Land Use and Sustainability

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partially taken from presentation by
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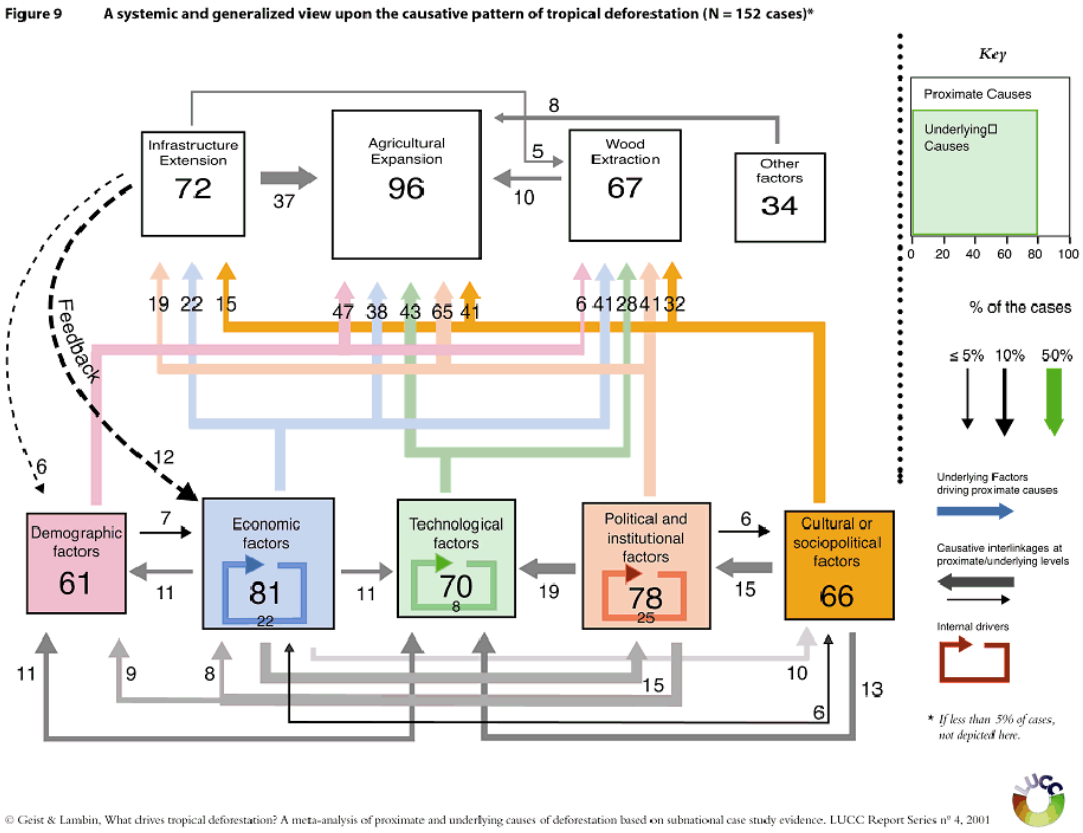
AAAS, Washington, D.C., 2011

Essential Message

- *Move beyond "traditional" driver research before land change science is surpassed by other global environmental change initiatives and orientations addressing CHES consequences.*
- Critical driver-oriented research remaining is aggregate, comparative, or synthesis in kind requiring systematic-quantitative exploration more so than more remote sensing.
  - Does not negate important monitoring needs.

Example: Incomplete Past Challenge

- Systematic assessment of drivers by spatio-temporal scale
  - How consistent are drivers by these scales?
  - Do areal variations in outcome reflect consistent human-environment conditions?
  - Do these conditions reflect interplay of processes operating at different scales.
- Can be addressed via secondary research activities



Themes & Issues Underway Linking Land Change Science to Sustainability

- Coupled human-environment systems beyond proximate linkages & with attention to issues of longer term consequences → labeled *sustainability, vulnerability, resilience, tradeoff assessment*

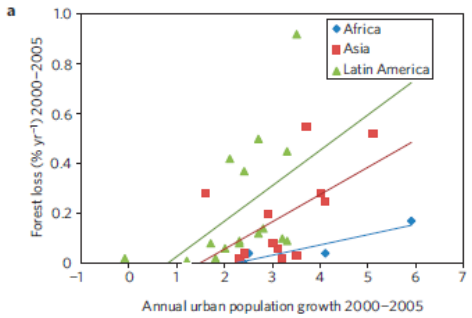
1. *Conditions of "rural" (?) economy*
2. *Environmental feedbacks on CHES*
3. *Tradeoffs ecosystem services & human outcomes*
4. *Spatial dimension #3*

