMap

BORDER STATES

USA

States:

New Mexico

Arizona

California

Texas

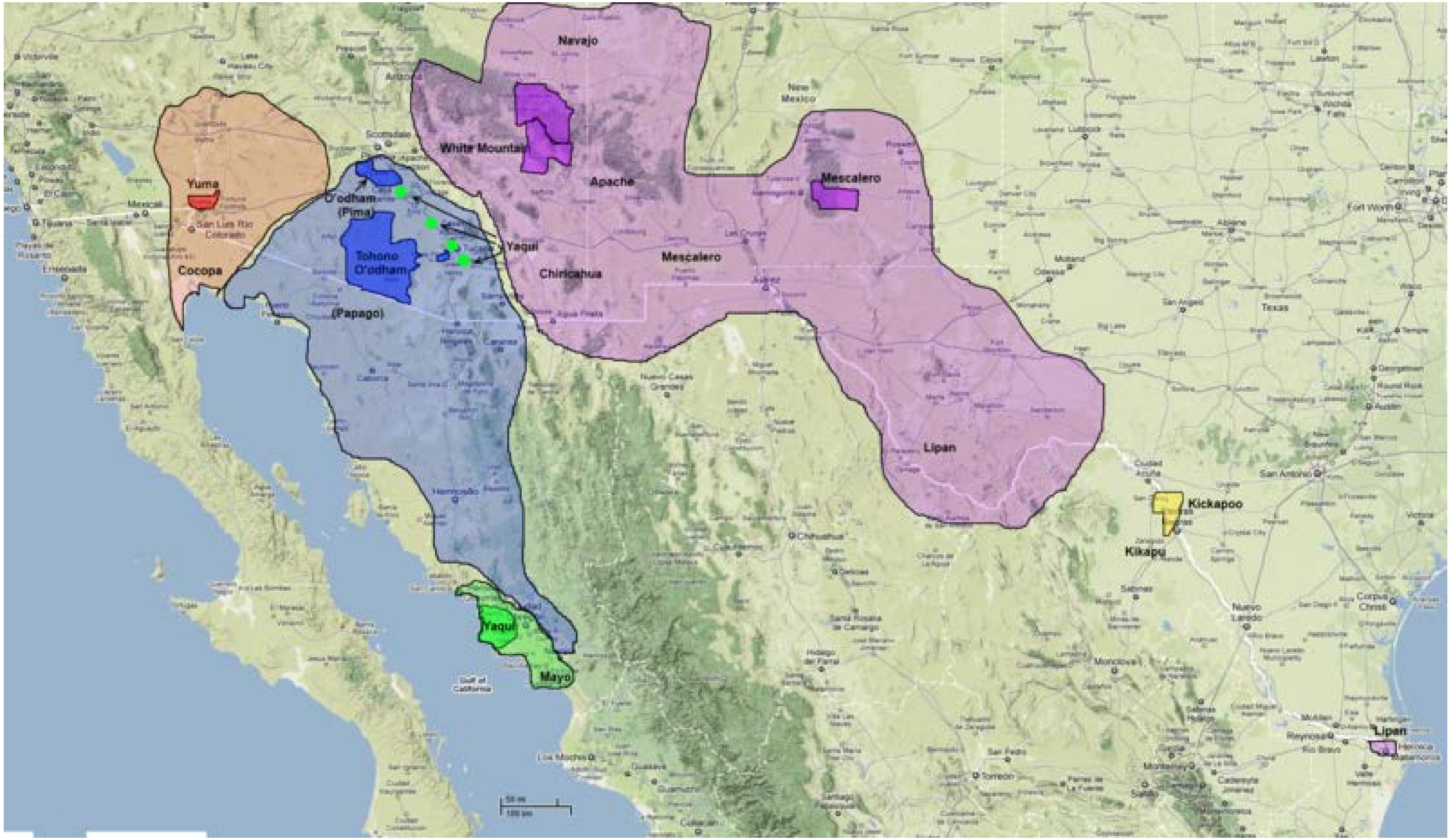
Mexico

States:

Baja California, Sonora, Chihuahua, Coahuila, Nuevo León y Tamaulipas.

