

Land[scape] Vulnerability & Resilience:

Where we are and where we may go before we got there.

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Clark University



Grand Challenges and Great Opportunities in Science, Technology, and Public Policy

Gilbert S. Omenn

2007 Science 314: 1696-1704



GLOBAL
I G B P
CHANGE

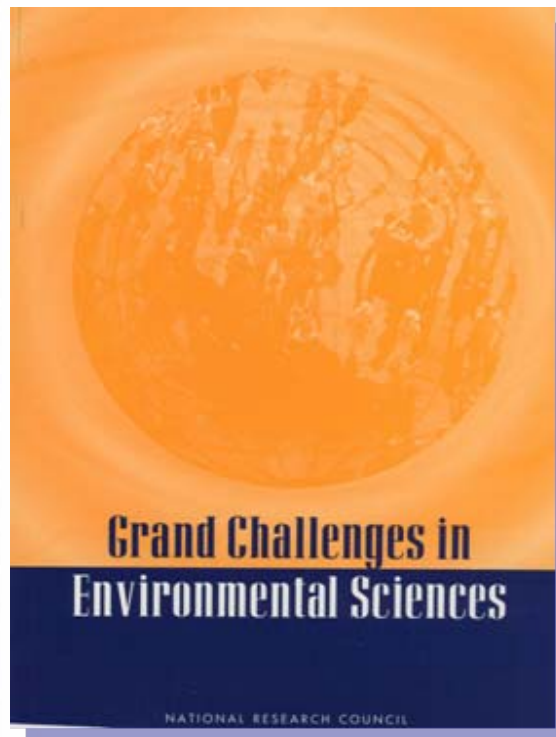


GC

TE



NRC for NSF



1 Grand Challenges

Environmental Sciences

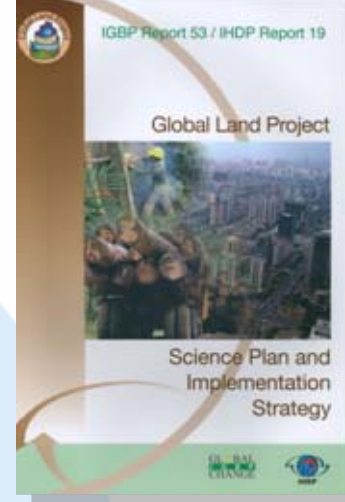
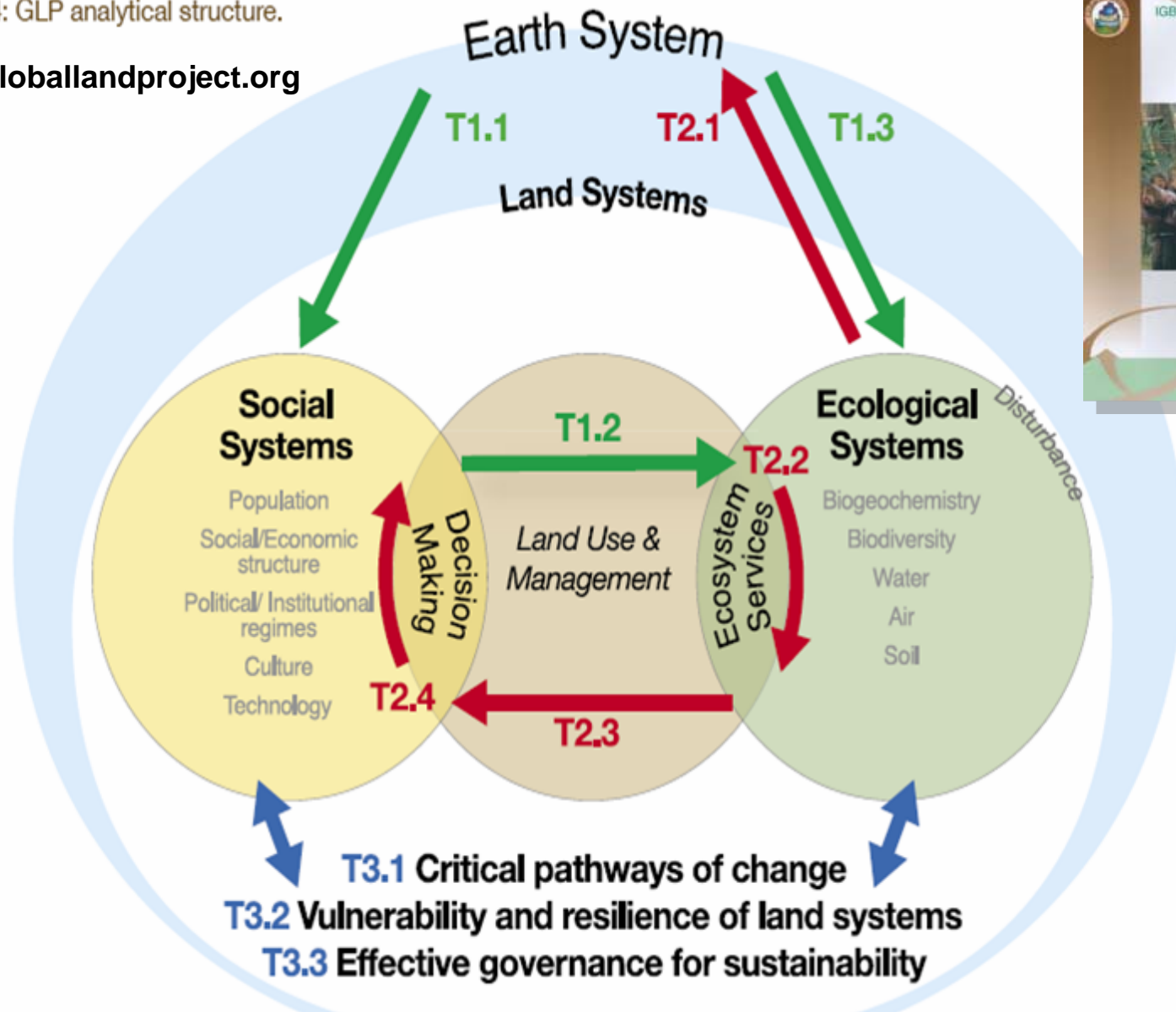
- Biogeochemical cycles (nutrient elements C, O, H, N, S, P and regulators K, Ca, Mb, Fe, Zn) and their perturbations
- Biological diversity and ecosystem functioning
- Climate variability—local and regional

Land use and land cover dynamics

- Markets, treaties, and rules to govern resource extraction and waste disposal
- Land use and land cover dynamics
- Reinventing the use of materials/nearly complete recycling

Figure 4: GLP analytical structure.

www.globallandproject.org



T3.1-3: Sustainable Land Architecture

GLP (IGBP-IHDP + ESSP) → Land Change/System Science

Resilience Alliance & Network → Resilience Science

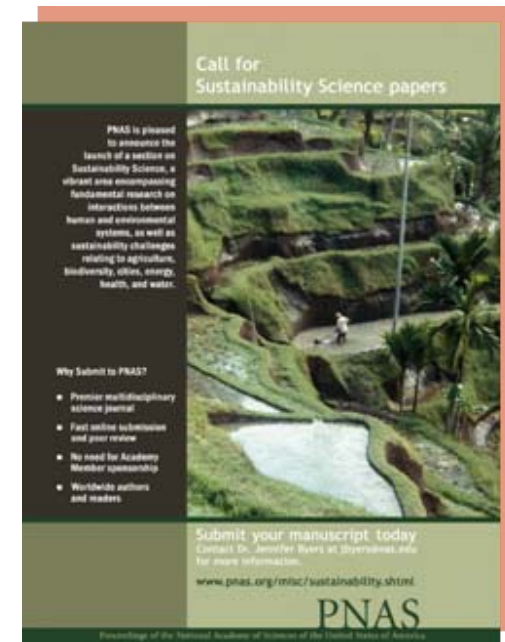
Social-ecological system + Resilience

Sustainability Science (AAAS + NAS + ESSP)

