

Rangeland Goods and Services:

Identifying Challenges and Developing Strategies for Continued Provisioning

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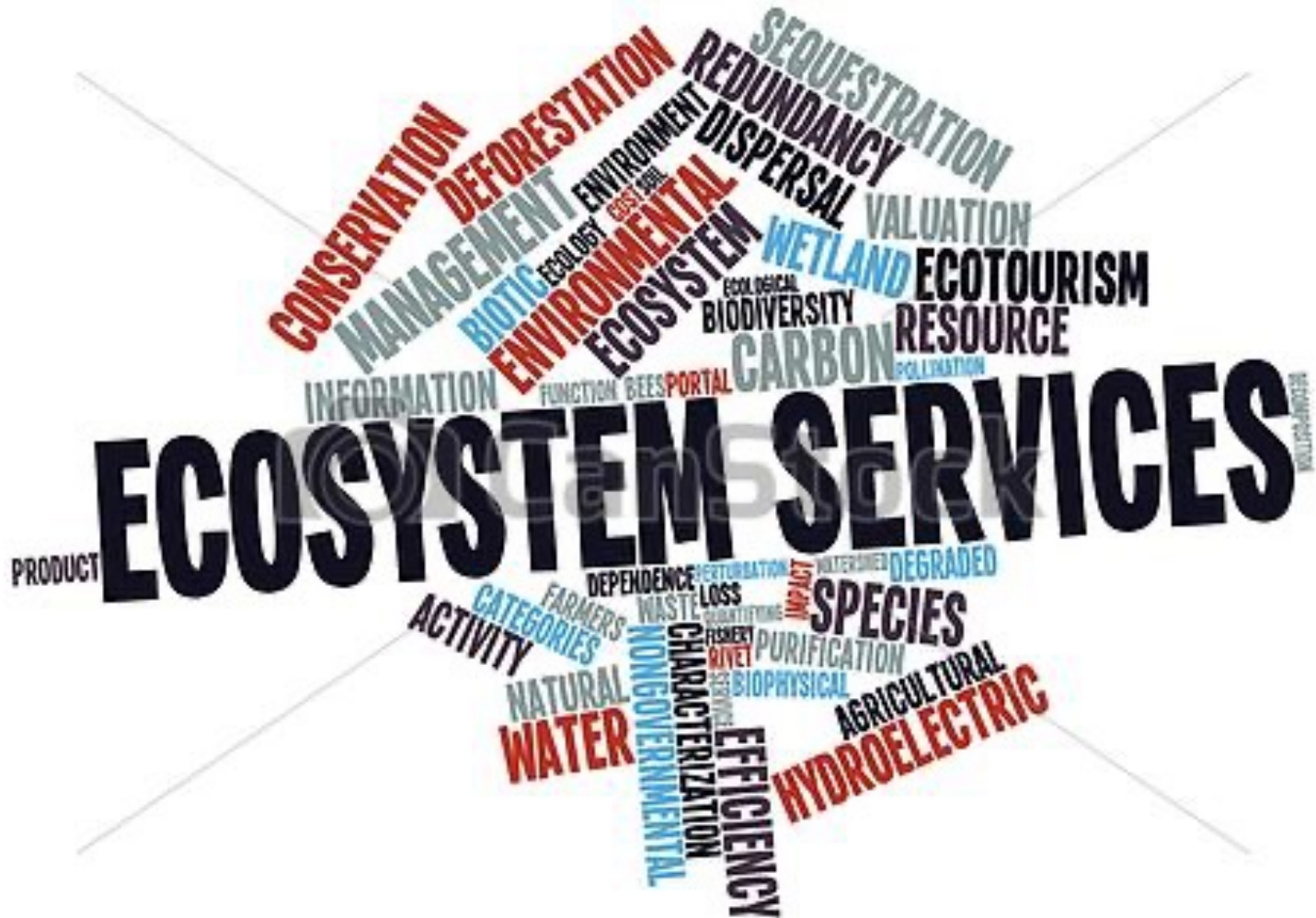
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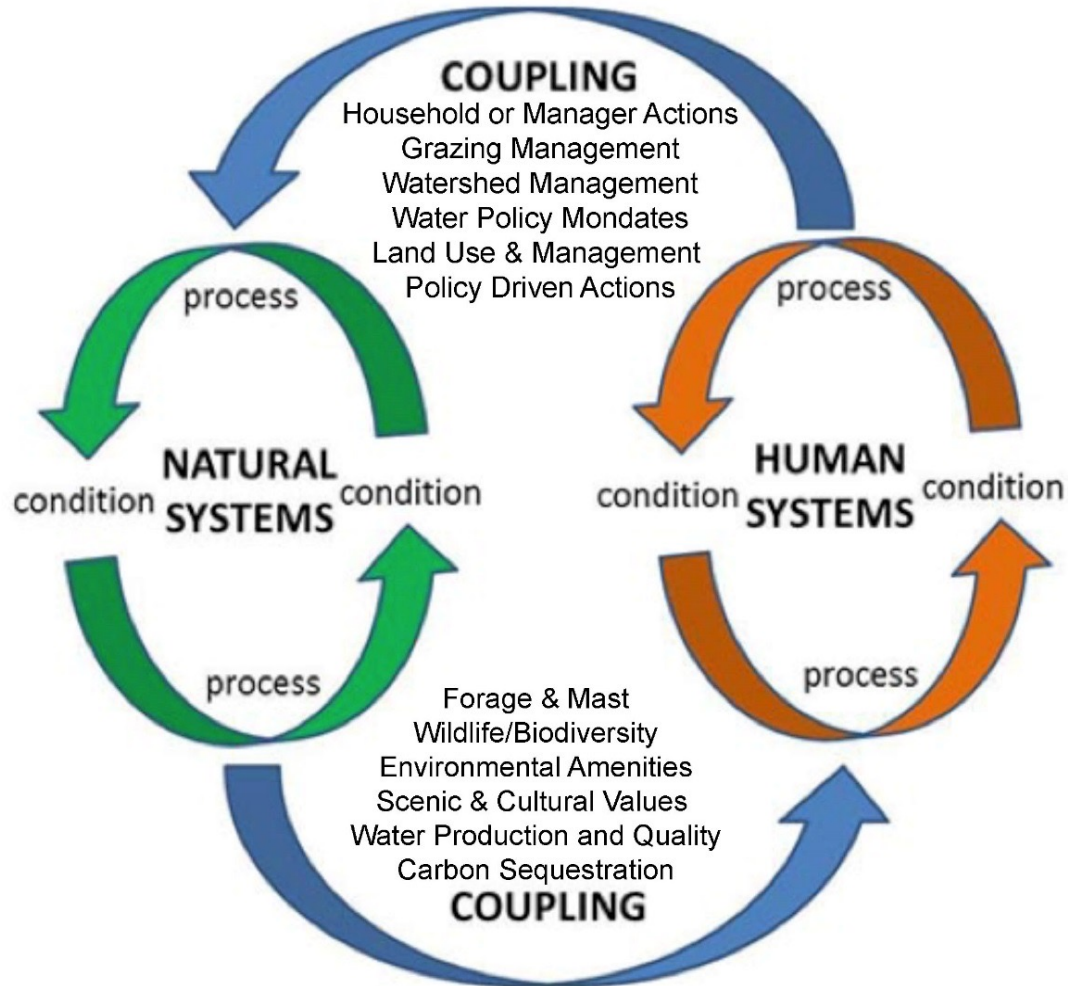
Texas A&M University