Land Change for Sustainability #1

- Move from land managing unit (household or farm) holding national-regional socioeconomic context constant to *quantitative assessments* of conditions of & change in area/regional economy
- Treat structural changes in rural economy linked to
  - [A] local urban-hinterland dynamics
  - [B] national-regional policies
  - [C] economic globalization

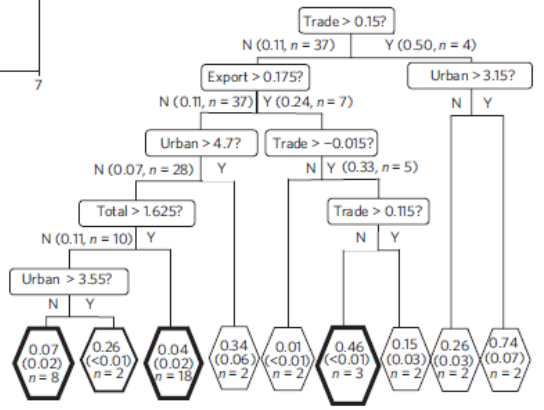
A. Urban Hinterlands

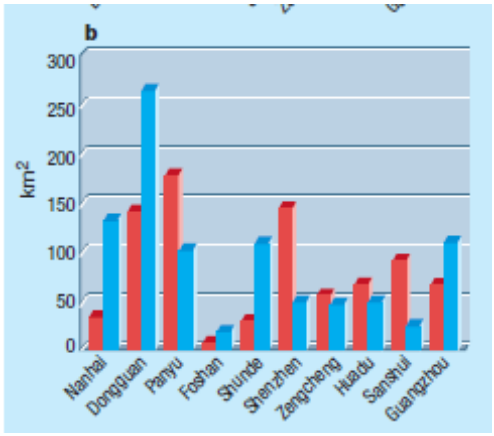
- Direct
  - Classic hinterland development = sustained or > land change as rural production required for urban areas
- Indirect
  - Loss of prime lands to urbanization = expansion of agr & forest loss elsewhere



DeFries et al. 2010 *Nat. Geosci.*

Linear regression & regression tree





Seto et al. 2000, *Nature*.

Farmland lost Pearl River Delta, 1990-96

B. National-Regional Policies

- Changes in land use policy → major shifts in land cover

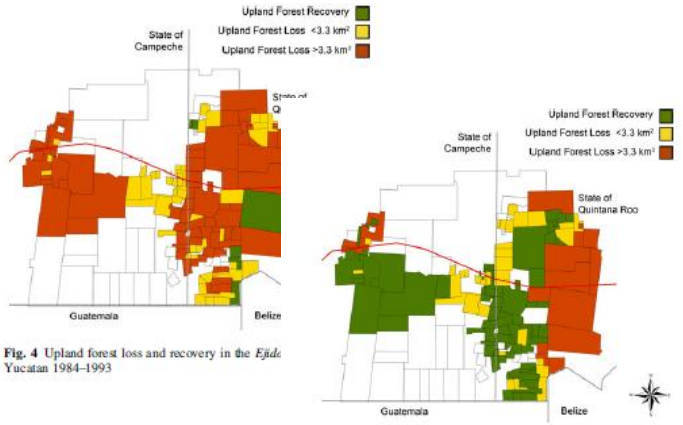


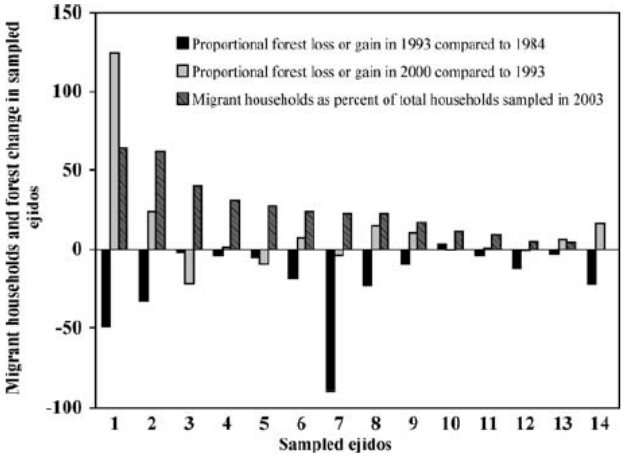
Fig. 4 Upland forest loss and recovery in the *Ejid* Yucatan 1984–1993

