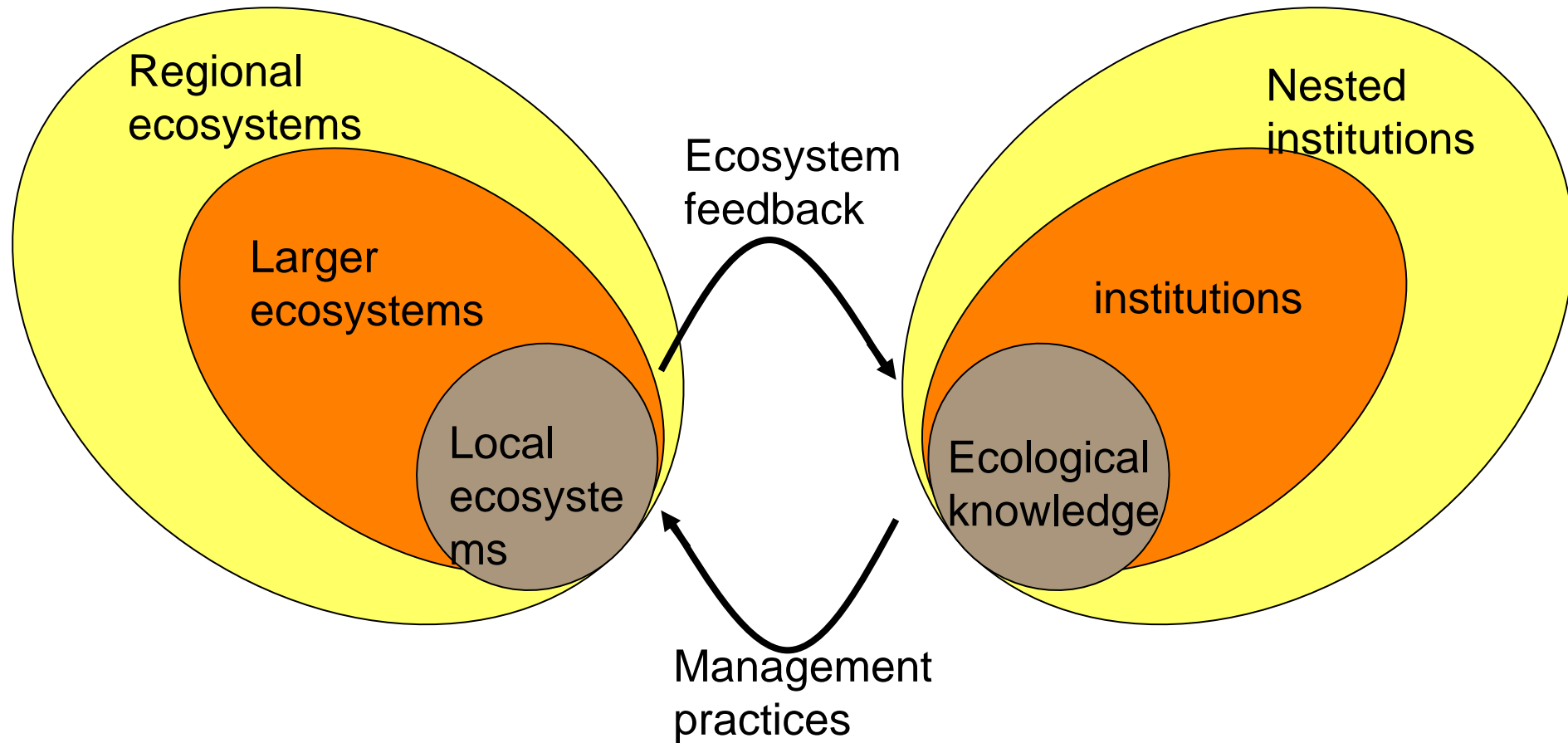


# Ecosystem Services in Social-Ecological Systems

Garry Peterson

Stockholm Resilience Centre, Stockholm University,  
Sweden

# Conceptual Model of a Social-Ecological System



# What distinguishes SES from other approaches

Focus on feedbacks between social and ecological - how social and ecological alter one another and “co-evolve”

Focus on structures and processes:

Scale

Shocks, Crisis, Reorganization

Transformation

These things are not always important....

# Alternative social-ecological lenses for looking at ecosystem services

Three examples

- Ecosystem service bundles
- Ecosystem services & regime shifts
- Social-ecological networks