Of Borders & Boundaries

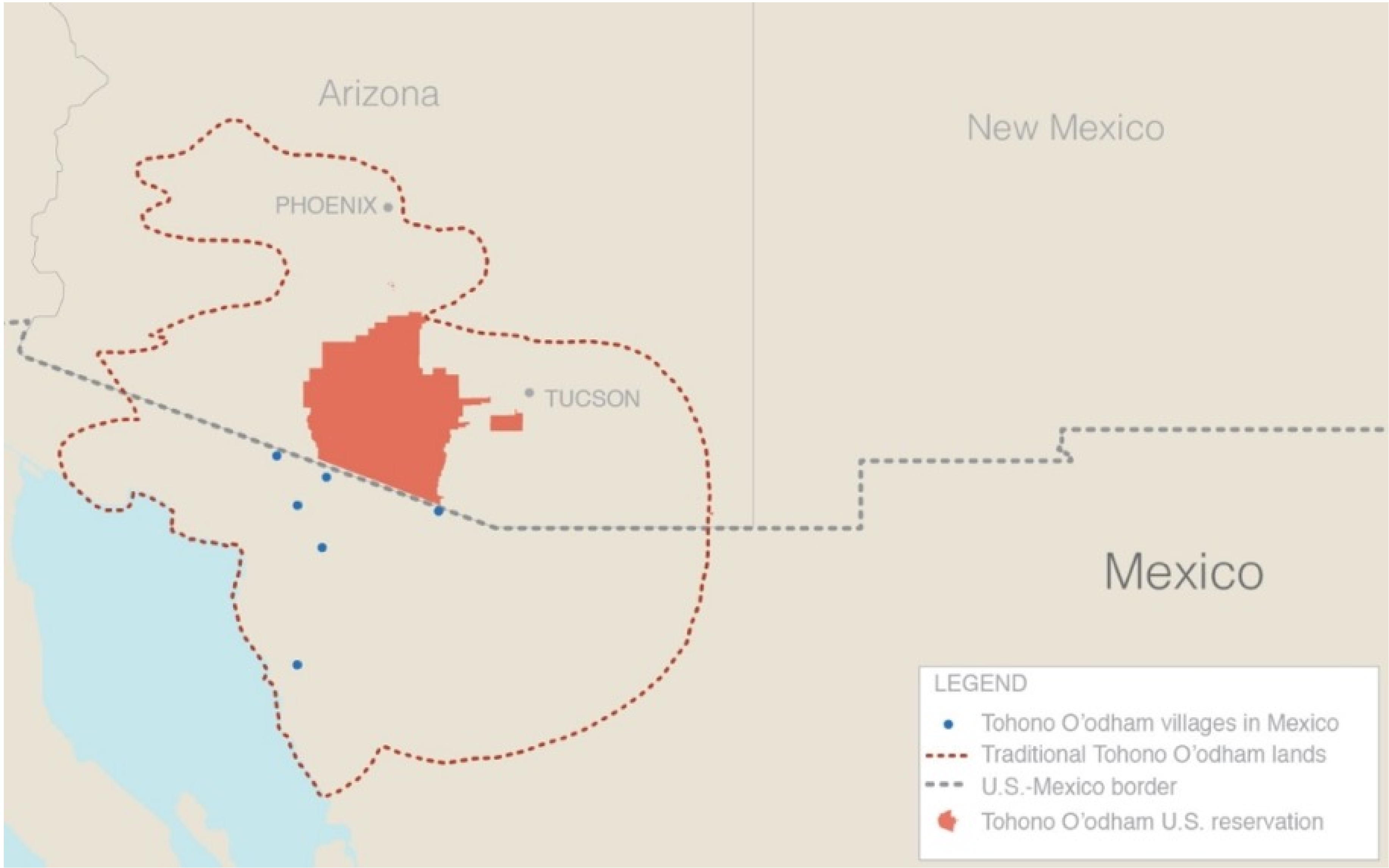
Native American Lands: The light areas are the tribes original territory.
The dark areas are their current reservations.