Fig. 5 Upland forest loss and recovery in the *Ejidos* of the southern Yucatan 1993–2000

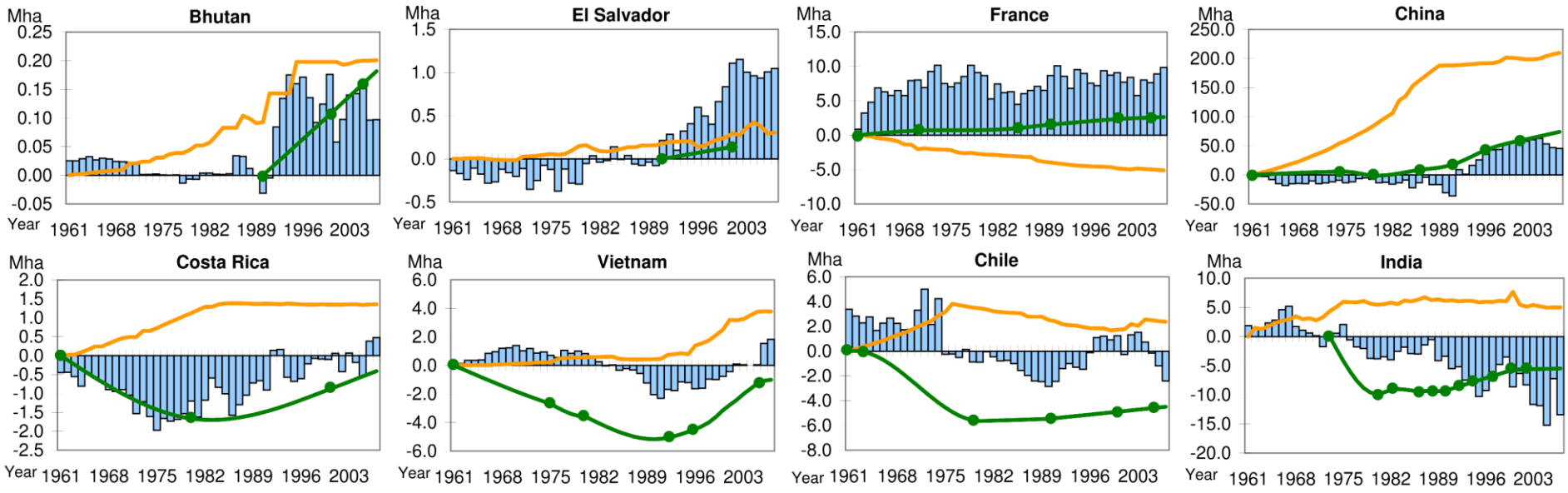
Rueda 2010: *Regional Environmental Science*

- Nonfarm rural sector remittances → same
- Diversify portfolios → same

Schmook + Radel. 2008 *Human Ecology*



C. Economic Globalization



Meyfroidt, Rudel, Lambin, PNAS, 2011

All recent forest transition countries:

- Additional global land use change embodied in their trade (*i.e.*, net displacement) offsets 22% of their total reforested area
- **Total net displacement increasing to >50% in 2003-07**
- What are implications for REDD regarding displacement & "virtual" wood

Land Change for Sustainability #2

Improve understanding of **environmental feedbacks** on land use (as opposed to mainly land use impacts on ecosystem) & land managers responses

Table 1. Atmospheric deposition of phosphorus as a function of canopy cover and forest age

Cover	[P], μg/liter	P input per event, g/ha	Cumulative P input, g/ha per month*	Estimated wet season P inputs, kg/ha†
Open field	24 ± 5[a]	4.2 ± 0.5[a]	43	0.26
4-yr-old forest	40 ± 5[b]	6.5 ± 0.5[b]	72	0.43
20-yr-old forest	59 ± 6[c]	11.8 ± 1.3[c]	119	0.71
Mature forest	65 ± 6[c]	12.3 ± 1.0[c]	134	0.81

Mean ± SE. Letters a–c indicate significant differences.
*For the period June 2 to July 1, 2006.
†Cumulative P input × 6 (average no. of rainy months).

