

Land Architecture and Tradeoffs: Foundations for Sustainability

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Sustainability Science

In a warmer world

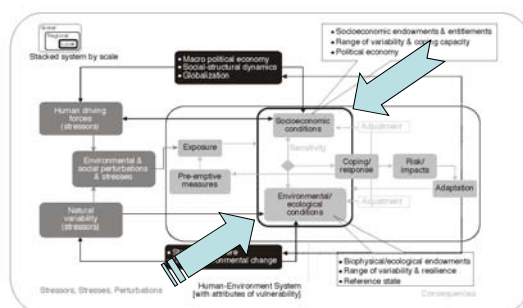
- Global
 - Provisioning humankind without threatening the base functions of the earth system

In a warmer (wetter/drier) world

- Local to regional
 - Maintaining and enhancing human well being without threatening ecosystem services

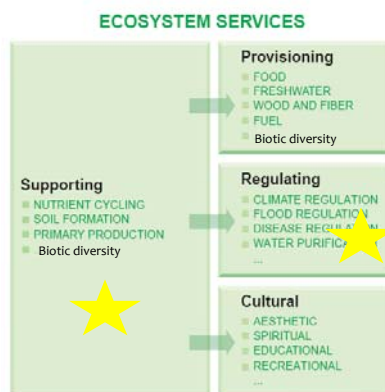
3 Pivots of SS

- #1 Coupled human-environment system = phenomenon of study and application
 - Synergy/feedbacks of the two subsystems affect one another and outcomes relative to external links and such issues as sustainability or vulnerability



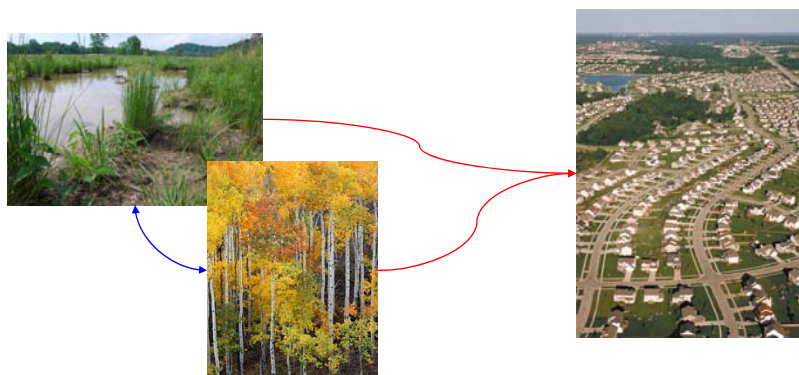
3 Pivots of SS

- #2 Natural capital expanded to include all ecosystem (or environmental) services



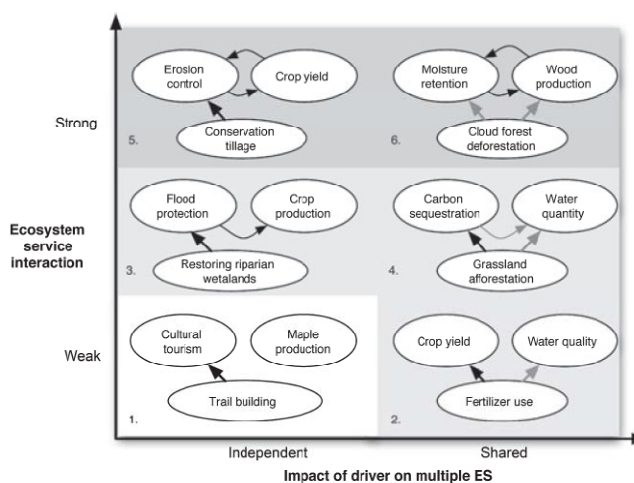
3 Pivots of SS

- #3 Tradeoffs among ecosystem services (outcomes land of cover) & between those services and human outcomes (outcomes of land use)



Underemphasized Facets of Tradeoffs

- *Physical tradeoffs* (change in service or human outcome relative to others), which can be as useful as *economic tradeoffs* (placing monetary value)



Bennett, Peterson, & Gordon, 2009, *Ecological Letters*

Underemphasized Facets of Tradeoffs

- Spatial dimensions of the tradeoff result:
 - land architecture (LA)
 - spatio-temporal scale of assessment
 - spatio-temporal dynamics