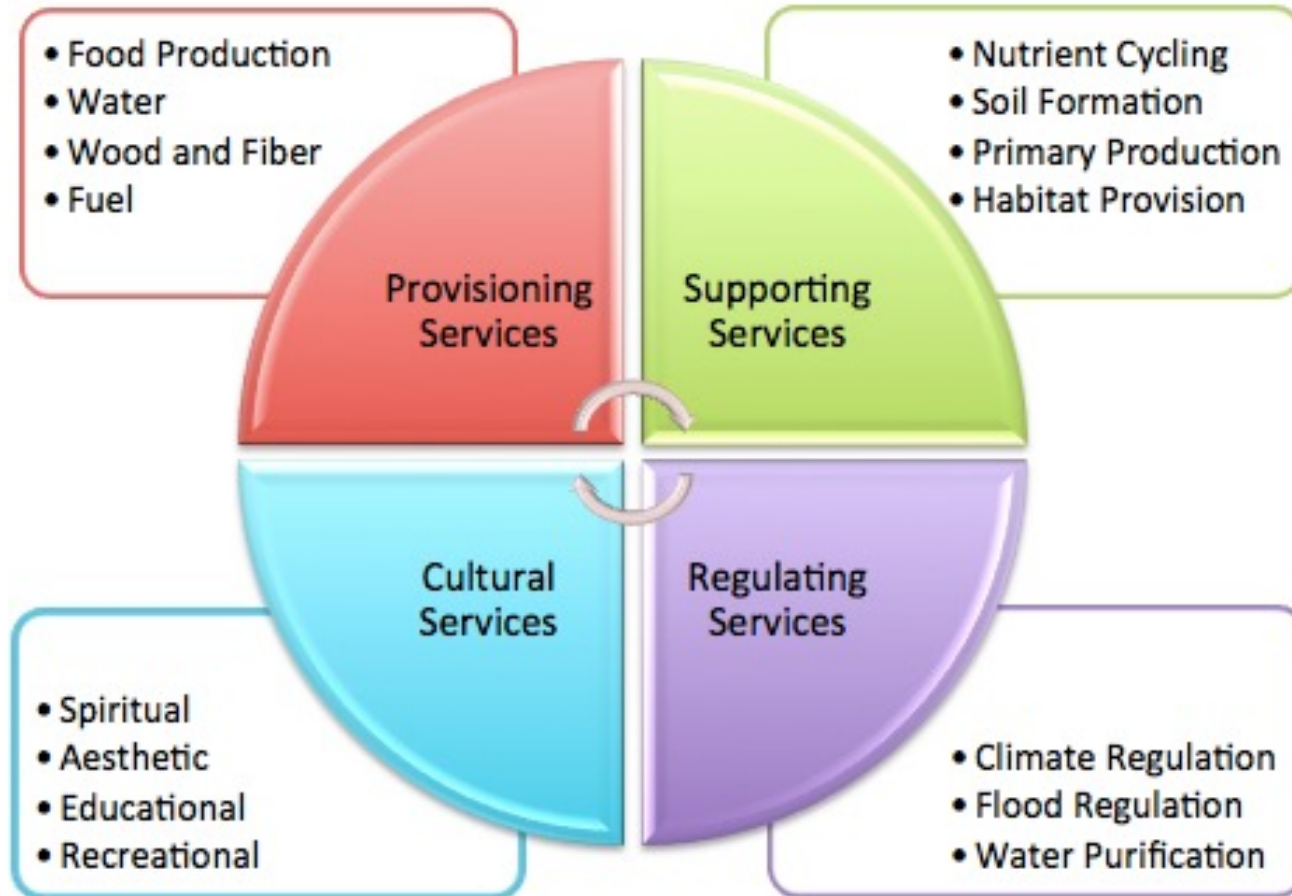
Benefits human's derived from nature



Social-Ecological System



Ecosystem Service Categories



Source: Millenium Ecosystem Assessment, 2005.