Coupled Human-Environment System + Vulnerability (Resilience)

Sustainability Science →
coupled HE or SE system

- XXXX
- XXXX
- LCS
- Vulnerability
- Sustainable Land Architecture



Call for Sustainability Science papers

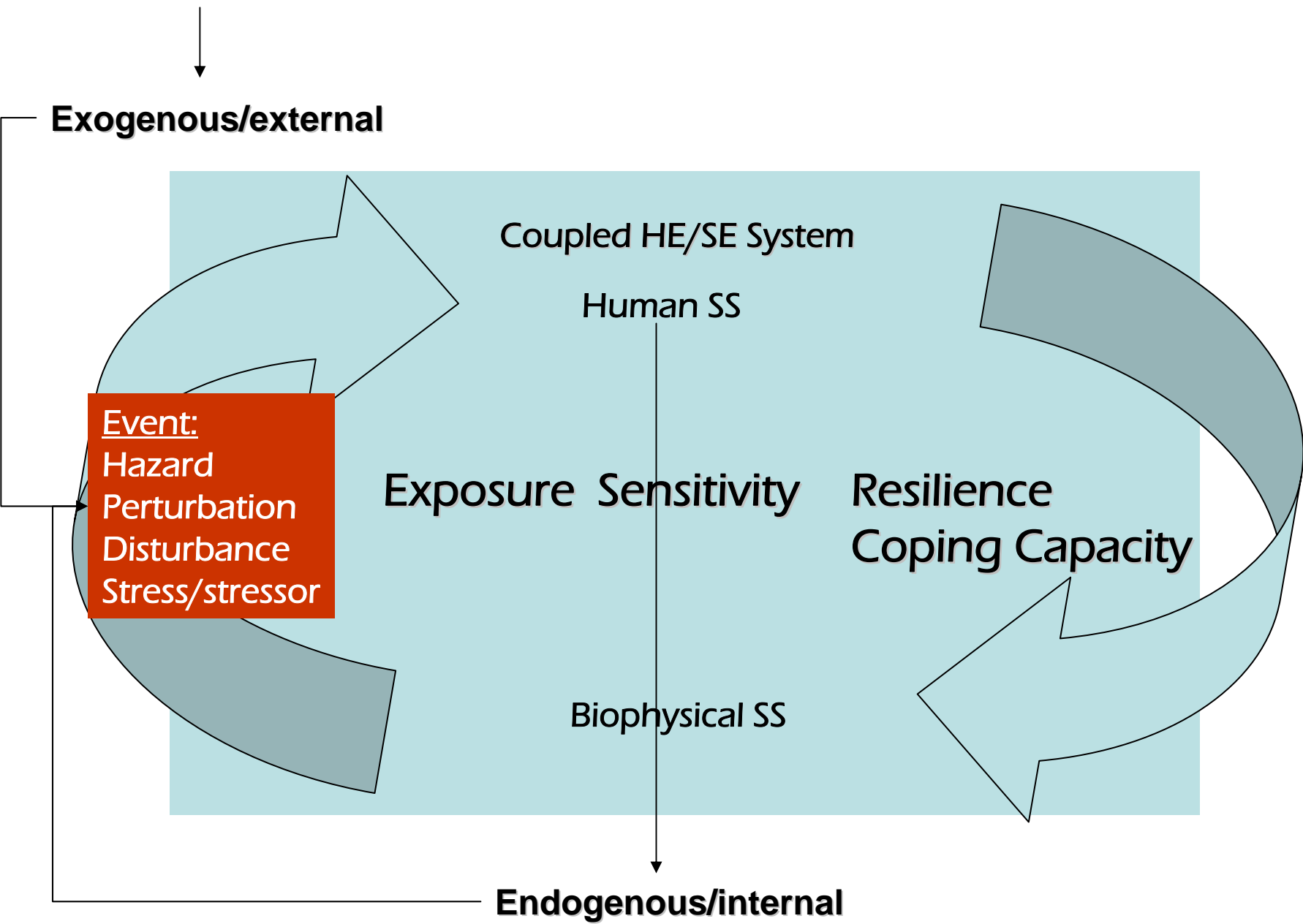
PNAS is pleased to announce the launch of a section on Sustainability Science, a vibrant area encompassing fundamental research on interactions between human and environmental systems, as well as sustainability strategies relating to agriculture, biodiversity, cities, energy, food, health, and water.

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www.pnas.org/misc/sustainability.shtml