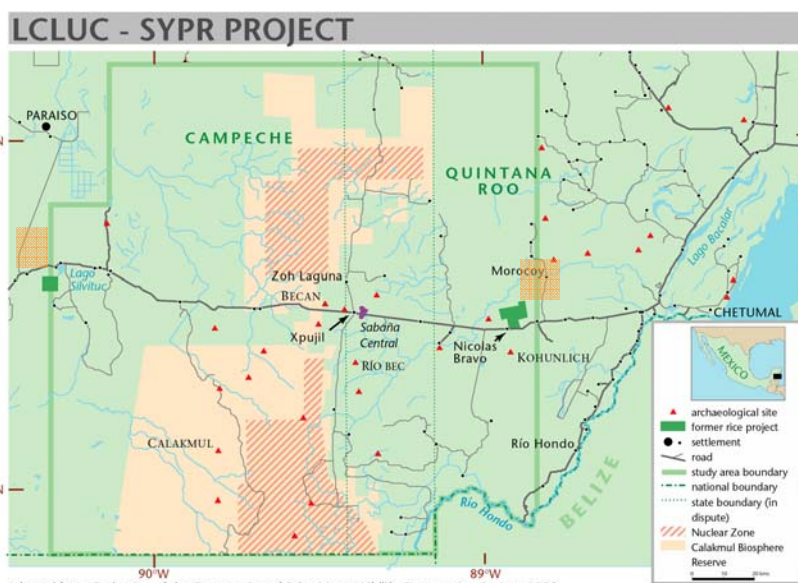


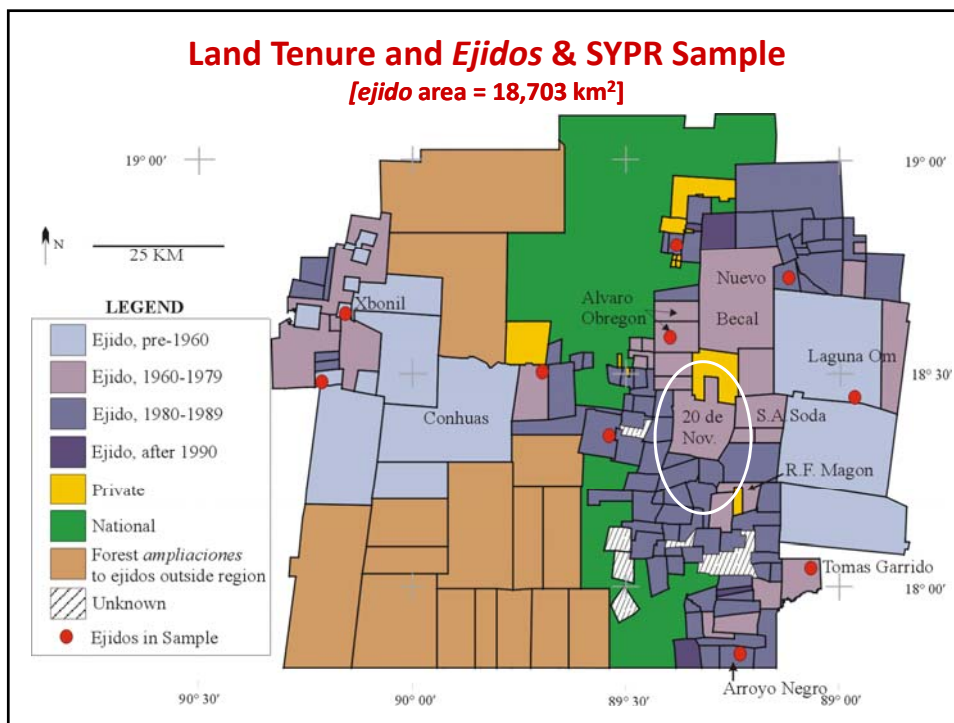
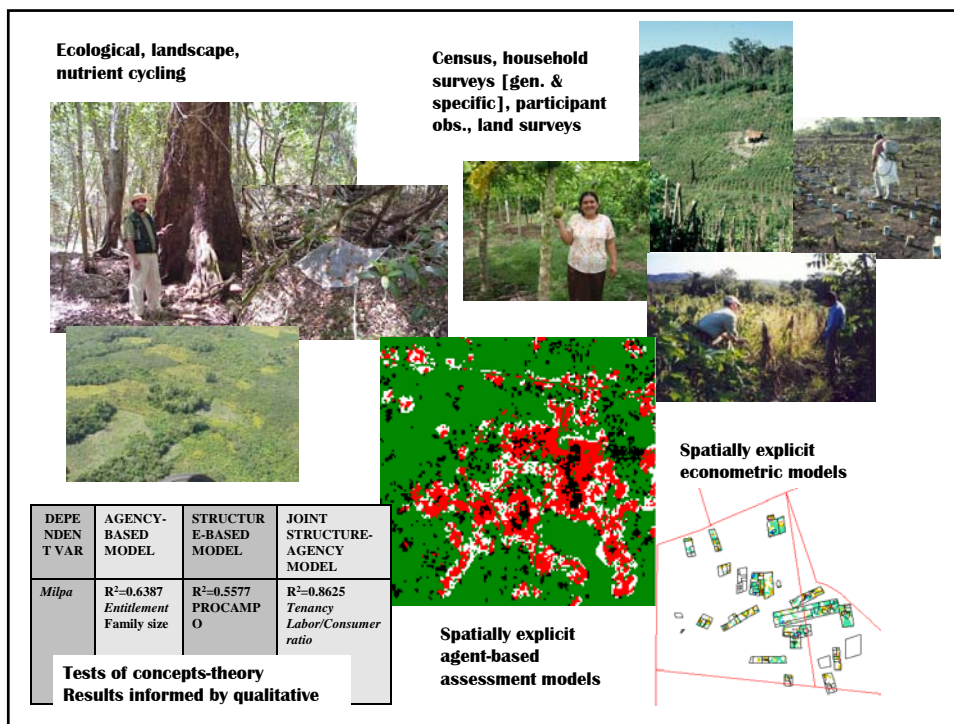
Where