Affected Peoples:
Yuma
Yaqui
Pima
Apache
Kickapoo

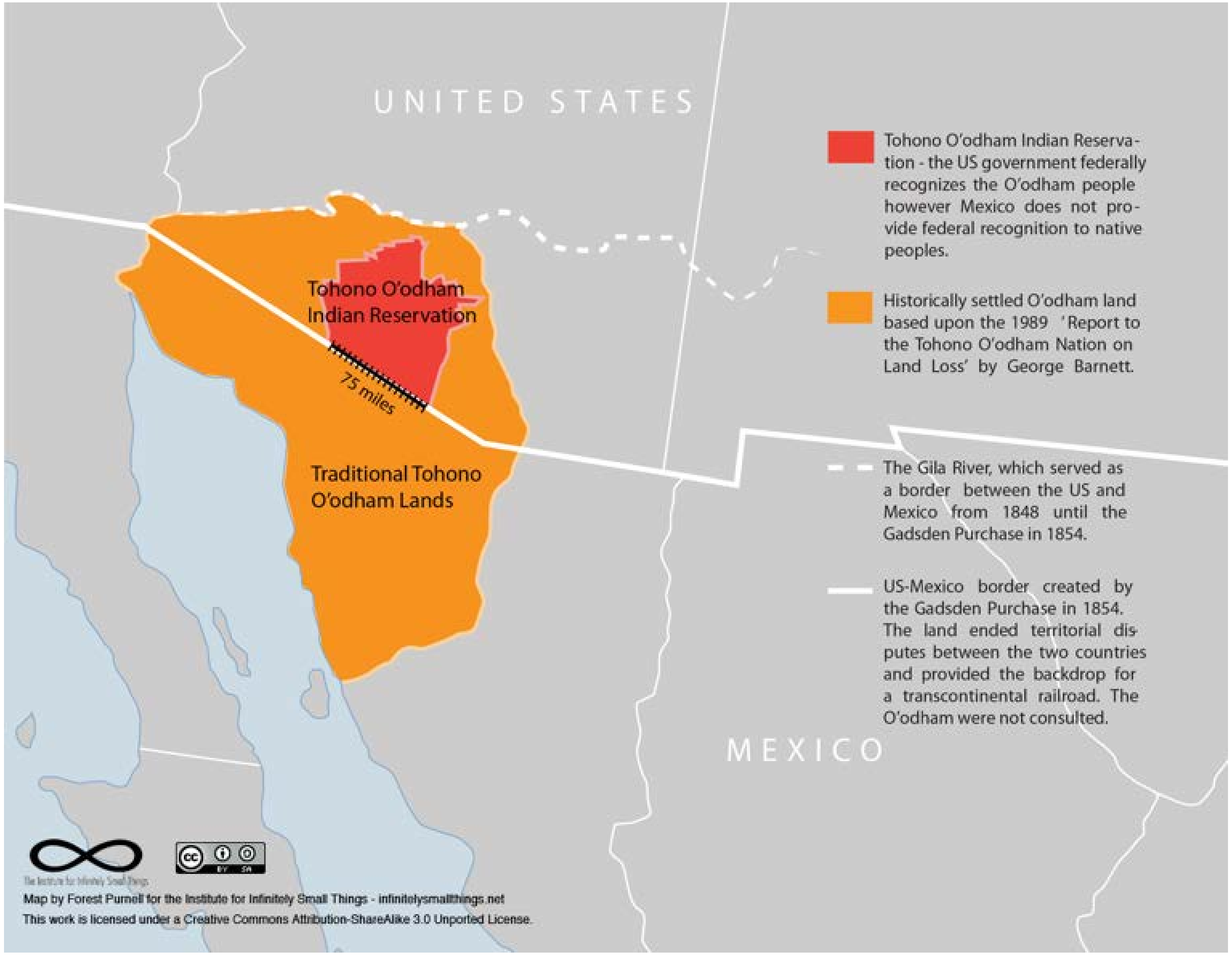
https://indigenouspeoplesandtheborder.wikispaces.com/Information+about+the+Native+American+tribes+that+historically+lived+on+the+US-Mexico+Border

Of Borders & Boundaries: Tohono O'odham



http://america.aljazeera.com/articles/2014/5/25/us-Mexico-borderwreakshavocwithlivesofanindigenousdesertpeople.html

Of Borders & Boundaries: Tohono O'odham



http://america.aljazeera.com/articles/2014/5/25/us-Mexico-borderwreakshavocwithlivesofanindigenousdesertpeople.html