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Exogenous/external

Coupled HE/SE System

Human SS

Event:
Hazard
Perturbation
Disturbance
Stress/stressor

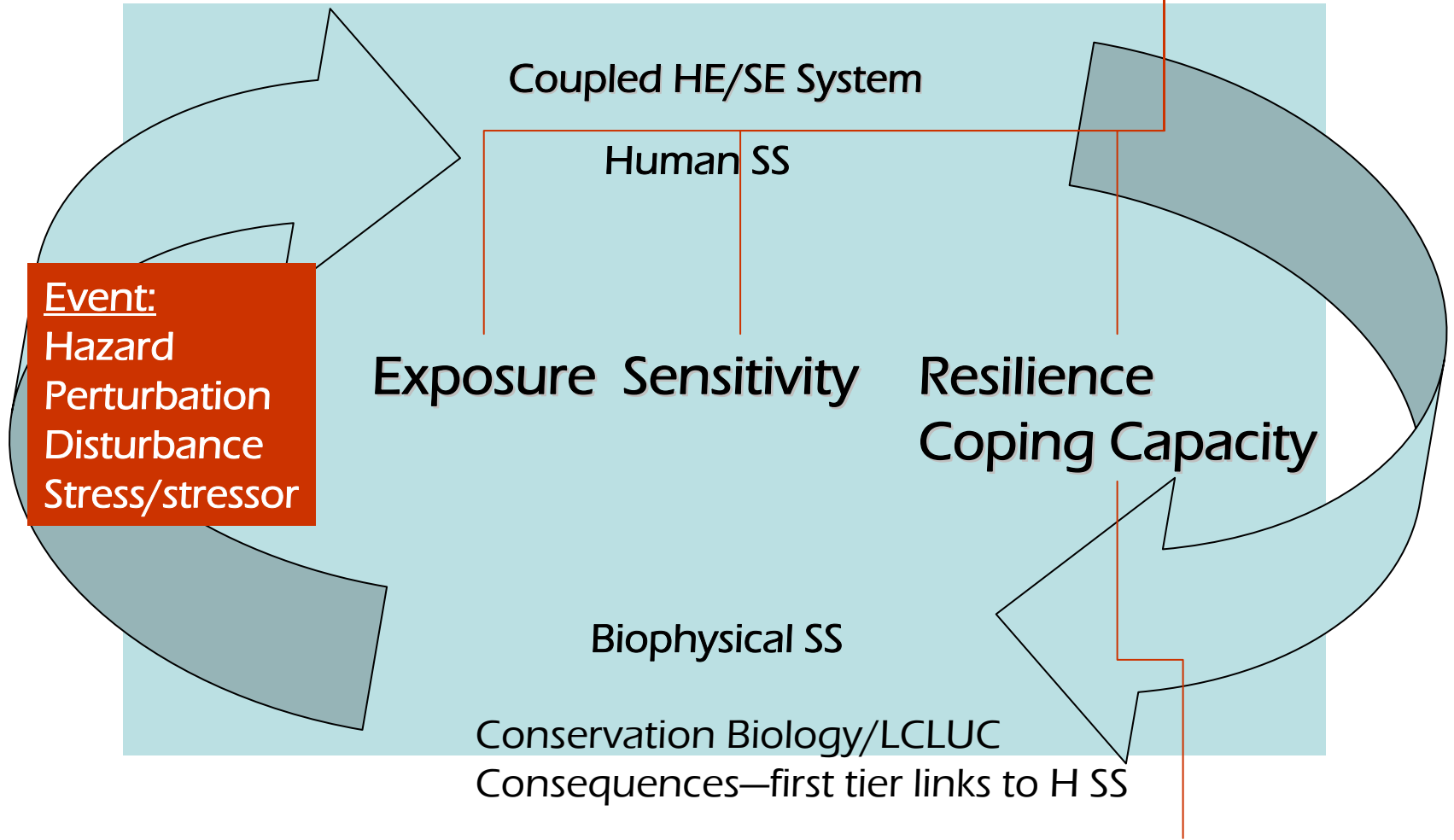
Exposure Sensitivity

Resilience
Coping Capacity

Biophysical SS

Endogenous/internal

Political Economy as cause of—
no coupled system



Event:
Hazard
Perturbation
Disturbance
Stress/stressor

Coupled HE/SE System

Human SS

Exposure Sensitivity

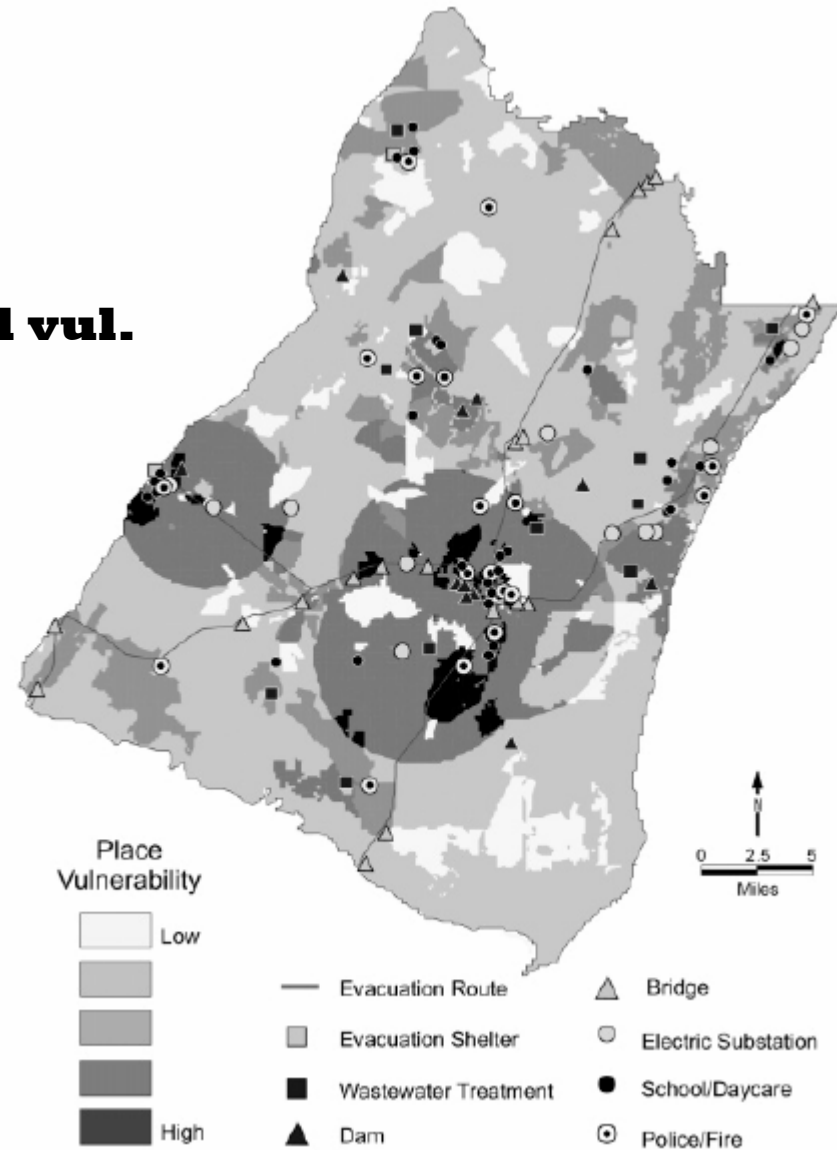
Resilience
Coping Capacity

Biophysical SS

Conservation Biology/LCLUC
Consequences—first tier links to H SS

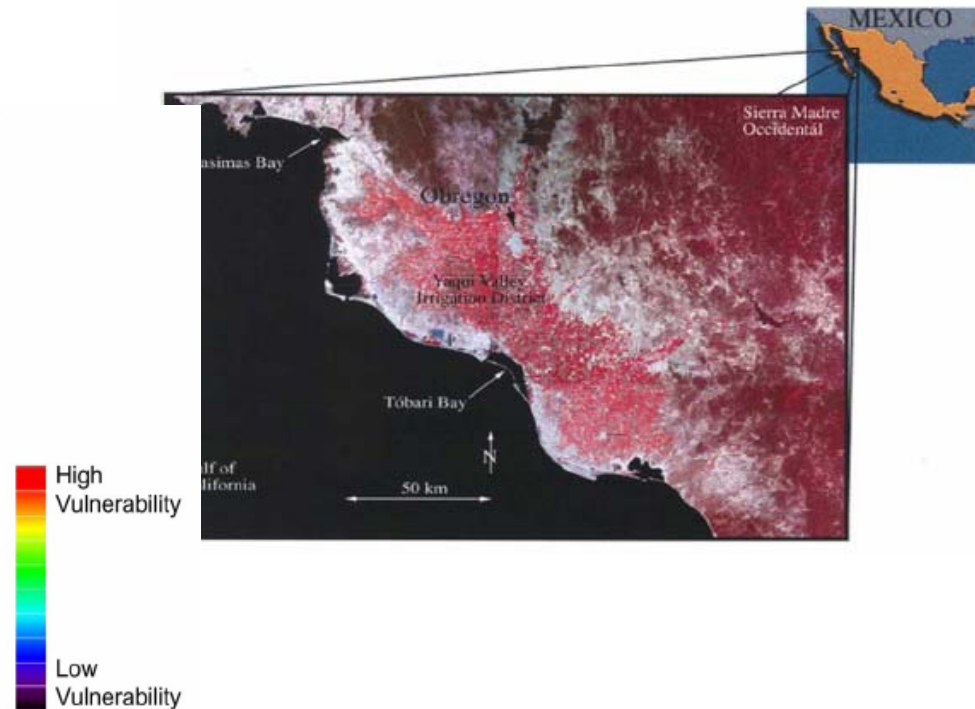
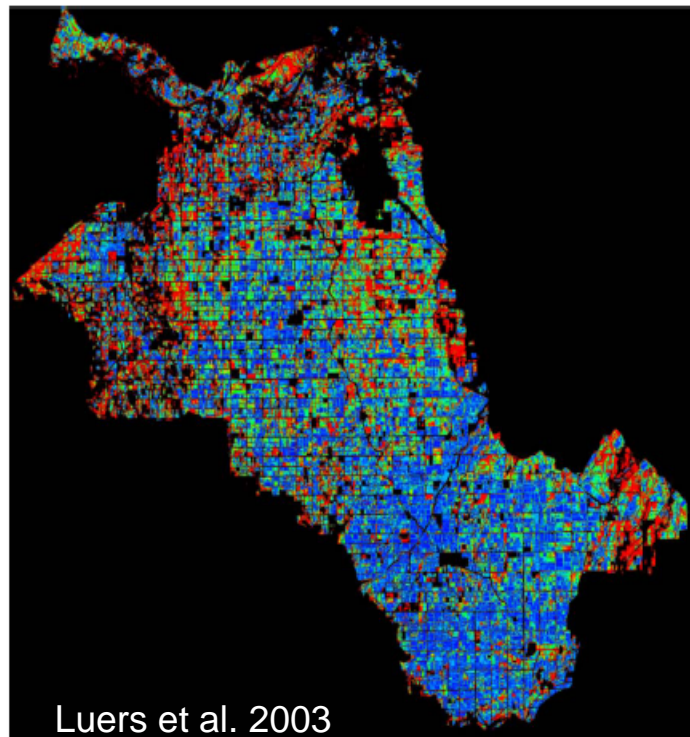
System abstractions—proven
use more for env. subsystem