LA = kind, amount, pattern, distribution of cover/use

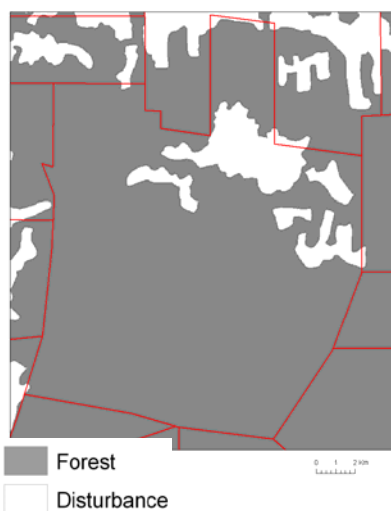


Simple Example from Southern Yucatan





Land Unit #1



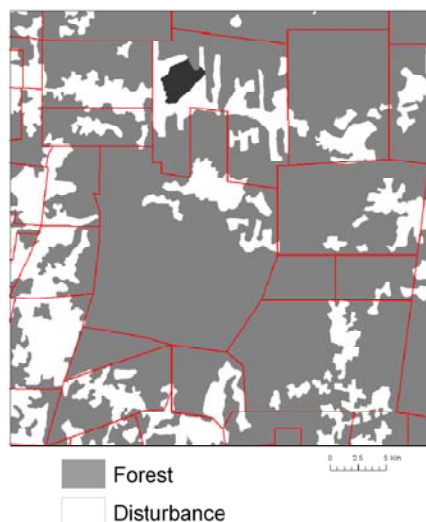
- LA favoring Reserve's biotic diversity and carbon storage themes
- Fragstats; PD 0.02, ED 2.01, LSI 2.67
- Carbon sink
- Old, slow growth species
- Captures large amount of P for nutrients
- Emits much water vapor for regional rf
- Lower farm income
- Focused are cultivated = reduced available soil P
- Weed-pest concentrations

Land Unit #2



- LA favors farming
- Fragstats: PD 0.16, ED. 5.91, LSI 4.2
- Secondary forest = less habitat for mature diversity species; lower carbon stocks; less evapotranspiration; less P capture
- Farm income higher
- Increase use of inputs (pesticides and fertilizers)
- External markets are key