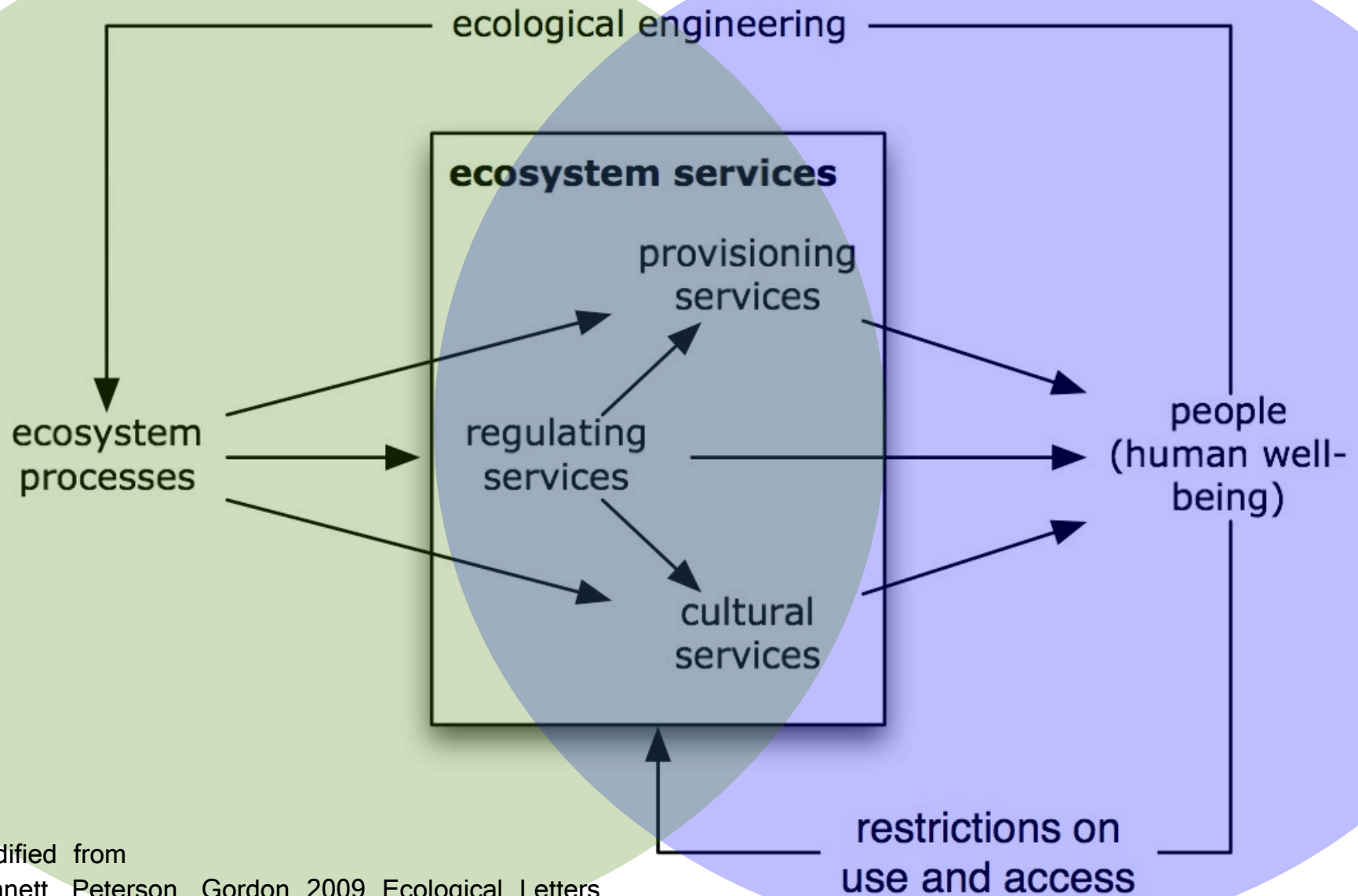
End with an integrated framework from  
PECS + open questions

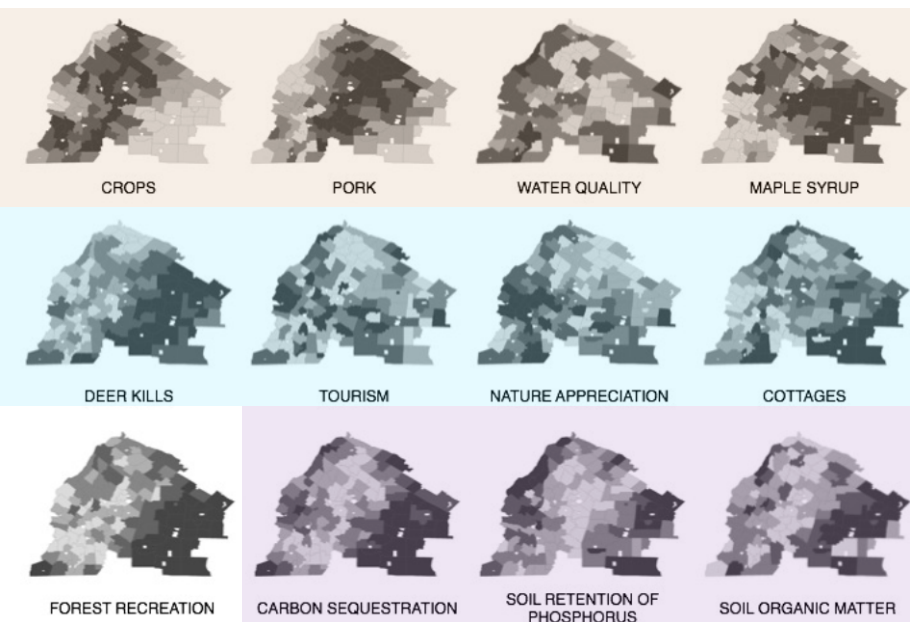
# Social-ecological bundles of Ecosystem Services

- Multiple social and ecological processes interact and influence other to produce particular clusters of ecosystem services
- Alternative model – independence - all ecosystem services vary independently of one another

# Ecosystem services

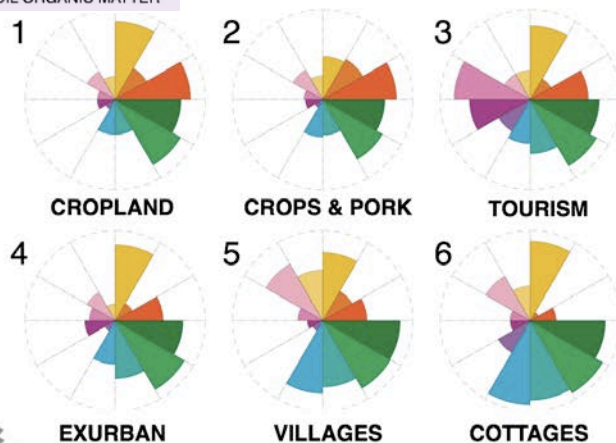
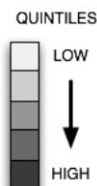
## Link social and ecological systems