Diverse Services Provisioned

Provisioning

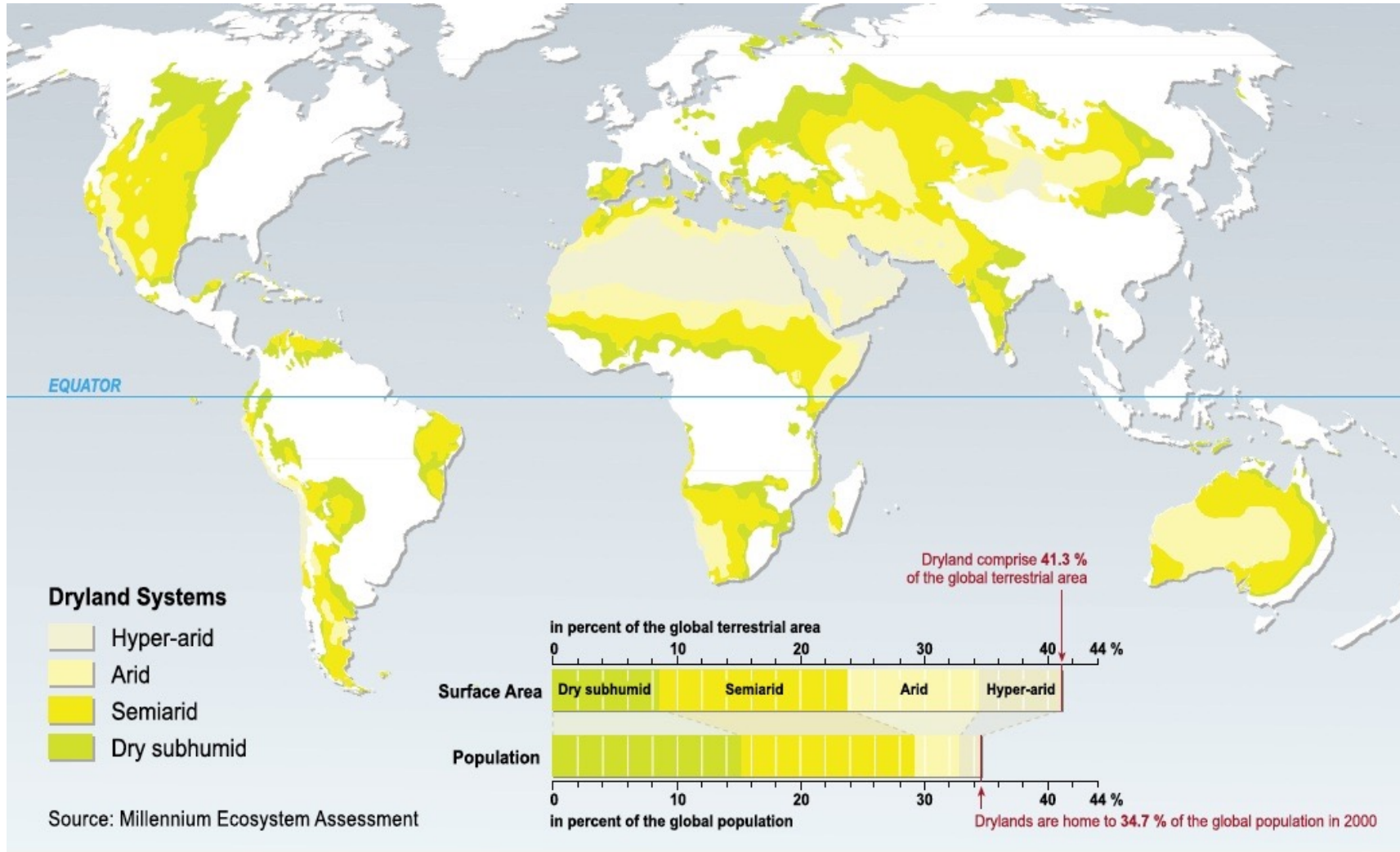
Supporting

Regulating

Cultural



Global Dryland MEA 2005



Ecosystem Services Supply

- Assess Earth's ecosystems
 - ✓ 1360 scientists; 95 countries
 - ✓ 4 yr preparation; 2001 – 2005
- **20 of 24 ecosystem services degraded in past 50 years**
 - ✓ Biodiversity loss
 - ✓ Water quality & quantity
 - ✓ Erosion regulation
 - ✓ Pest regulation
 - ✓ Natural hazards regulation



ECOSYSTEMS AND HUMAN WELL-BEING

Synthesis

Supply of Rangeland ESs

- Intensive livestock grazing increases:
 - ✓ Carbon emissions
 - ✓ Soil erosion
 - ✓ Biodiversity loss
- 10-20% rangelands degraded
- 15% converted to cropland past 50 years



Demand for Rangeland ESs

- 70-100% greater food demand 2050
 - ✓ Human population approaching 9 billion
 - ✓ Greater global affluence and diet quality
- Increasing demand for animal protein
 - ✓ 600M livestock added in past 30 years
 - ✓ 830M livestock may be added by 2030
- Substantially greater forage demand
- Ecological footprint of production



A Rangeland Dilemma

- *Increasing* demand for ESs
- *Decreasing* ESs supply
- *Marginalized* inhabitants
- *Effective* policy?
- *Alternative* approaches?