Land Unit #1 Embedded in Others



Given LA in which units are embedded

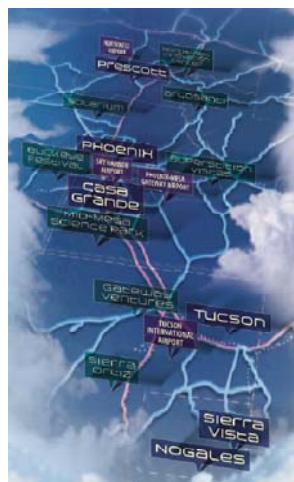
- bio-goals of Unit 1 not likely met
- farm goals of Unit 2 affected by increased pests, decrease P and precipitation

Each unit and region = different tradeoffs given its LA and its embedded LA

- Absent tradeoff assessment, cannot determine vulnerability and resilience of any coupled system
 - Within its usual range of variance
- Design or architecture of land system = critical but overlooked facet of tradeoffs
 - Land architecture essential for built environment
 - LA = kind, amount, pattern, distribution of land use-cover

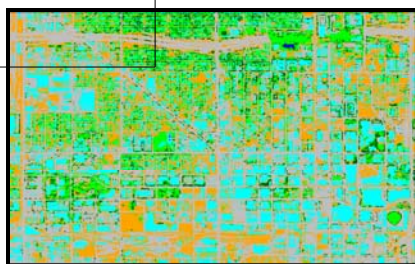


Hypothetical Example of Phoenix & Central Arizona Megapolitan



Thank you Soe Myint for the subsequent imagery.

Commercial



- + heat island (clim rs)
- - biotic diversity (ps)
- + carbon & lead emissions (ss)
- + albedo (ss)
- + tropospheric pollution (clim rs)

Poor scores on most environmental services

- + economic income/growth
- + employment opportunities
- + cultural/entertainment access

Scores high on many human outcomes

High (?) Density Residential



- Buildings
- Unmanaged soil
- Grass
- Other impervious surface
- Swimming pools
- Trees and shrubs
- Lakes, ponds, and canals

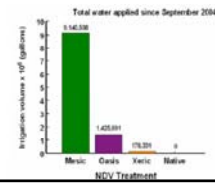


- + heat island offset (clim rs)
- -- native biotic diversity (ps)
- -- potential carbon & lead emissions (ss)
- + tropospheric pollution (clim rs)
- -- albedo (ss)

Variable scores on environmental services

- -- amt. daily travel
- + access to social services
- + neighborhood diversity
- + heat related health issues

Variable scores on human outcomes



Low Density Residential



- +/- heat island (clim rs)
- +/- household water use
- + native biotic diversity (ps)
- + carbon & lead emissions (ss)
- + albedo (ss)
- -- tropospheric pollution (ss) [but]

Variable scores on environmental services

- + per capita tax base [- on per area]
- + per capita spending
- + health insurance coverage
- + landscaped valued
- -- social diversity

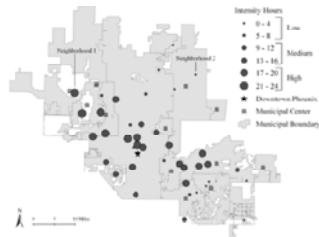
Scores high on many human outcomes

Urban-Agri-Wildland Interface



- -- heat island (clim rs)
- +/- water use/ha (ps)
- + native biotic diversity (ps)

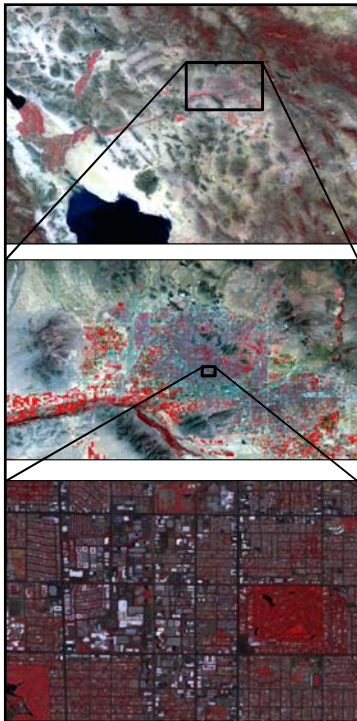
Environmental services scores depend on amount of agr.



- + maintains agri. sector
- -- housing development
- + access to favored landscapes

Scores high on AZ citizen assessment.

Scalar Dynamics



Decreased metro-area per capita water consumption offset by regional desiccation

Biotic friendly LA of metro-fringe rendered moot by loss of habitats in region.