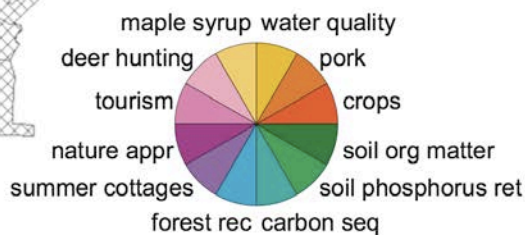
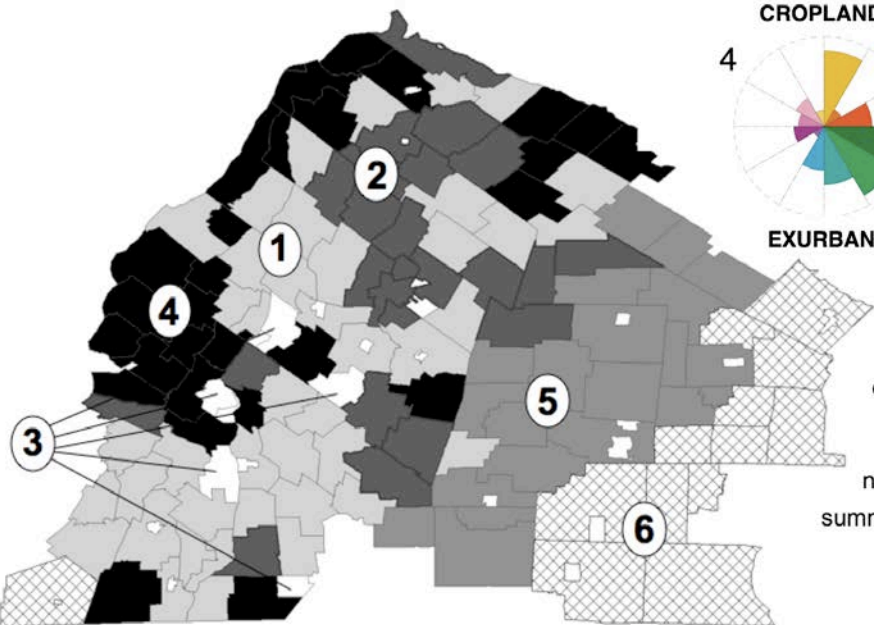


Social-ecological systems define patterns of ES services

Different social, geographic, ecological factors predict each ES best



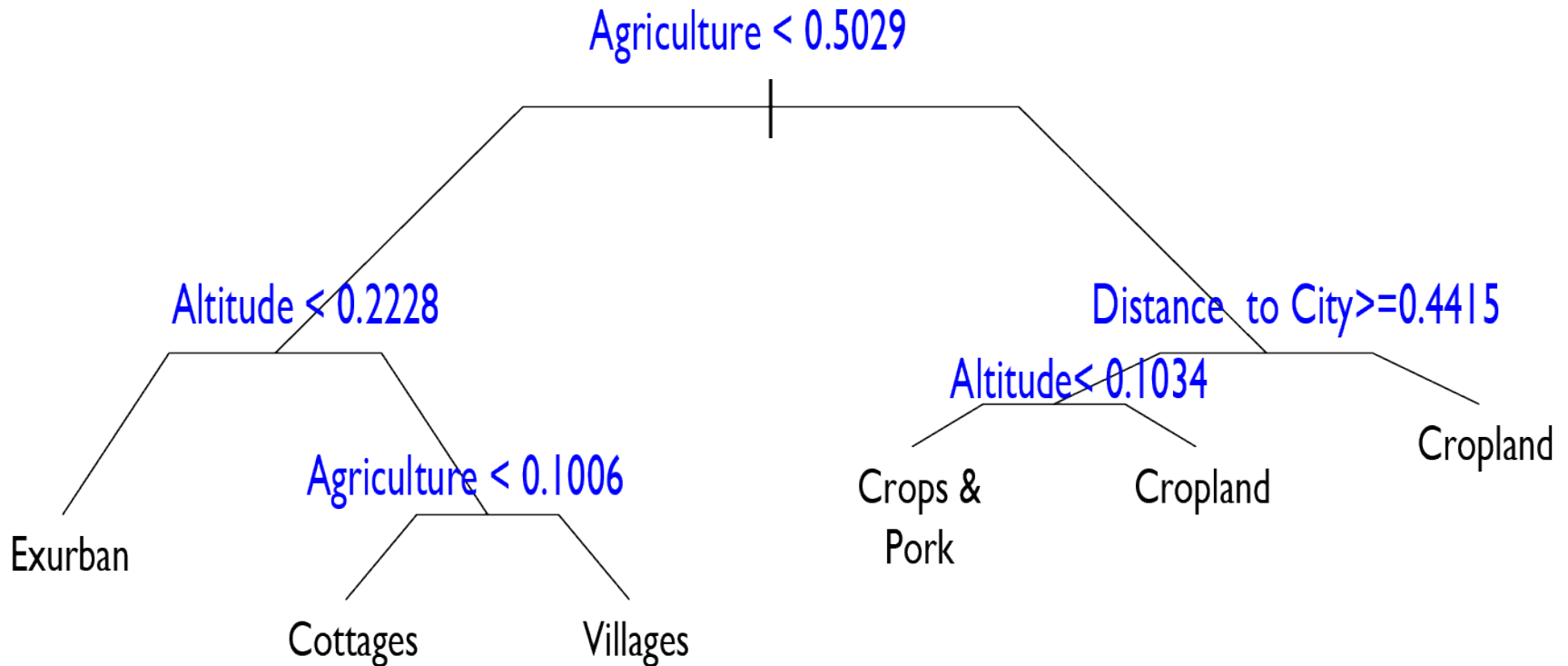
Social-ecological systems define ES bundles