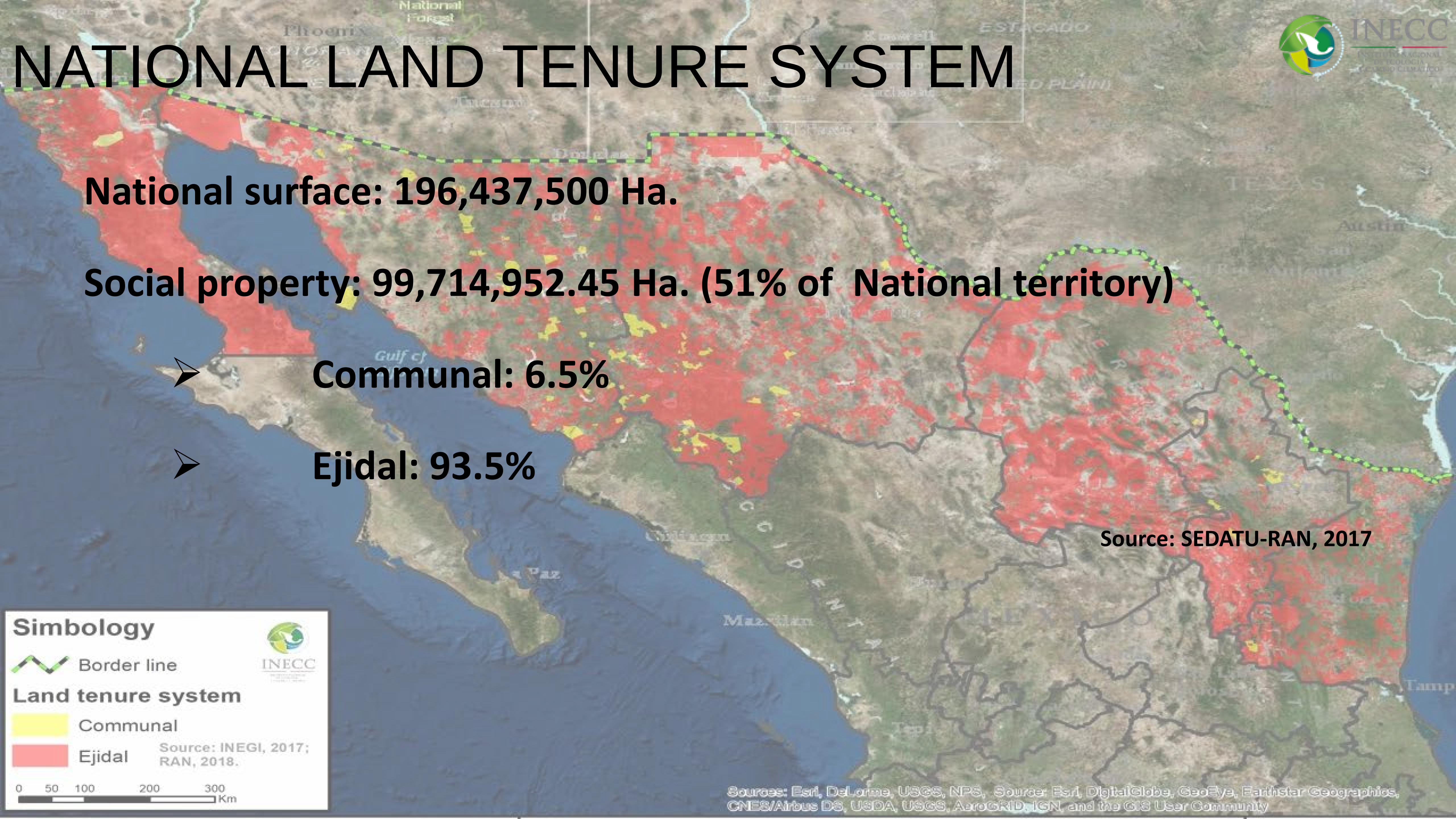
NATIONAL LAND TENURE SYSTEM

National surface: 196,437,500 Ha.

Social property: 99,714,952.45 Ha. (51% of National territory)

- **Communal: 6.5%**
- **Ejidal: 93.5%**

Source: SEDATU-RAN, 2017



Why is it important to consider the region as a whole?

SHARED GODOS: FUNCTIONAL CONNECTIVITY & ECOSYSTEM SERVICES

Key elements:

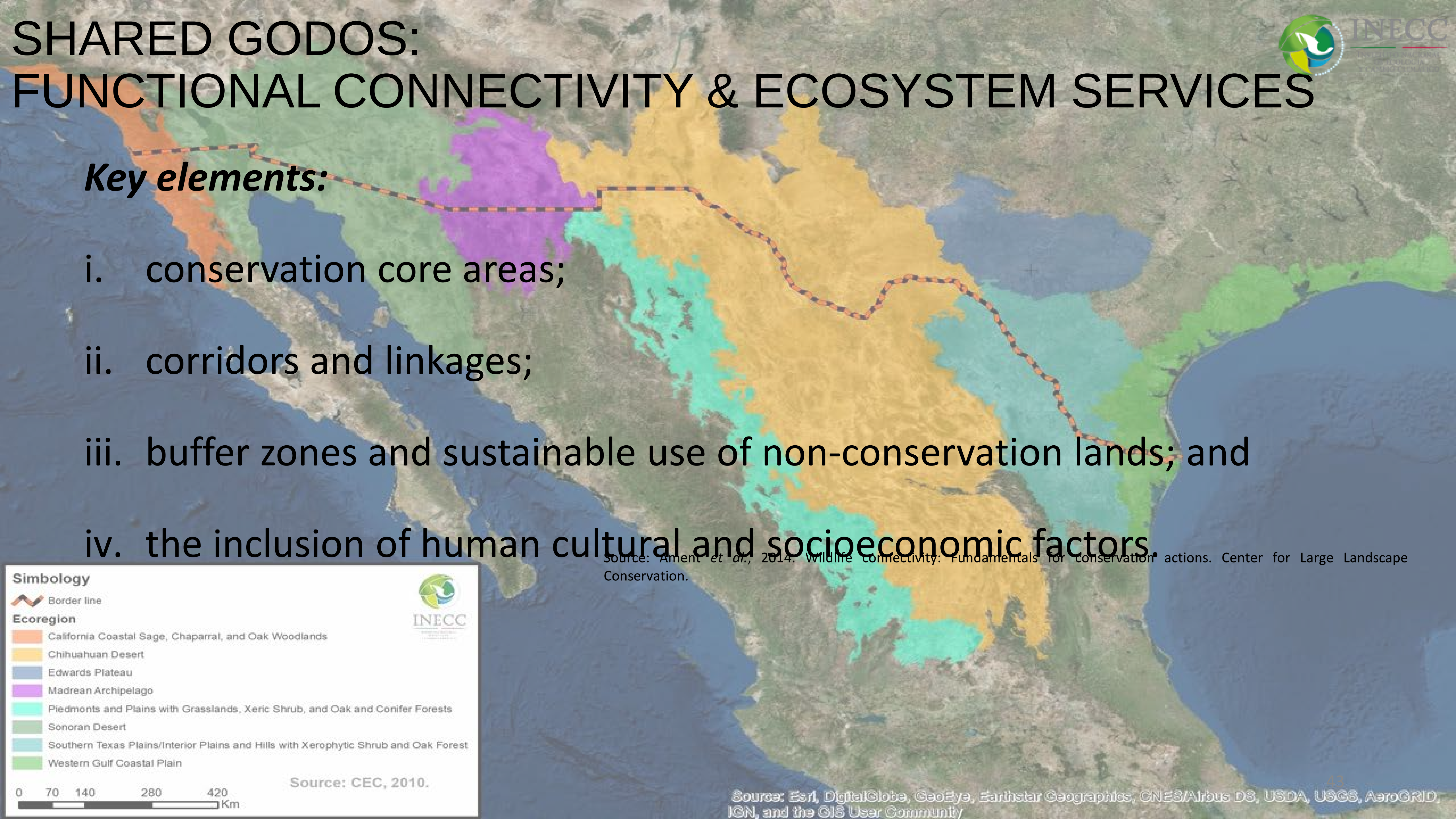
i. conservation core areas;