Woody Plant Encroachment



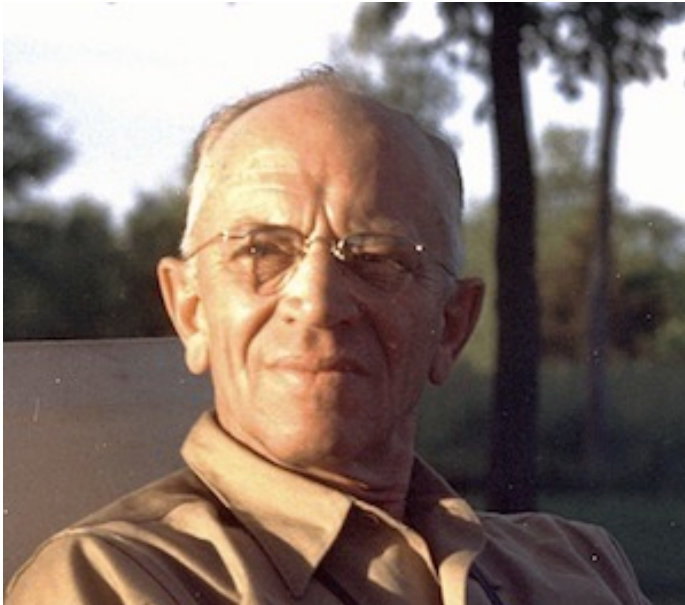
Exurban Development



Cropland Conversion



Aldo Leopold – Early American Conservationist



- Promoted environmental ethics and land conservation in U.S.
- 1887 – 1948
- Professor Univ. Wisconsin
- Founder of wildlife management
- A Sand County Almanac 1949

“Crux of the problem is that every landowner is the custodian of *two* interests - the public interest and his own” - 1934.

“Crux of the Problem”

- Economic markets value *goods*, but not the ecosystems that supply them.
- Provisioning services are *private* goods, while other categories of ESs are *public* goods – regulating, cultural and supporting.
- Provisioning services are internal to markets, while other ES categories are often *external* to markets.
- *External* ESs are frequently perceived to have no value in land use decisions.

Private vs Societal Benefits

	Extensive Management	Intensive Management
Private Benefits	\$20/ha	\$40/ha
Societal Benefits	\$50/ha	\$10/ha
Total benefits	\$70/ha	\$50/ha

Private Benefit = Positive \$20; land use change beneficial

Societal Benefit = Negative \$40; land use change detrimental

Societal benefits become an externality!