# Ecosystem Service bundle CART model

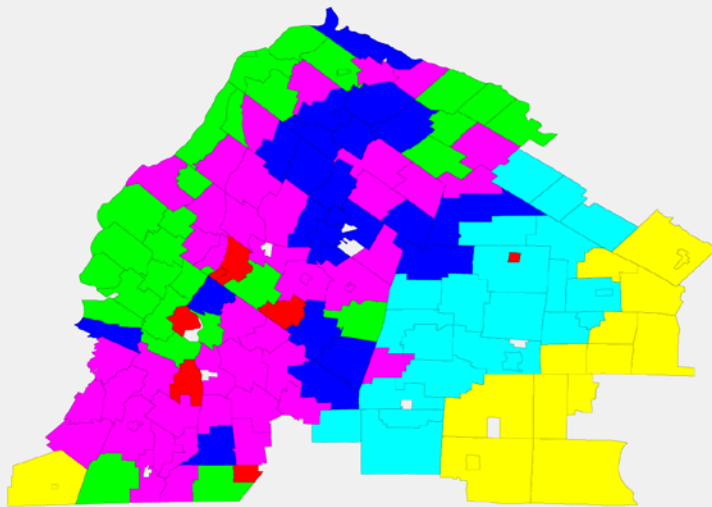
Uses 3 social-ecological variables

Predicts 5 bundles

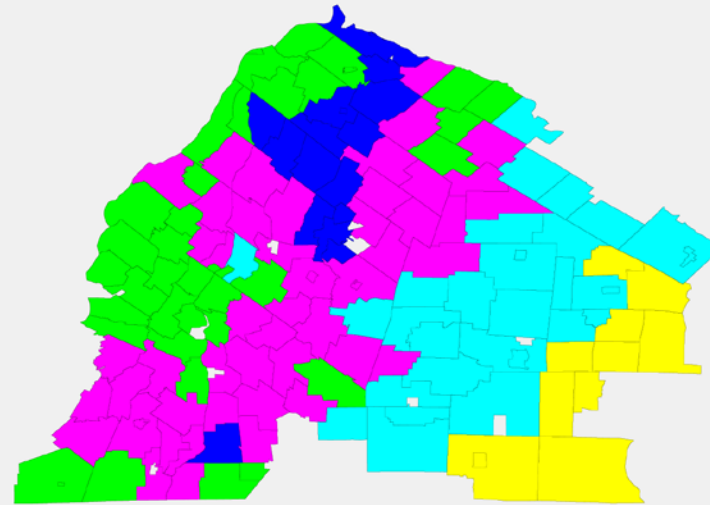




# Can use ES bundles to predict 12 individual ES

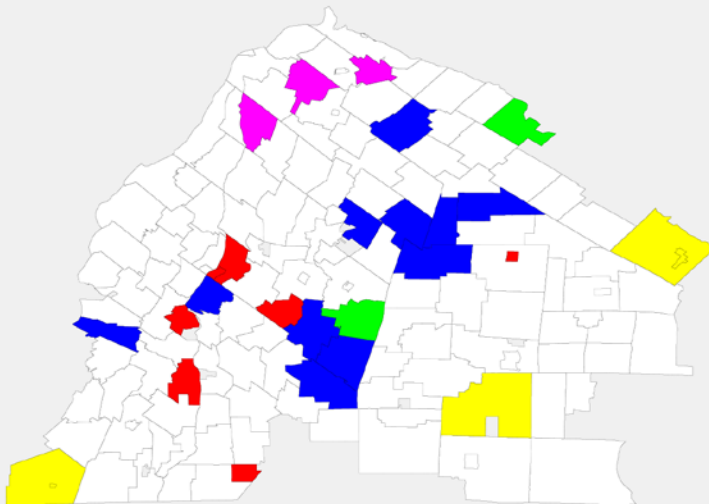


Actual ES Bundles

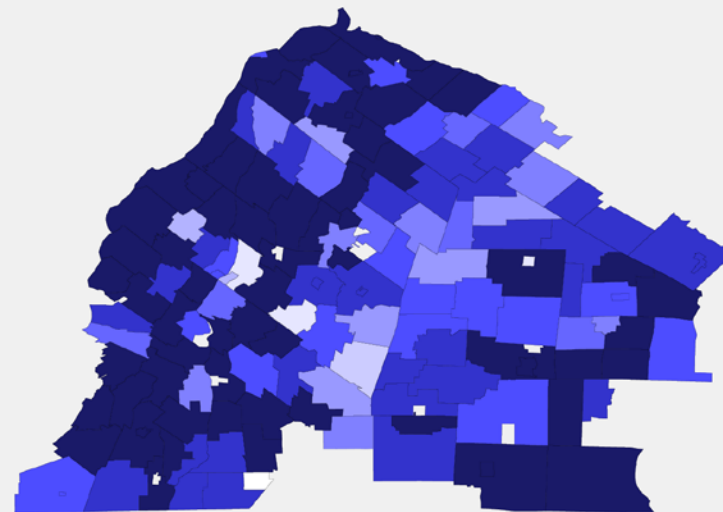


Predicted ES Bundles

- Cropland
- Crops & Pork
- Tourism
- Exurban
- Villages
- Cottages



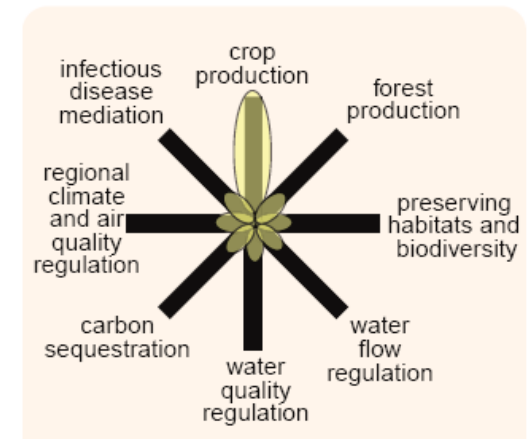
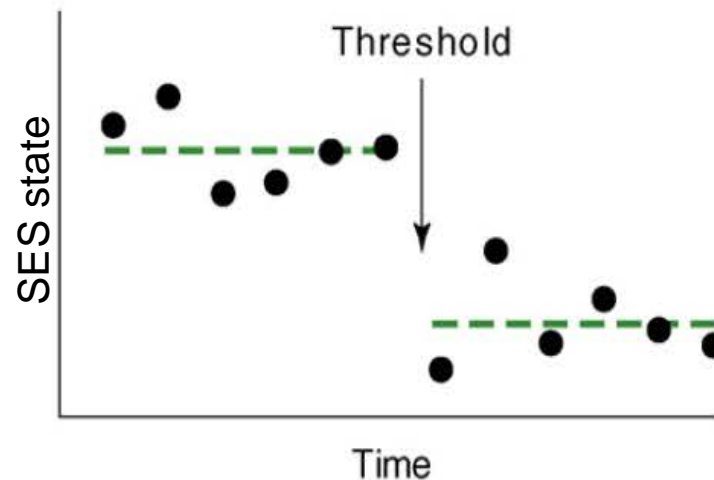
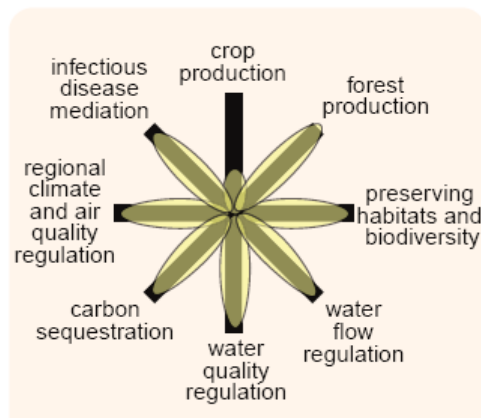
Incorrect Bundles



- R<sup>2</sup>
- under 0.1
  - 0.1 - 0.2
  - 0.2 - 0.3
  - 0.3 - 0.4
  - 0.4 - 0.5
  - 0.5 - 0.6
  - 0.6 - 0.7
  - 0.7 - 0.8
  - 0.8 - 0.9
  - over 0.9

# Ecosystem Services & Regime Shifts

**Large, persistent (and often abrupt) shift in the set of ecosystem services produced by an SES**

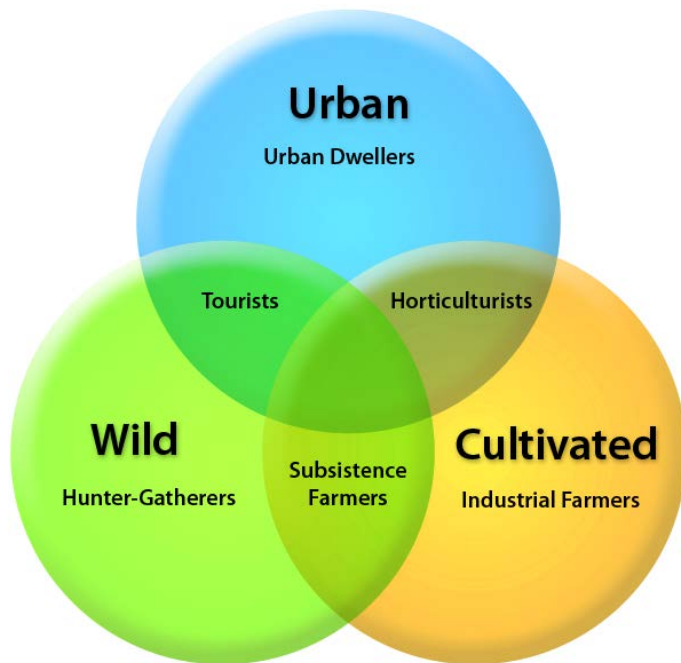


Abruptness affects the capacity to adapt

*Biggs & Peterson, in prep.; Foley et al. 2005.; Raudsepp-Hearne et al 2010*

# Ecosystem Service Regime Shifts

## Generic ES users



	Urban Dwellers	Horticulturists	Industrial Farmers	Subsistence Farmers	Hunter-Gatherers	Tourists
<b>ECOSYSTEM SERVICES</b>						
Freshwater	X	X	X	X	X	X
Crops		X	X	X		
Livestock				X		
Fisheries						
Wild food/products				X	X	X
Timber / woodfuel				X	X	X
Hydro power	X	X				
Air quality Regulation	X	X				X
Climate Regulation	X			X	X	X
Water Purification	X	X	X	X	X	X
Soil Erosion Regulation			X	X		
Pest / Disease Regulation		X		X		
Pollination		X		X	X	
Natural Hazard Regulation	X			X	X	X
Recreation	X			X	X	X
Aesthetic	X	X		X	X	X
Spiritual				X	X	X
Educational	X			X	X	X