ii. corridors and linkages;

iii. buffer zones and sustainable use of non-conservation lands; and

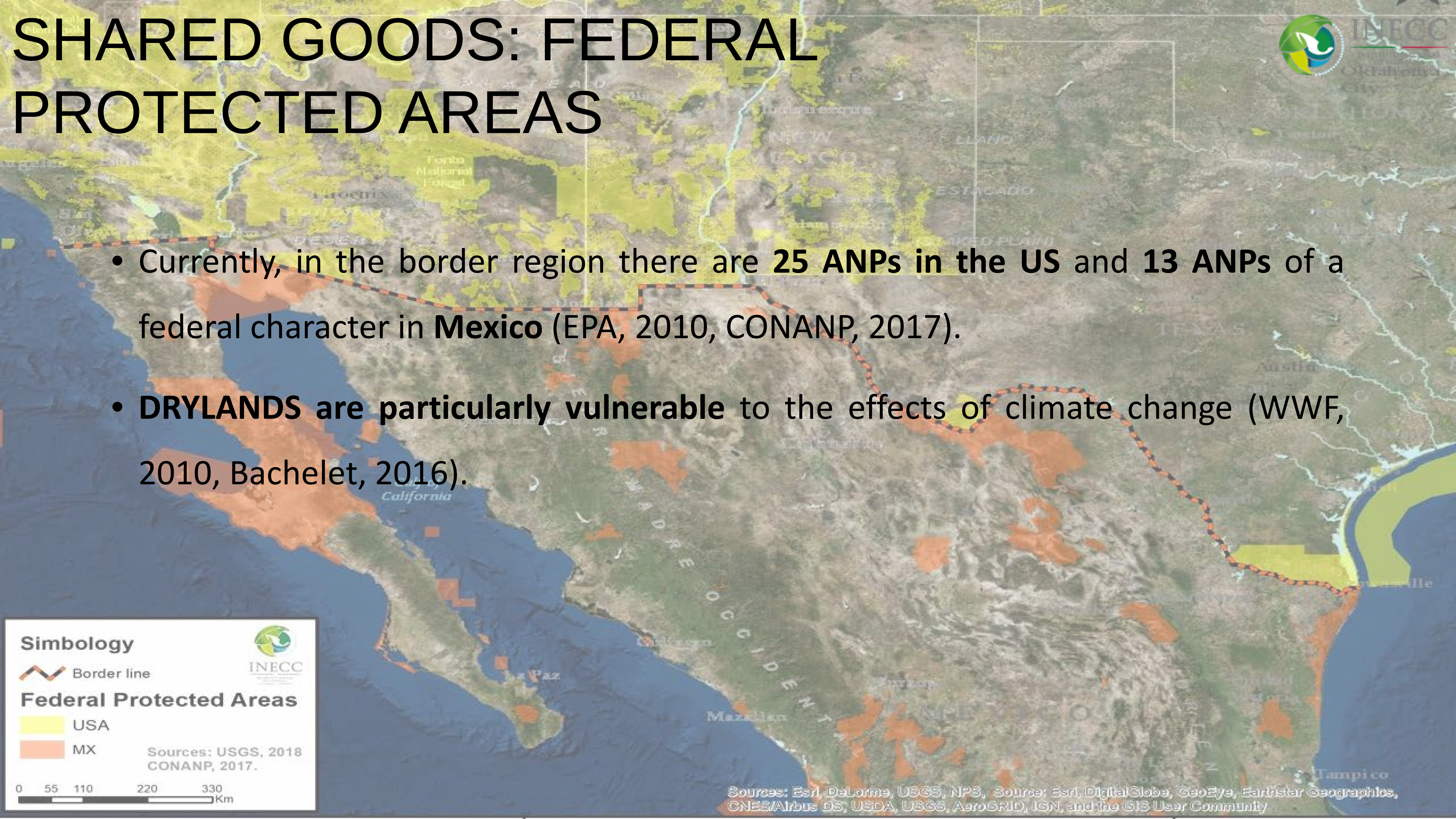
iv. the inclusion of human cultural and socioeconomic factors.