Land Use - ES Tradeoff

infectious disease mediation

crop production

forest production

preserving habitats and biodiversity

water flow regulation

water quality regulation

carbon sequestration

regional climate and air quality regulation

natural ecosystem

infectious disease mediation

crop production

forest production

preserving habitats and biodiversity

water flow regulation

water quality regulation

carbon sequestration

regional climate and air quality regulation

intensive cropland

infectious disease mediation

crop production

forest production

preserving habitats and biodiversity

water flow regulation

water quality regulation

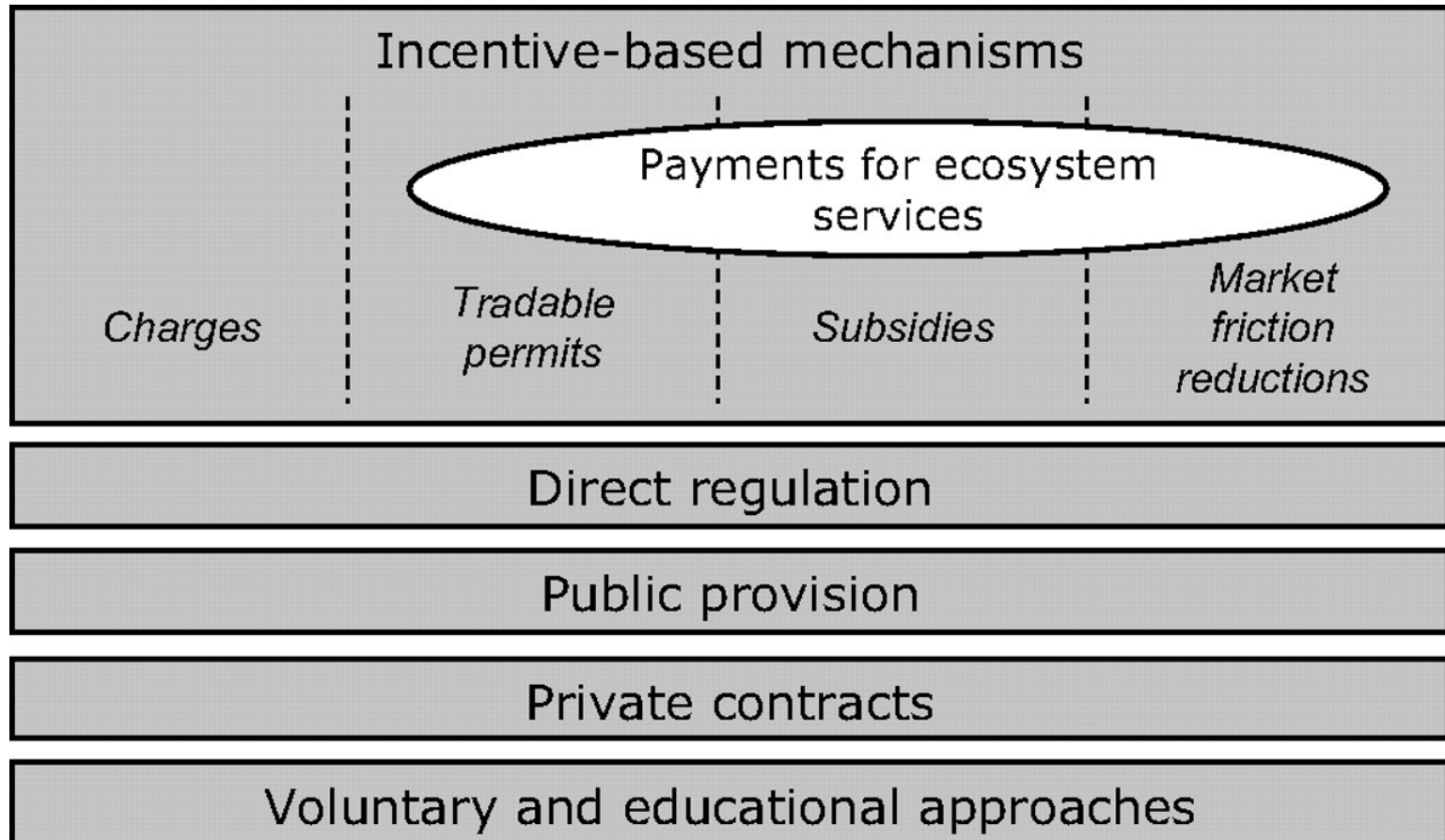
carbon sequestration

regional climate and air quality regulation

cropland with restored ecosystem services

Increase in one service decreases the supply of others.