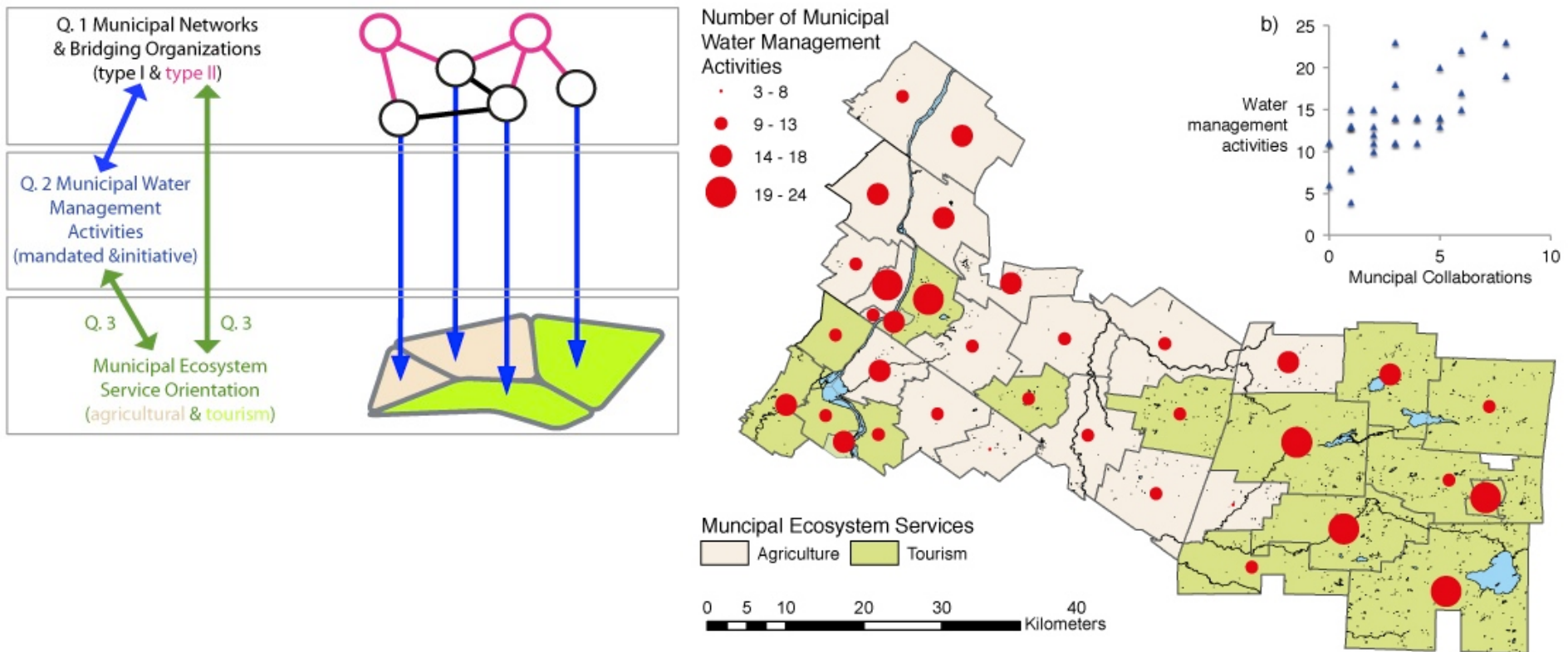
# Impact of regime shifts on ecosystem services across groups

	Industrial Farmers	Horticulturists	Urban Dwellers	Tourists	Hunter- gatherers	Subsistence Farmers	Total ES impact
Locust Plagues to Outbreaks							
Undammed to Dammed River							
Grassy to Bushy Savanna							
Clear to Eutrophic Lake							
Submerged to Floating Plants							
Normoxic to Hypoxic Coast							
Forest to Savanna							
Forest to Cropland							
Normal to Saline Soil							
Original to New River Channel							
High to Low Soil Organic Matter							
Vegetated to Desert							