Lawrence et al., *PNAS* 2007, 104 – P limiting nutrient & reduced with loss in forest cover

Schneider & Fernando, *Biotropica* 2010, 42 – invasive bracken follows multi-burned parcels

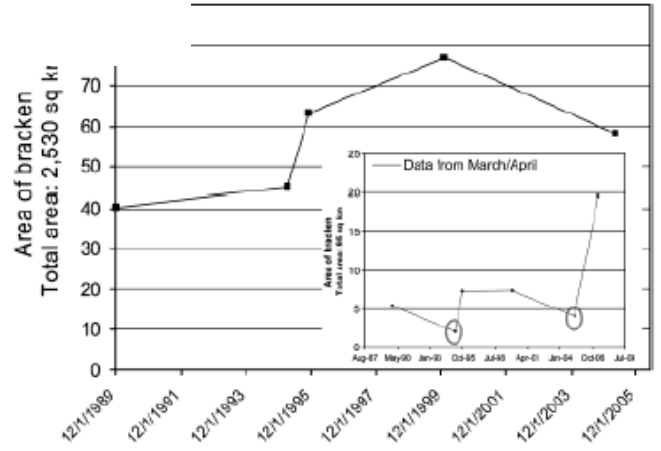
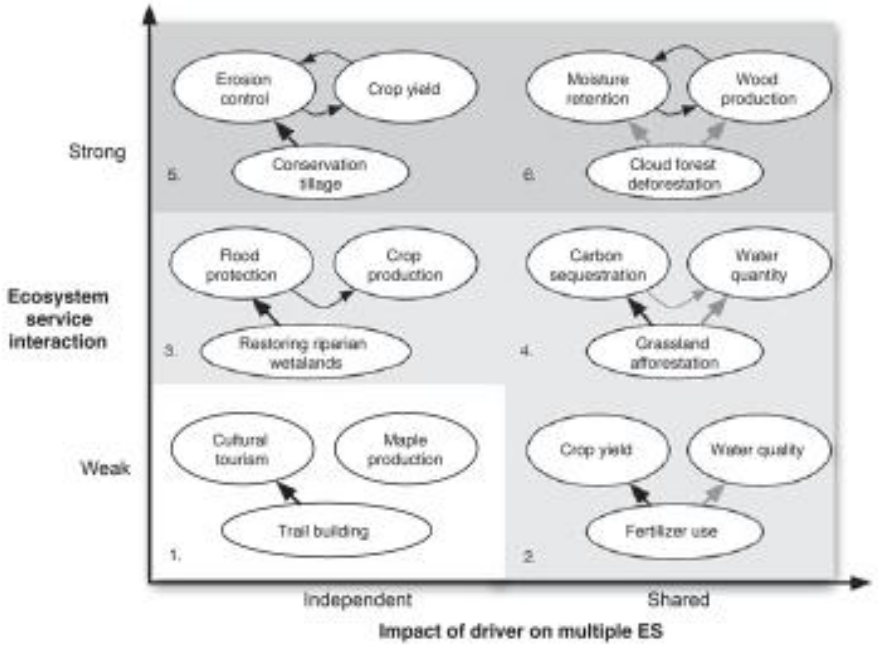
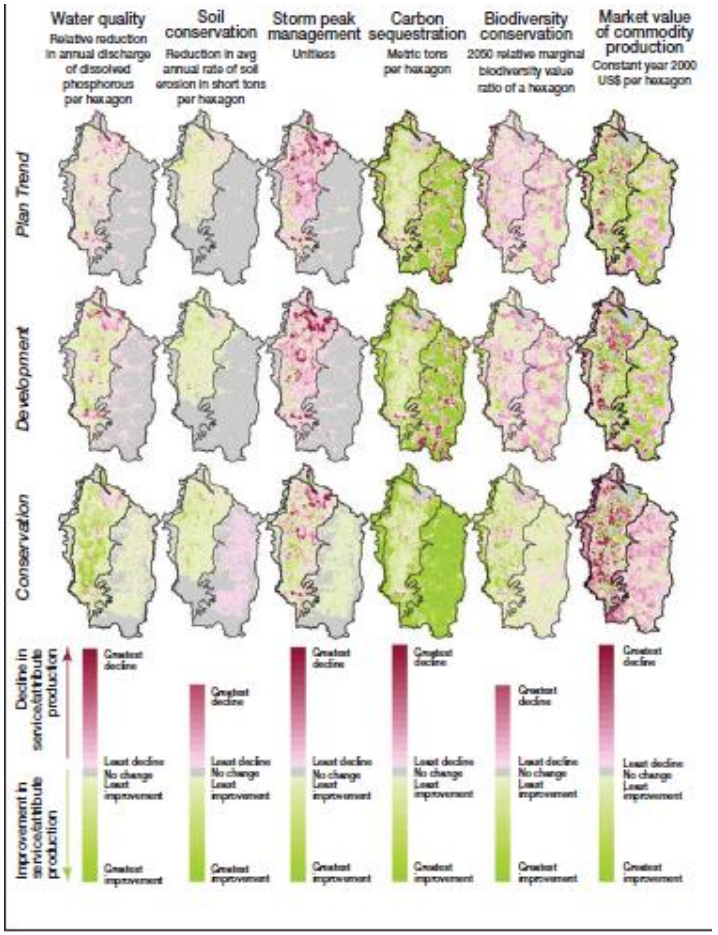