Place-based vul.

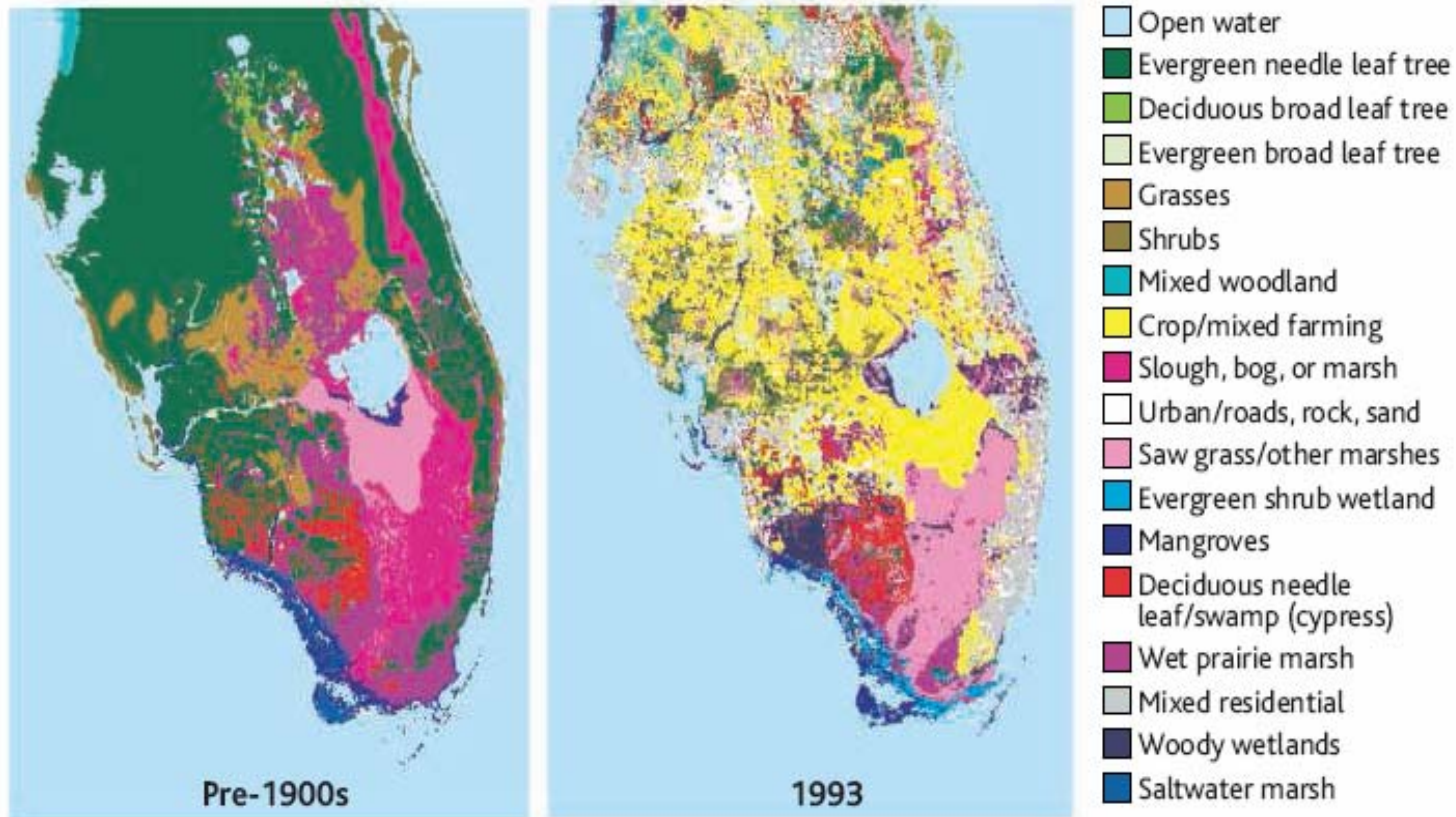


- **No. of LCLUC or GLP studies directed to vulnerability are few.**

- A structural reason; change must take place



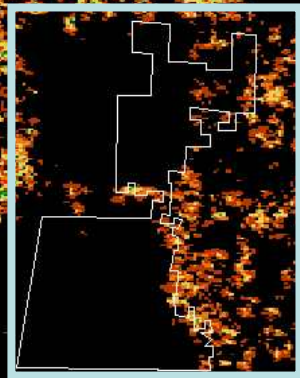
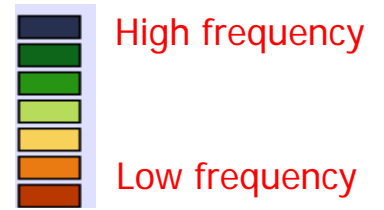
- **No. of studies directed to resilience are more common but not directed to the coupled system & not land necessarily based.**
- **Many studies that could be reshaped to address vulnerability.**



Pielke 2005 & Marshal et al. 2004

Land change → surface sensible & latent heat flux → with specific impacts on afternoon sea breeze fronts → *marked changes in spatial distribution & amount (↓) of July-Aug precipitation + increase in diurnal temp. cycle*