# Social-ecological networks

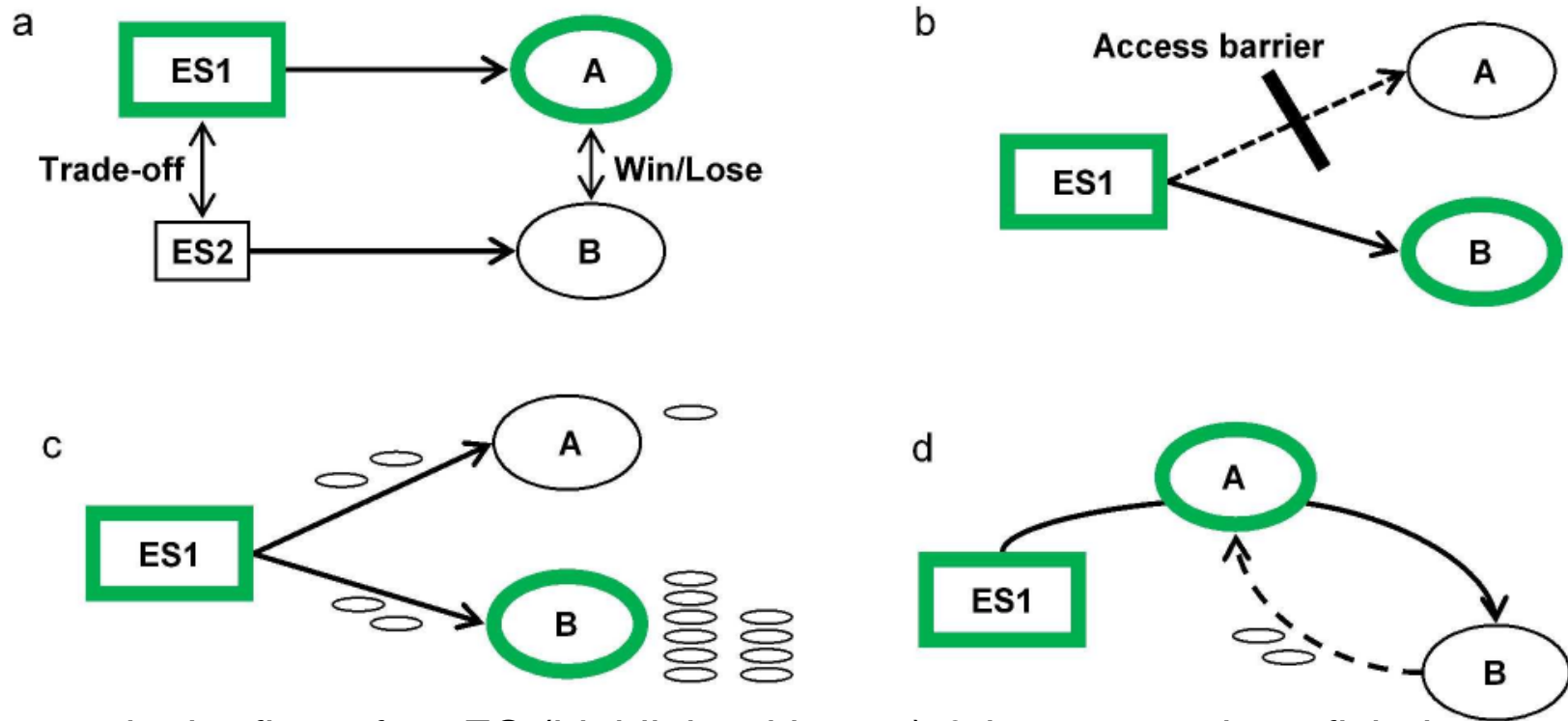
- Network analysis useful way can be applied to both people and ecosystems
- Useful way of simplifying mapping connections while paying attention to diversity and inequality
- Area of rapid development
- Örjan Bodin at SRC, & his collaborators, have done a lot of work in this area (e.g. recent paper in GEC – book last year)

# Social-ecological networks to simplify analysis of social-ecological systems



(Rathwell & Peterson In Press Ecology and Society)

# Disaggregating Society for analyzing ES



Increase in the flow of an ES (highlighted boxes) & impacts on beneficiaries A and B.

a – Trade-offs between different ES lead to winners and losers

b – Access mechanisms determine the wellbeing impacts of changes in ES.

c – Contribution of ES to wellbeing depends on social context. Increasing ES1 contributes more to the wellbeing of A than B.

d – Wellbeing contributions of ES1 to A results from the desire and willingness to pay of B to consume ES1.