Aligning Private and Public Interests



Payment for Ecosystem Services

- Transparent system for *additional* provision of ESs through *conditional* payments to voluntary providers.
- Requires a *market* of potential buyers, and *contracts* with providers focused on *well-defined* ESs.
- Primarily focused on *watersheds*, *C sequestration* and *biodiversity*.
- Agri-environmental schemes represents a type of PES.

Diverse Services Provisioned

Provisioning

Supporting

Regulating

Cultural



Potential Benefits of ESs Framework

- More complete accounting of *diverse* ESs that are *heterogeneously* distributed across global rangelands.
- Create markets for supporting and regulating services that are currently '*external*' to land use decisions.
- More *comprehensive* valuation of rangeland systems, including ecological and social variables and drivers.
- Improve livelihoods of the worlds most *marginalized* human inhabitants.

Attributes of Rangeland ES

- ESs are *limited* per unit area, but they are *vast* in aggregate.
- Aggregate *non-market* ESs may be of greater *societal* value than total provisioning services.
- Societal payments for non-market ESs may reduce need for provisioning services by local inhabitants.
- May provide a means for poverty alleviation and a reduction of rangeland degradation.

Required Ecological Knowledge

- Key species supplying ESs
 - ✓ Dominant species most important
- Structure and processes underpinning ESs
 - ✓ Originate from ecological processes
- Influence of major environmental variables
 - ✓ Informed by disturbance ecology & resilience theory
- Spatial and temporal considerations
 - ✓ Cross-scale interactions least understood

Required Institutional Knowledge

- Develop *markets* of potential buyers, *contracts* with sellers, and accounting procedures for *transactions*.
- Organizational *entity* to assume this responsibility.
- Remove *perverse* policies that over-value provisioning services to marginalize other ESs.
- Minimize use of payments to marginalizing ESs in other areas '*leakage*'.
- Effectiveness of PES schemes still *uncertain* – minimal verification.

Land Use - ES Tradeoffs

infectious disease mediation

crop production

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carbon sequestration

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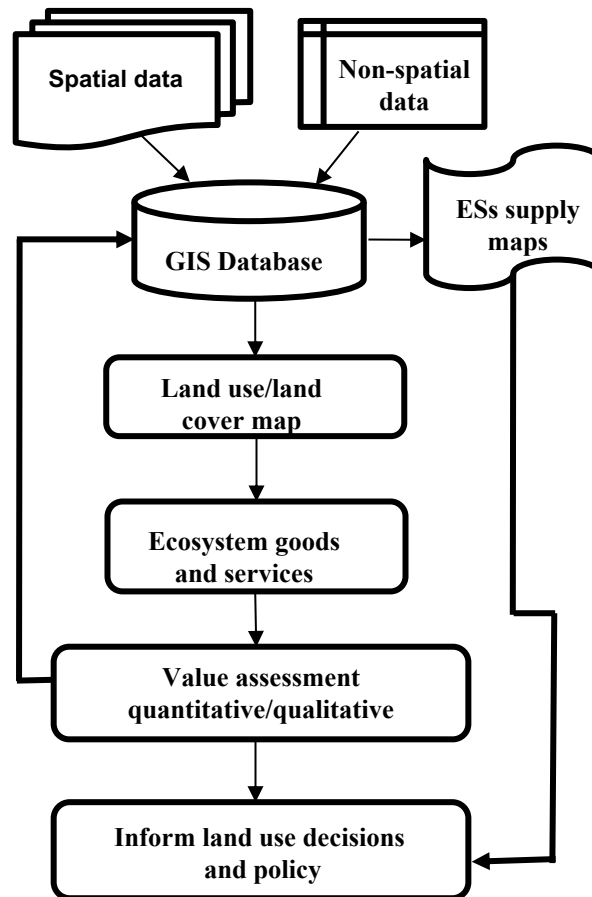
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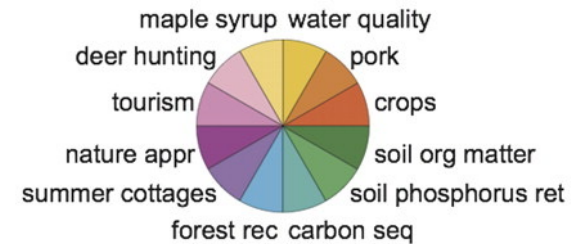
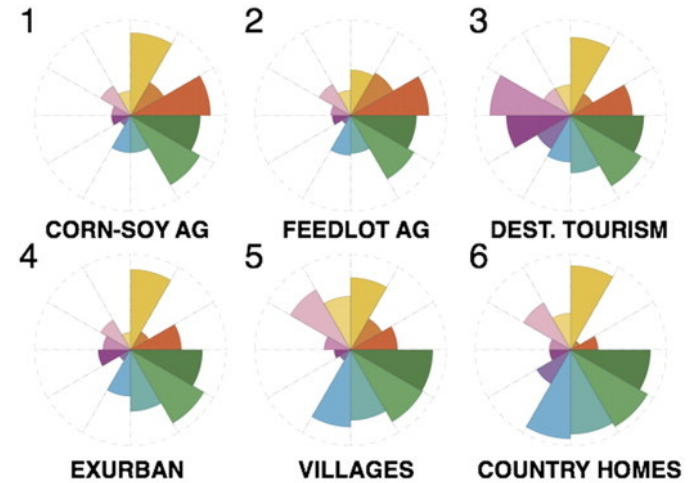
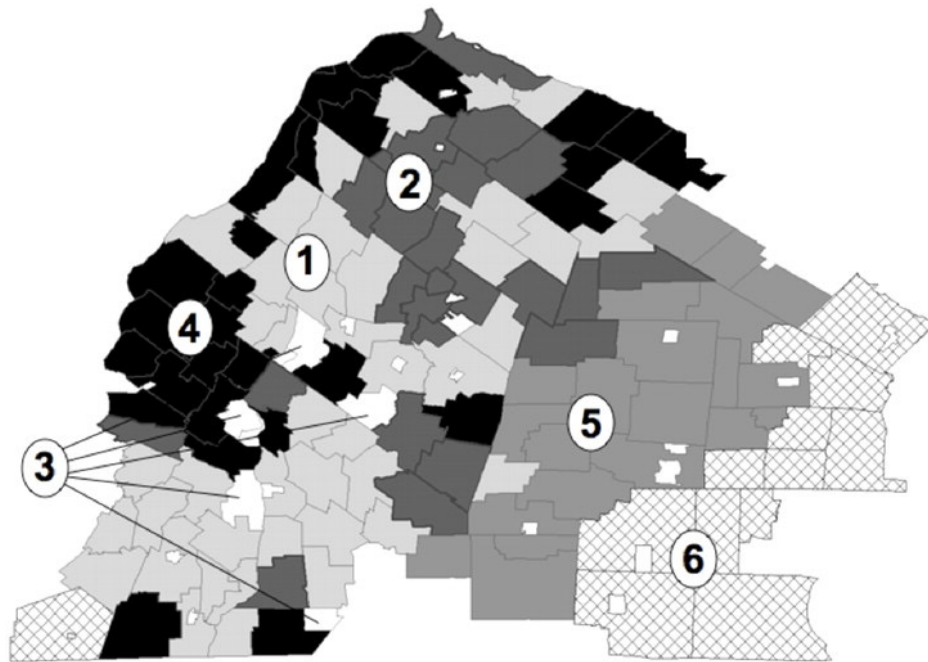
Increase in one service decreases the supply of others.