Fire Frequency summary Yucatan Peninsula 2000-2006



J. Rogan & SYPR Project

Zoh Laguna Annual Precipitation

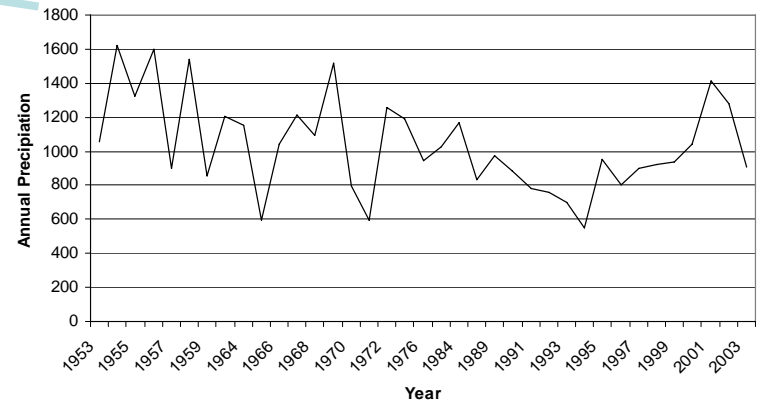
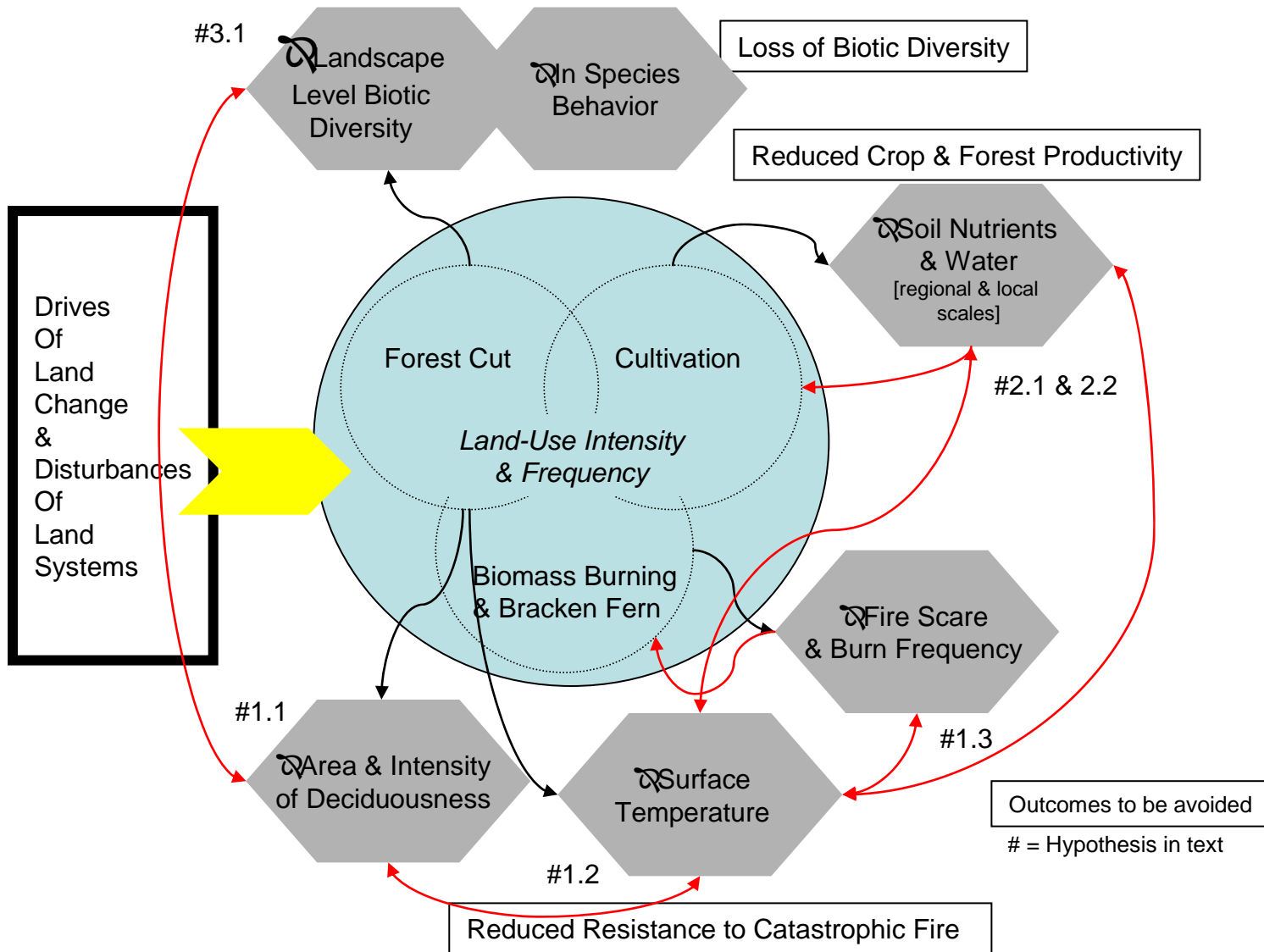


Fig. 3: Hypotheses Linking Resilience-Vulnerability of Ecosystem Services to “Outcomes-to-Avoided”