Source: Ament *et al.*, 2014. Wildlife connectivity: Fundamentals for conservation actions. Center for Large Landscape Conservation.



SHARED GOODS: FEDERAL PROTECTED AREAS

- Currently, in the border region there are **25 ANPs in the US** and **13 ANPs** of a federal character in **Mexico** (EPA, 2010, CONANP, 2017).
- **DRYLANDS are particularly vulnerable** to the effects of climate change (WWF, 2010, Bachelet, 2016).

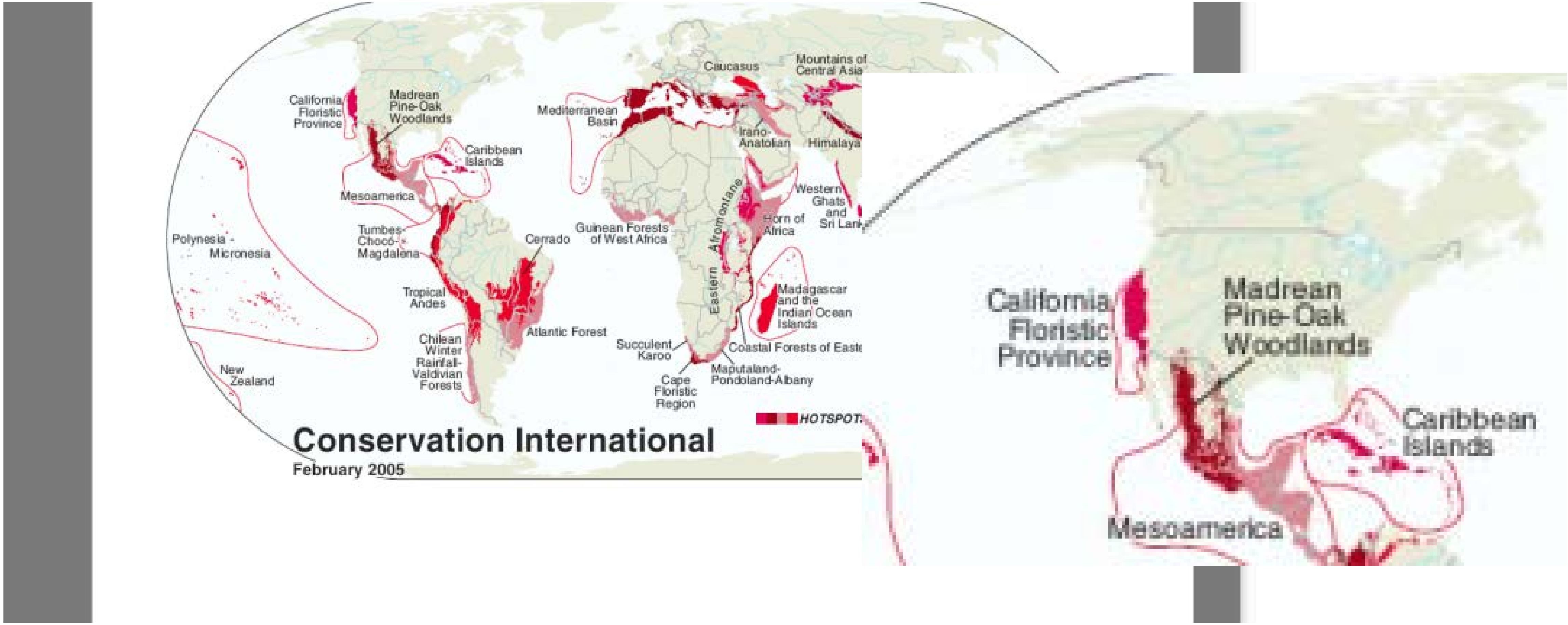


CONSERVATION IN BORDER DRYLANDS (MEXICO)

- There are **24 priority terrestrial regions**, as well as **13 priority hydrological regions**, which are the basis for implementing conservation efforts. In addition to **15 Areas of Importance for the Conservation of Birds**, **10 RAMSAR** sites and **581 Epicontinental aquatic priority sites** (CONABIO, 2008).
- The ecosystems present in the border region have an **enormous natural value**, among which the **Sonoran Desert and Chihuahuan Desert, the Bravo / Grande River**, the wetlands of the **Colorado River Delta and Laguna Madre** stand out.