FIGURE 3. Total land affected by bracken fern from 1989 to 2005 from LMM results.

Land Change for Sustainability #3

- Link multi-ecosystem service tradeoffs, especially beyond provisioning services, with human outcomes





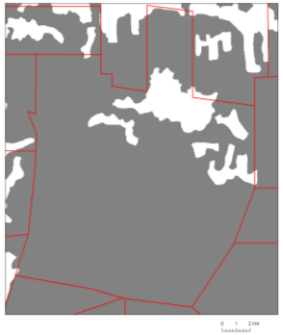
Nelson et al. *Front Ecol Environ* 2009, 7 – to econ. value

Bennett et al. *Ecol Letters* 2009, 12 – multiple services bundled

Land Change for Sustainability #4

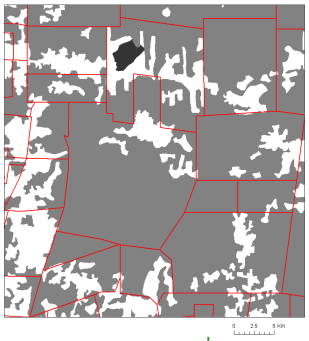
- Accounting for kind, amount, shape, pattern of land-use/cover + spatial dynamics – on ecosystems, services, and human outcomes

Local pattern A



PD, ED, LSI ↑
Forest structure ↑
Biomass ↑
Carbon ↑
Biodiversity ↑
P Capture ↑
Bracken fern ↓
Evapotrans. ↑
Farm income ↓
Degrad. fram land. ↑
Req. off farm income ↑

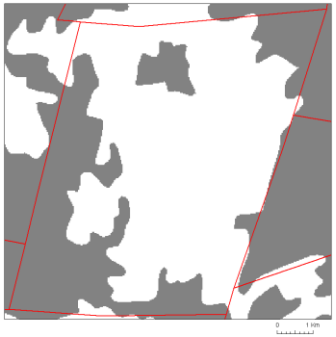
Local patter A affected by area pattern



Biodiversity ↓
Habitat restriction ↓
Precipitation ↓?
Ecotrourism ↓
Farm Yields ↓

pattern and scalar interactions matter and must be treated more concretely with human outcomes

Local pattern B



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Farm income ↑
Degrad. Farm land ↓
Req. off farm income ↓

B Turner 2010. *Land Use Policy*.

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LCLUC SHOULD NOT BE LEFT BEHIND BY AAAS, NAS, ICSU, AND INDEPENDENT EFFORTS, e.g.,

SUSTAINABILITY SCIENCE
DIVERSITAS
RESILIENCE
PROGRAMME ON ECOSYSTEM CHANGE & SOCIETY

WHICH INCREASINGLY MOVE BEYOND DRIVERS TO ADDRESS CHES CONSEQUENCES,
WITH REMOTE SENSING AS ITS BASE

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