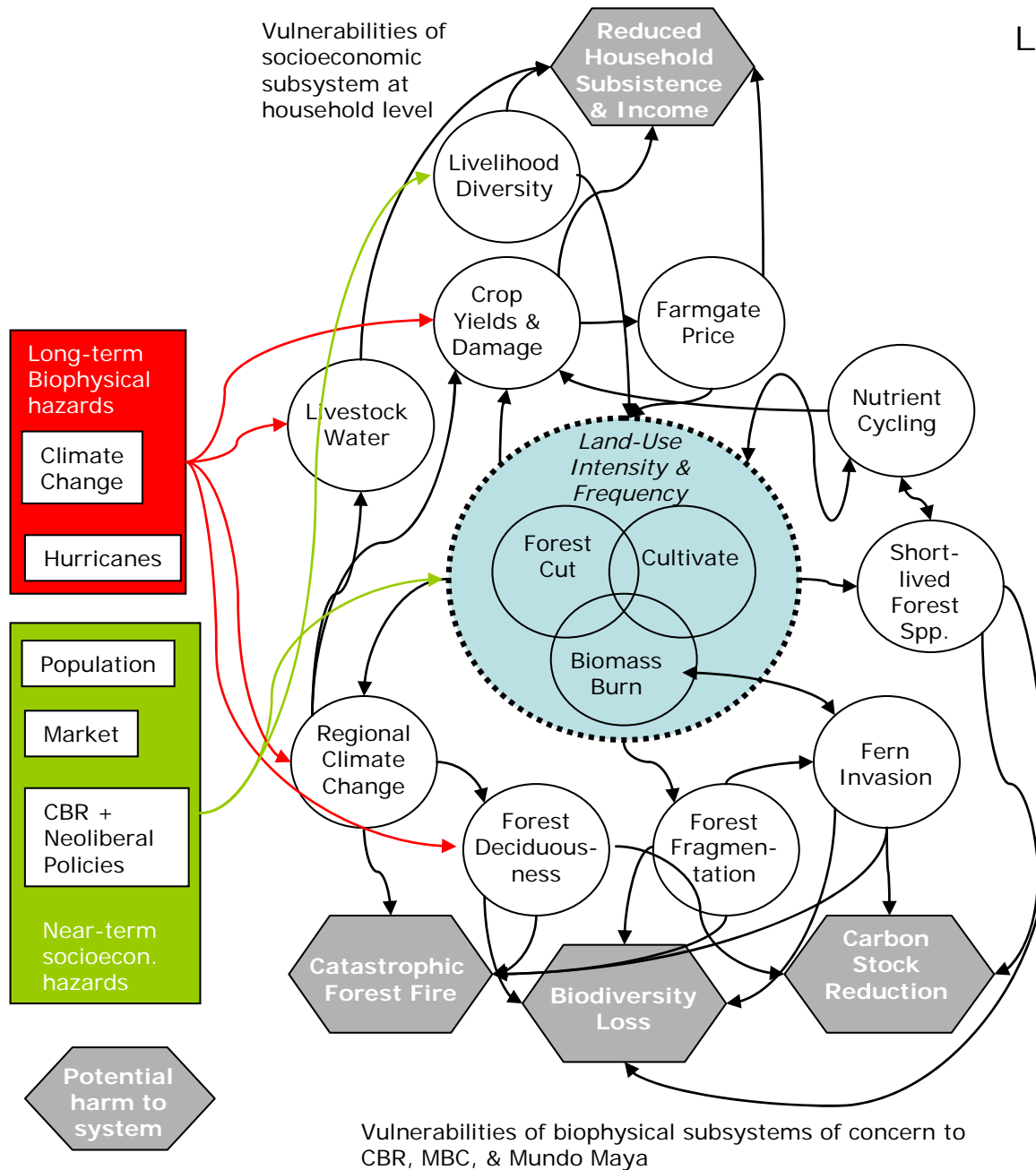


Fig. 2: Coupled System Vulnerability to Hazards in SYPR

WIN-WIN ECOLOGY

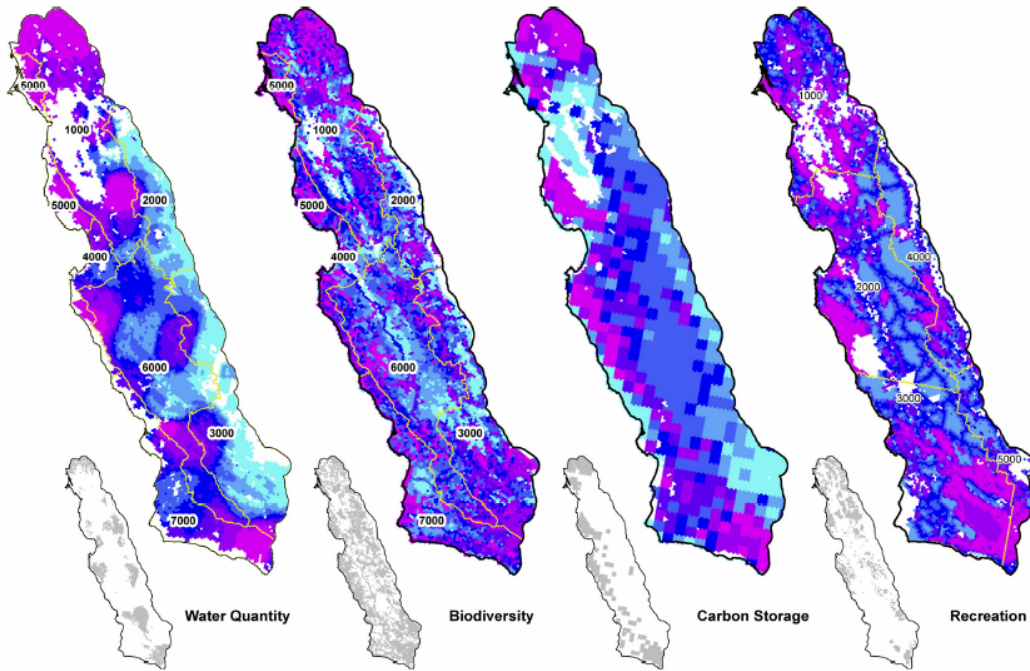
HOW THE EARTH'S SPECIES CAN SURVIVE
IN THE MIDST OF HUMAN ENTERPRISE



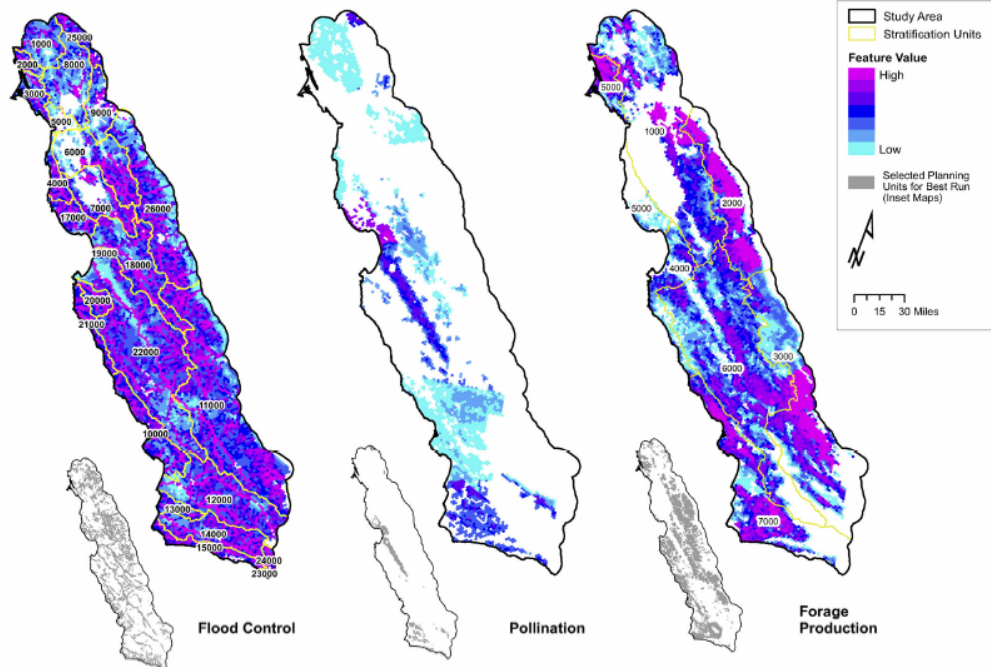
MICHAEL L. ROSENZWEIG

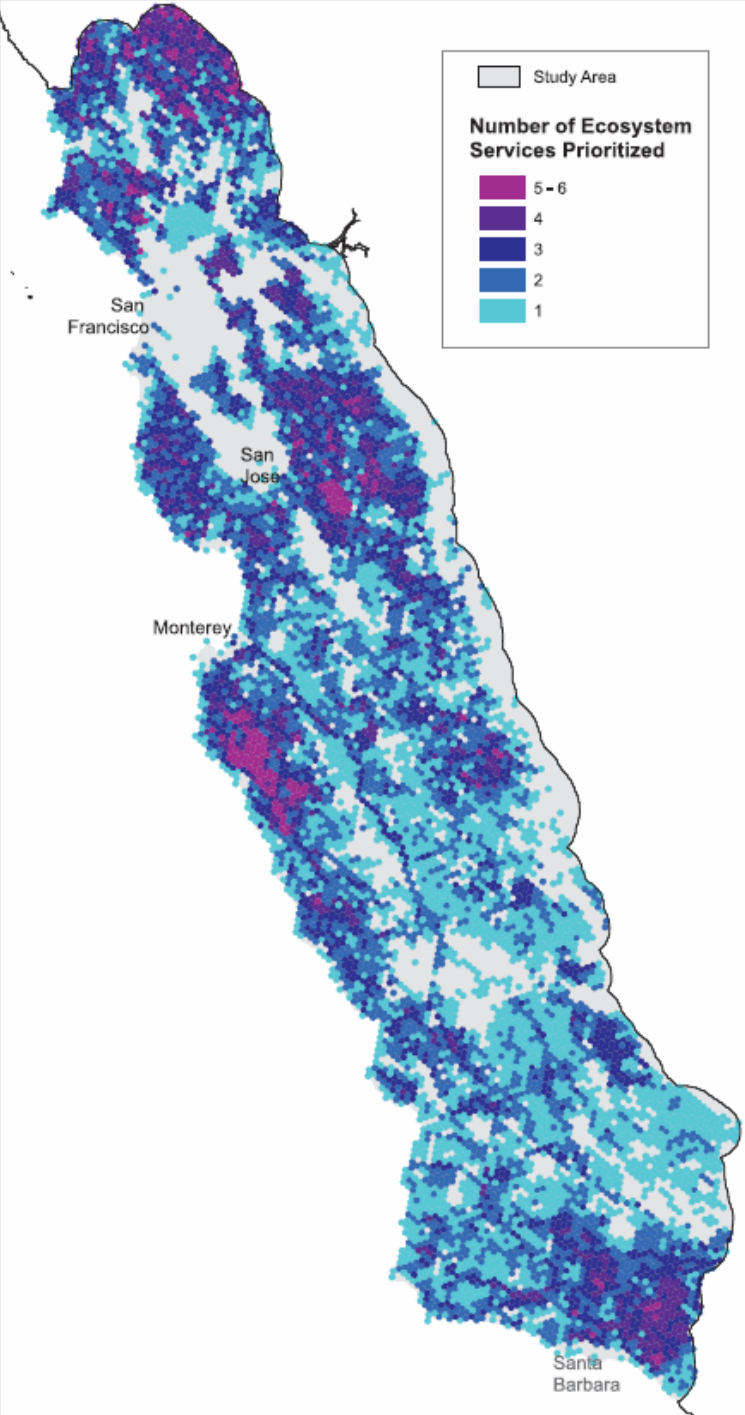
Sustainable Land Architecture

Spatial Congruence of 6 Ecosystem Services and Biodiversity



Does a focus on conservation-preservation of biodiversity alone yield best results for other ecosystem services?