Photo: ©Ian Shive

~35 BIODIVERSITY HOTSPOTS IN THE WORLD



http://www.cepf.net/resources/hotspots/Pages/default.aspx click for updates

US protected lands mismatch biodiversity priorities

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Edited* by Edward O. Wilson, Harvard University, Cambridge, MA, and approved March 17, 2015 (received for review September 23, 2014)

Because habitat loss is the main cause of extinction, where and how much society chooses to protect is vital for saving species. The United States is well positioned economically and politically to pursue habitat conservation should it be a societal goal. We assessed the US protected area portfolio with respect to biodiversity in the country. New synthesis maps for terrestrial vertebrates, freshwater fish, and trees permit comparison with protected areas to identify priorities for future conservation investment. Although the total area protected is substantial, its geographic configuration is nearly the opposite of patterns of endemism within the country. Most protected lands are in the West, whereas the vulnerable species are largely in the Southeast. Private land protections are significant, but they are not concentrated where the priorities are. To adequately protect the nation's unique biodiversity, we recommend specific areas deserving additional protection, some of them including public lands, but many others requiring private investment.

conservation priorities | protected areas | endemism | range size | extinction

of species richness (19), but they are generally not the species in need of conservation efforts.

In identifying conservation priorities, one must consider both existing protected areas and the intrinsic vulnerability of species. Vulnerable species tend to be in two groups (10): those with small geographic ranges, which is often correlated with local rarity, and large-bodied species that are sparsely distributed across large ranges. The latter species, which are relatively few but include predators like panthers and wolves, were largely extirpated from the east and still face persecution across large extents of the west.

Most imperiled species are of the first group: small range size is the best predictor of extinction risk and, thus, the first metric for conservation priority (20–22). We focus on small-ranged species defined in several ways. First, we consider endemics—those with their entire range in the United States (*Methods*). Amphibians (70%) and freshwater fish (68%) show the highest levels of endemism, followed by reptiles (30%), trees (29%), mammals (28%), and birds (<3%). Patterns of endemism for all taxa are consistently centered in the Southeast, although the west also has significant

[redacted]