Organization of PES Programs

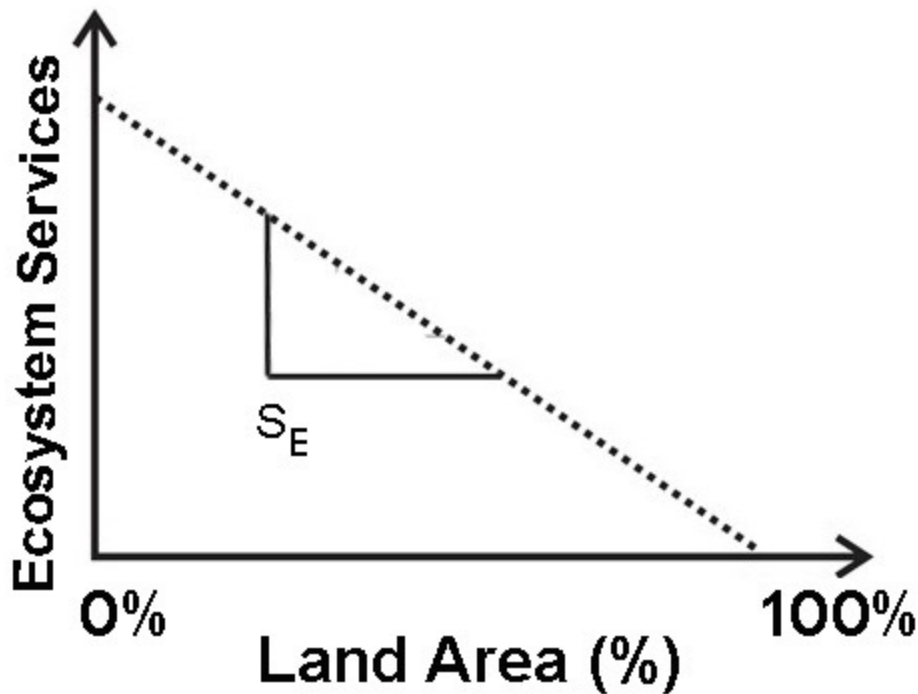


- Map major ecosystems
- Categorize 'bundles' of ESs
- Past trends in LU change
- Corresponding trend in ESs
- Project future LU change
- Impact on ES supply & demand
- Policies to guide LU change