Spatial Congruence of 6 Ecosystem Services and Biodiversity

[Because]...benefits [of ecosystem services] vary in the scale of their operation and dependence on habitat, [with dramatic affect on] simultaneous management for multiple services.

Protecting [locations] selected for their biodiversity value is not likely to maximize protection for the full suite of benefits unless [changes in biodiversity priorities].

[Benefits] are more easily met if demand occurs at broad scales and supply varies considerably at local to regional scales. [e.g, carbon storage]

[In the reverse] spatial mismatches are exacerbated and [benefits] may be more difficult to achieve. [e.g., water]

Ecosystem (Environmental?) Goods & Services



food production



slope stability



tourist attraction



fire prevention



water purification



biodiversity



pollination



fibre production



fodder production



flood protection



carbon sequestration



beauty



recreation



stabilising micro-climate

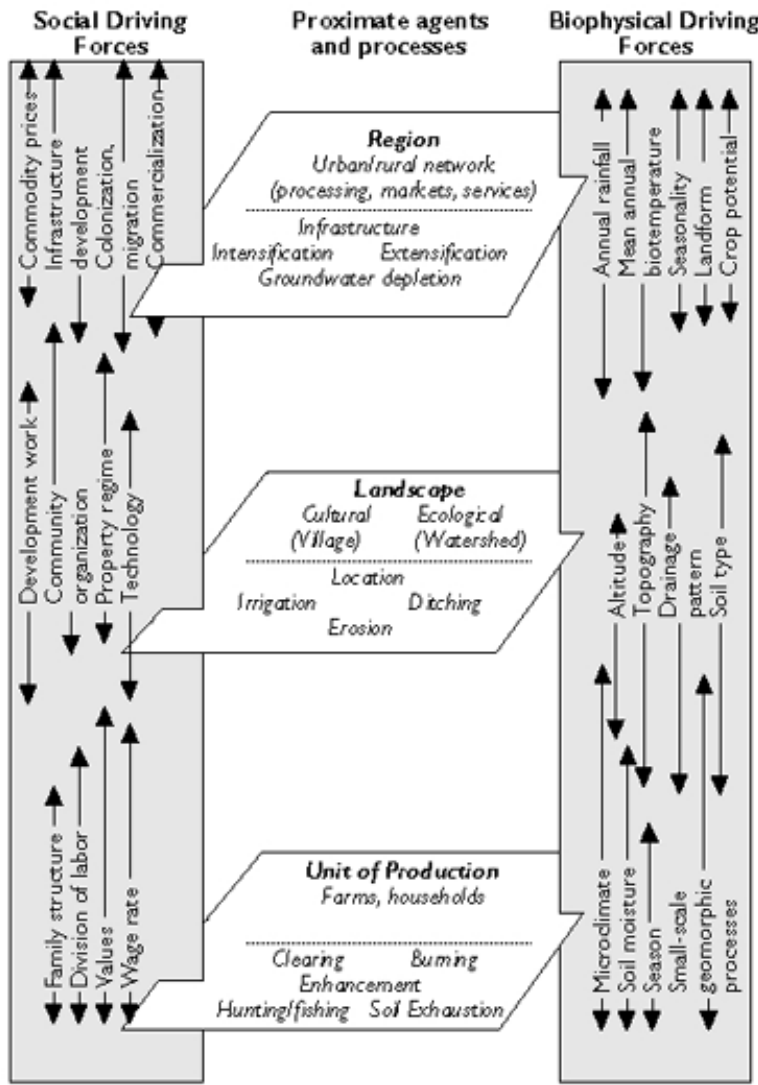
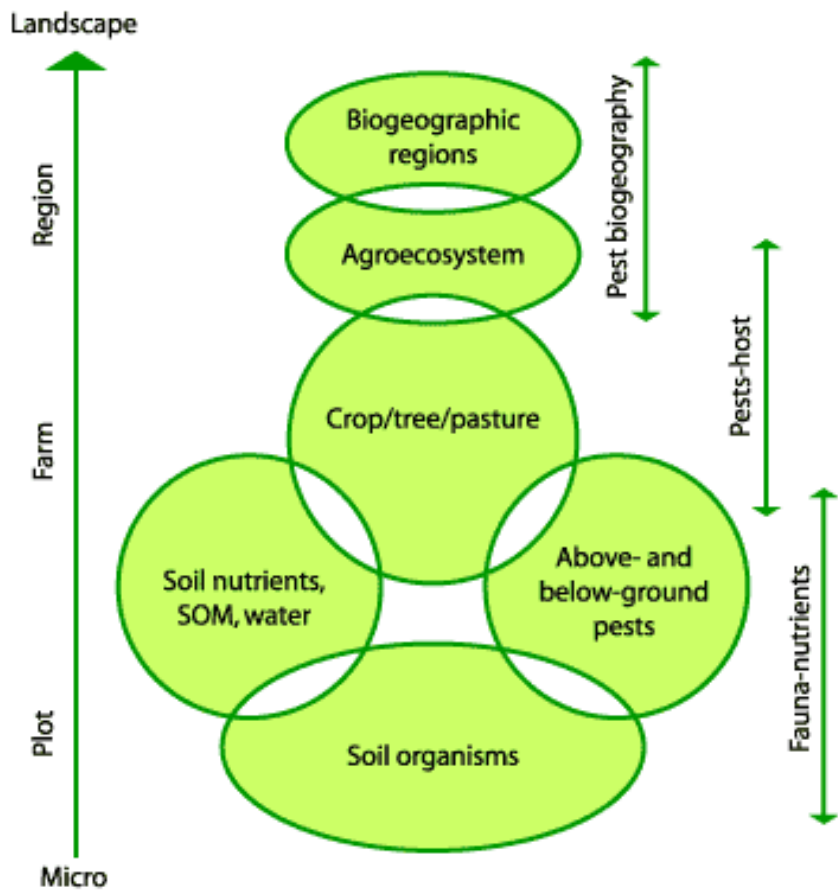