Areas That are Not Protected

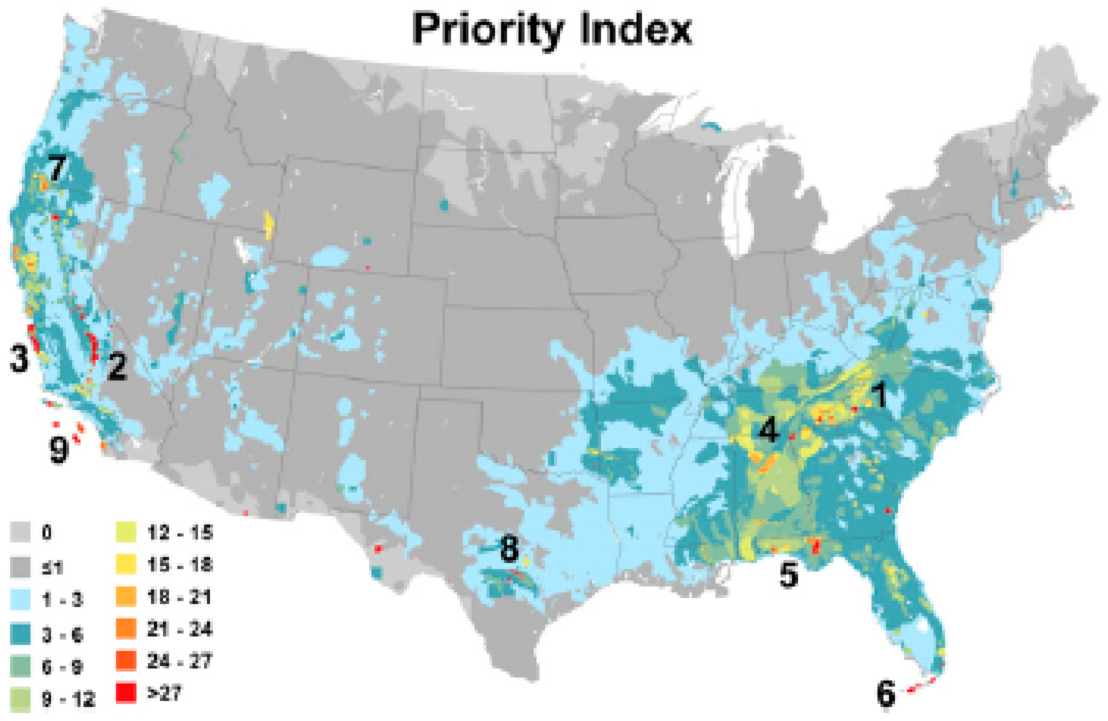

Fig. 4. Summed priority scores across all taxa and recommended priority areas to expand conservation: 1, Middle to southern Blue Ridge Mountains; 2, Sierra Nevada Mountains, particularly the southern section; 3, California Coast Ranges; 4, Tennessee, Alabama, and northern Georgia watersheds; 5, Florida panhandle; 6, Florida Keys; 7, Klamath Mountains, primarily along the border of Oregon and California; 8) South-Central Texas around Austin and San Antonio; 9, Channel Islands of California.

GIS Results available at BiodiversityMapping.org

SHARED GOODS: DRYLANDS BIODIVERSITY

- The drylands provide habitats for 80% of North America’s mammal, bird and amphibian species.
- Drylands provide important habitats for many unique species that are of global conservation concern.
- Drivers of dryland biodiversity loss:
  - habitat conversión, climate change, over-harvesting, grazing pressures, introduced species, and inappropriate soil management

Source: Davies, J., Poulsen, L., Schulte-Herbrüggen, B., Mackinnon, K., Crawhall, N., Henwood, W.D., Dudley, N., Smith, J. and Gudka, M. 2012. *Conserving Dryland Biodiversity*. xii +84p

Photo: ©Krista Schlyer

CONSERVING DRYLAND BIODIVERSITY

INECC
INSTITUTO NACIONAL DE ECOLOGÍA Y CAMBIO CLIMÁTICO

Strategies for dryland biodiversity conservation:

1. Innovation, knowledge and science
2. Incentives and investment
3. Governance and empowerment
4. Mainstreaming dryland biodiversity

Source: Davies, J., Poulsen, L., Schulte-Herbrüggen, B., Mackinnon, K., Crawhall, N., Henwood, W.D., Dudley, N., Smith, J. and Gudka, M. 2012. *Conserving Dryland Biodiversity*. xii +84p

Photo: ©Krista Schlyer

SHARED GOODS: NATIVE COMMUNITIES

Native communities are major players in border politics, indigenous communities and indigenous nations address border policy in the context of their historical and contemporary relationship with the land, based on their spiritual and cultural practices, traditional subsistence and interaction with plants and animals, and a continuous responsibility for caring for their land.

- The indigenous people who live along the border depend on the natural environment for their sustenance and survival, as well as for ritual purposes.
- Marginalized communities are more vulnerable to extreme events, caused by climate change.

Source: Semarnat-EPA, 2012. *Programa ambiental México-Estados Unidos FRONTERA 2020*

Photo: ©Villasana, A.

COMMON PROBLEMS: AIR POLLUTION

- The international report of Greenhouse Effect Gases (GHG) under the Kyoto Protocol are: Carbon Dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulfur Hexafluoride (SF_6).
- The most common and harmful air pollutants in the border area include suspended particles (PM10 and PM2.5) and tropospheric ozone.
- Mexico has been implementing various actions to support the Mexican border states to develop a State Climate Action Plan (PEAC); one of the most important inputs for the PEAC is the inventory of GHGs.

Photo: ©Krista Schlyer

COMMON PROBLEMS: COASTS AND SEAS

- **Pressure by various sectors** due to the use of resources, including fishing, tourism, industrial (oil / mining) and urban.
- The impacts of climate change are reflected in the **environmental quality of the coastal line**.
- **Overexploitation of coastal resources and pressures on species of commercial importance, including species at risk**.
- **Gulf of Mexico**, increased load of organic material that comes from the Mississippi River water basin
- **Gulf of California**, tourism, fishing, wastewater discharges. Upper Gulf
- **Laguna Madre Region**, diverse habitats and communities such as rivers, coastal lagoons, estuaries, reef systems, seagrasses and mangroves.

Photo: ©Krista Schlyer

OTHER COMMON PROBLEMS

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- Poverty
- Climate change
- Land degradation
- Droughts
- Water quality and availability
- Pollution and waste management

STRATEGIC AXES

- Environmental health;
- Public health;
- Sustainability and development;
- Territorial and urban planning;
- Education and environmental culture;
- Mitigation and adaptation programs to climate change;
- Conservation programs for wild species (migratory, species at risk and vulnerable to climate change); and
- Attention to marginalized and indigenous communities.

CHALLENGES

- Identify the territorial, ecological, social and economic processes of the region and their behavior in the face of different perspectives to base the implementation of actions and public policies.

Photo: ©Roy Toft

Embattled Borderlands

Krista Schlyer

http://storymaps.esri.com/stories/2017/embattled-borderlands/index.html