Map Ecosystem Service Bundles



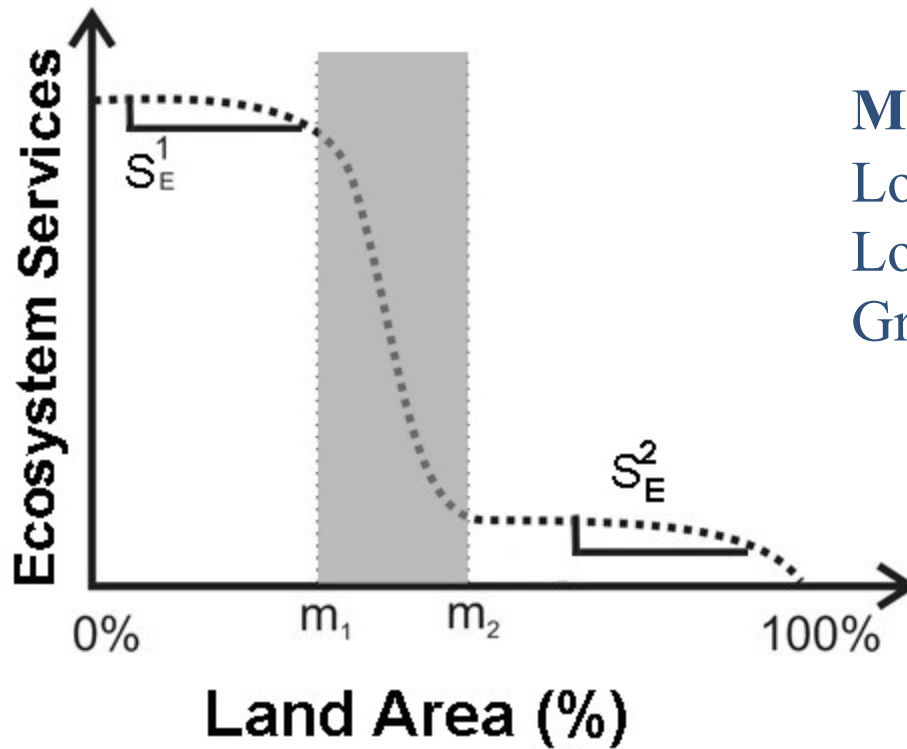
Linear ES Response



Appropriate?
C sequestration
Plant production

Inappropriate?
Biodiversity hotspots
Wildlife corridors
Watershed protection
Riparian systems

Threshold ES Response



Marginal costs

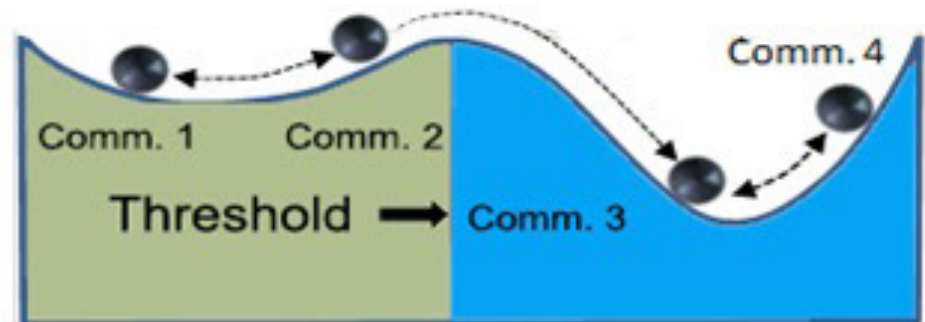
Low when abundant

Low when depleted

Greatest value in middle

ESs Compatible with Resilience?

- Resilience – ability of systems to *change* in response to disturbance and yet retain critical function.
- Supply of ESs could provide a useful *metric* for assessing resilience of SESs.
 - ✓ Thresholds represent conditions at which capacity to supply specific ecosystem services is lost.



Reduce Perverse Incentives

- 2.6M ha grassland *converted* to cropland in U.S. since 2000 for production of biofuel crops.
- Renewable Fuels Standard stipulates that crops can only be produced on lands converted *prior* 2007.
- 1.5M ha of *ineligible* land may have been enrolled because of insufficient accounting and enforcement.
- Federal crop insurance in U.S. also incentivizes conversion of *marginal* lands to cropland.

Ecosystem Services: A Path Forward?

- Value of *aggregate* non-market ESs to society relative to current provisioning services.
- An accounting system capable of recording transactions of *diffuse* ESs distributed over *vast* areas.
- Ability of payment for societal benefits to modify *resource dependence* of marginalized inhabitants.
- Utility of ESs as a viable *metric* to assess resilience of SESs.
- *Exclusive emphasis on provisioning services is not a viable path forward.*