Reduced water demands by loss of agr. lands partially offset by inner-city and metro-area temperature increases

Inner-city green cooling offset by metro-area warming

What's Needed

- “Real-world” land architecture → multiple land classes
- Multiple ecosystem tradeoffs
- Multiple human outcomes
- Combine in spatially explicit & dynamic models
- Test robustness of modeling outcomes

 <p>International Conference on Urbanization and Global Environmental Change</p> <p>“Opportunities and Challenges for Sustainability in an Urbanizing World” Arizona State University Tempe, AZ USA October 15-17, 2010</p> <p>The first Open Science Conference of the Urbanization and Global Environmental Change (UGEC) Project is an international effort to bring together scientists, practitioners, policy makers, and stakeholders to understand the multi-faceted interactions between urban areas and global environmental change. The conference seeks to build a forum for reflection, exchange of knowledge, experiences, lessons, ideas, and information, contributing to the creation of efficient strategies for urban sustainability. The structure and approach of the conference is specifically designed to foster dialogue among participants. Oral presentations and posters are encouraged to communicate the knowledge and lessons learned from research projects and practices.</p> <p>Abstract submissions are now being accepted through May 15, 2010 online at www.UGEC2010.org.</p>	 <p>GLP Open Science Meeting</p> <p>“Land Systems, Global Change and Sustainability” Arizona State University Tempe, AZ USA October 17-19, 2010</p> <p>The aim of the Open Science Meeting “Land Systems, Global Change and Sustainability” is to advance the science of land systems and their change for analysis and response to global change and sustainability. This event will bring together large parts of the international research community working on land change issues, showcase the width and scope of ongoing research, help build a community in this highly interdisciplinary field, inspire new research and facilitate review, theory building and extrapolation. The Open Meeting invites poster and oral presentation and will be organized around a number of themes, emerging from the GLP Science Plan.</p> <p>Abstract submissions are now being accepted through May 15, 2010 online at www.GL2010.org.</p>
<p>GLP and UGEC Joint Day</p> <p>“Sustainable Land Systems in the Era of Urbanization and Climate Change” October 17, 2010</p> <p>The UGEC Project and the Global Land Project (GLP) will convene on Sunday, October 17th to focus jointly on the urban, land, and climate change interface; the themes embedded in these linkages constitute one of the next phases of emphasis in global change and climate change science. This day will involve plenary, open paper, and poster sessions, as well as workshops, in order to build contacts and networks among urban and land-change specialists and to foster more collaboration worldwide, expanding the range of issues addressed.</p> <p>Abstracts for this joint day may be submitted at either the GLP or UGEC conference website: www.UGEC2010.org www.GL2010.org</p>	

UGEC is a core-project of the International Human Dimensions Programme on Global Environmental Change (IHDP) www.ihdp.unu.edu



GLP is a core-project of both the IHDP and International Geosphere-Biosphere Programme (IGBP) www.igbp.net





NEW: Keynote Speakers for plenary sessions (in **bold** confirmed):

17-19th October 2010: GLP Open Science Meeting: Land Systems, global change and sustainability

- **Eric Lambin** (University of Louvain, Belgium)
- **John Foley** (University of Minnesota, US)
- Harald Mooney (requested) (Stanford University, US)
- **Emilio Moran** (Indiana University, US)
- Bob Scholes (CSIR, South Africa) (requested)
- **Ruth DeFries** (University of Maryland, US)
- **Terry Chapin** (University of Alaska, US)
- Sandra Diaz (Universidad Nacional de Córdoba, Argentina) (requested)
- **Kerry Smith** (Arizona State University, US)
- **Charles Perrings** (Arizona State University, US)
- **Steven Polaski** (University of Minnesota, US)
- **Ann Kinzig** (Arizona State University, US)
- David Tilman (University of Minnesota) (requested)

17th October 2010: GLP/UGEC joint day: Sustainable land systems in the era of urbanization and climate change

- **Morgan Grove** (USDA Forest Service)
- **Marina Alberti** (University of Washington, US)
- **Michael Batty** (University College London, UK)
- David Singleton (requested)
- Nancy Grimm (Arizona State University, US) (requested)
- **Pat Gober** (Arizona State University, US)
- **Grady Gammage** ...
- **Michael Crow** (plenary chair) (Arizona State University, US)