game reserve

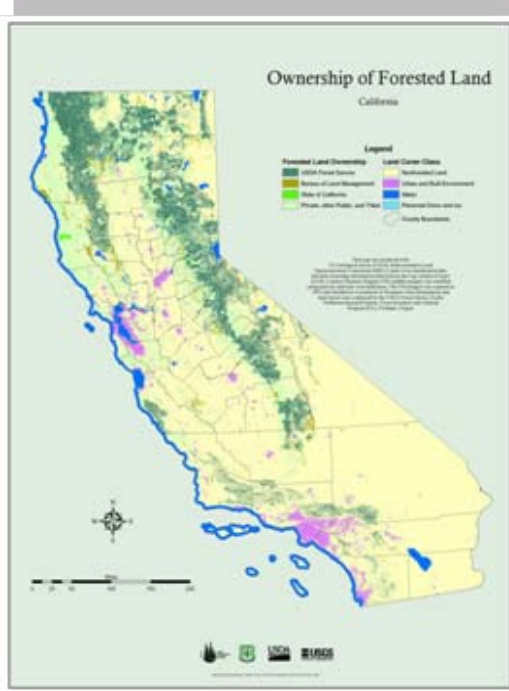


shelter for life stock

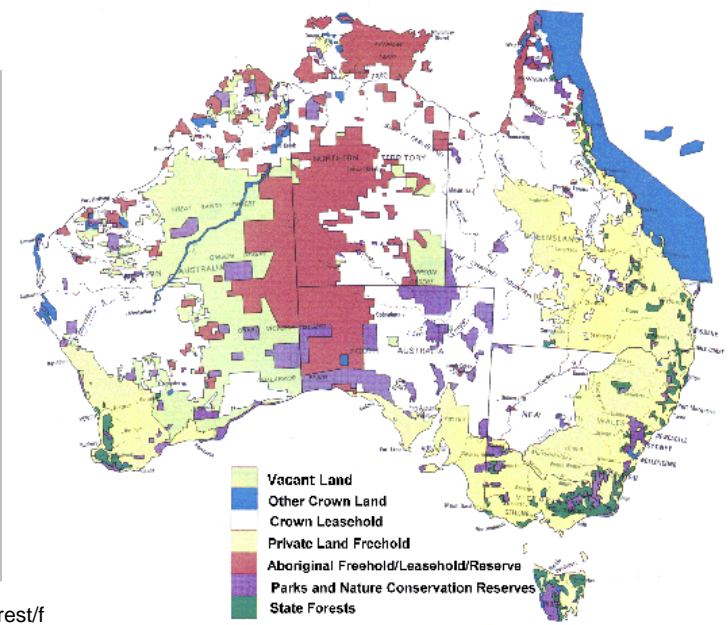
Multiscale Driving Forces in Land Use/Land Cover Change



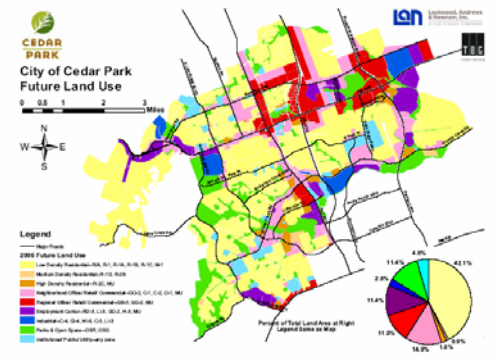
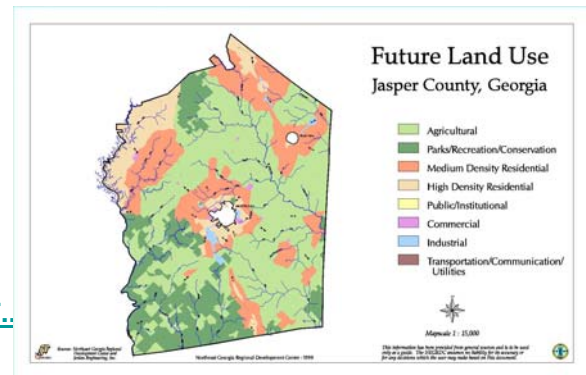
Towards Governance of Global Terrestrial Surface



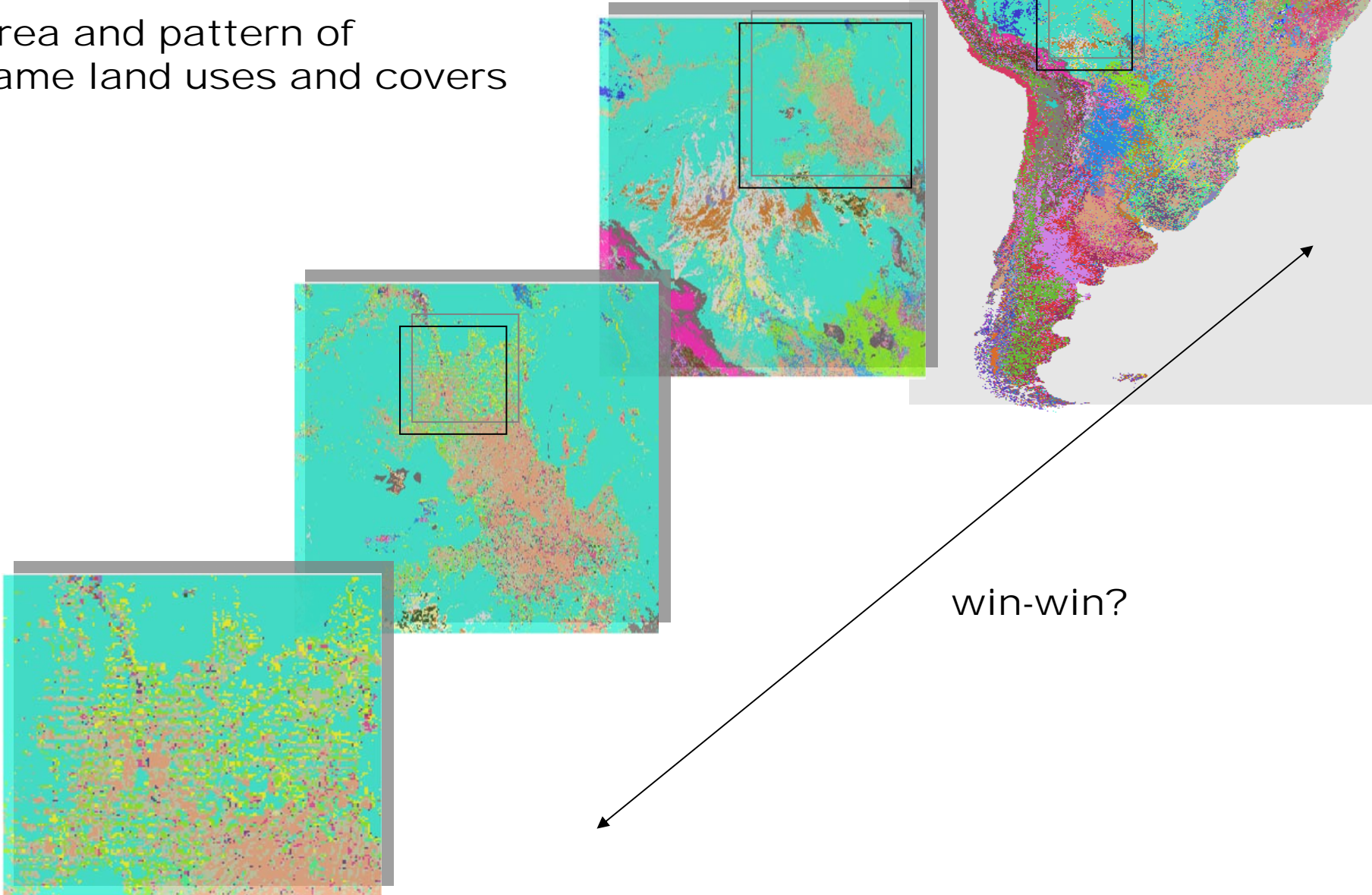
<http://atlas.nrcan.gc.ca/site/english/maps/environment/forest/orestcanada/landcover>



<http://>



Area and pattern of
same land uses and covers



win-win?

- **SS is the next multiple decadal orientation of climate-global change and development science.**
- **LCLUC-GLP poised to become foundational to sustainability science (SS)**
- **Vulnerability & especially sustainable land architecture are critical themes.**