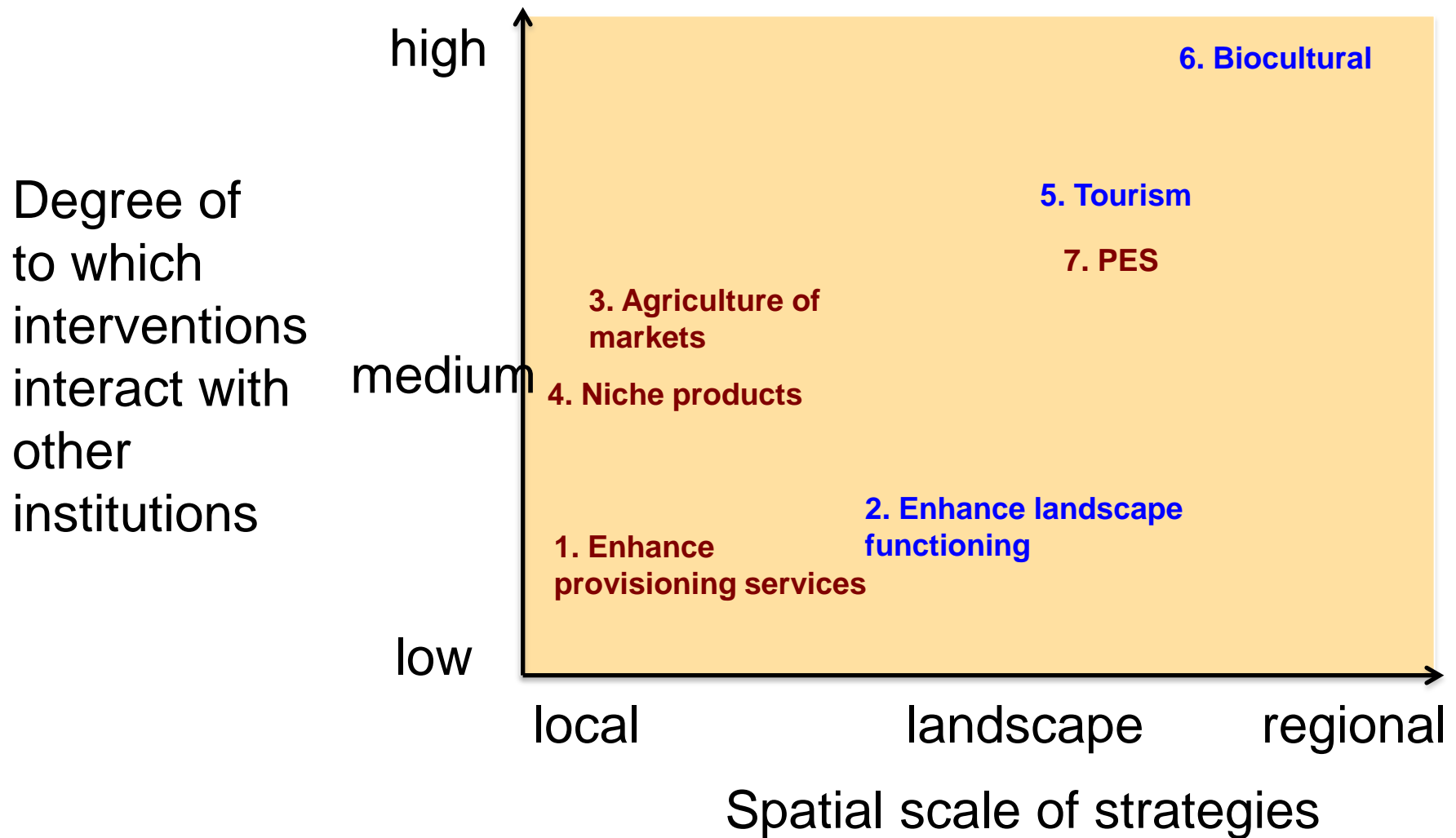
# Many different approaches

## Poverty Alleviation & Ecosystem Services

- Enhance provisioning services (for subsistence)
- Enhancing landscape function (resilience)
- Agriculture for markets (\$)
- Niche products (\$)
- ES Tourism (\$)
- Biocultural enhancement/re-invention (cultural)
- PES (\$)

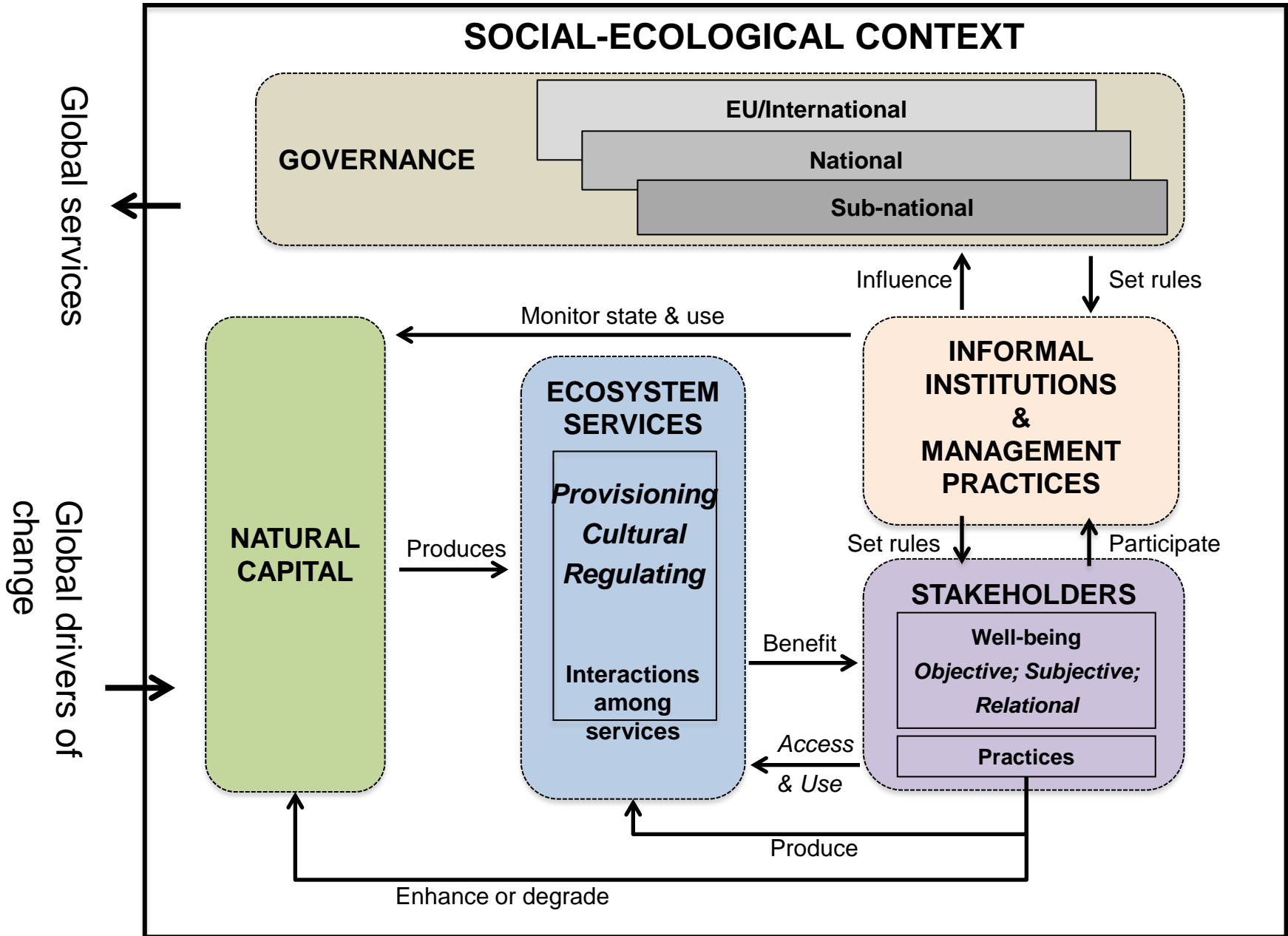


# Social-ecological context of strategies varies



Red – fast interventions; Blue – slower (Reyers et al In Prep)

# Programme on Ecosystem Change & Society



# Research needed to fill the gap of evidence

- How do ecosystem services produce human wellbeing - especially non-provisioning services?
- How to measure regulating ecosystem services?
- How do ecosystem service interactions vary across time, space, and people?
  - Interactions
    - How to conceptualize; memory; spatial subsidies; mobile links
    - Urban vs./and Rural
  - Ecosystem service regimes
    - Shared drivers; feedbacks; robustness; ES use
  - Combined social-ecological dynamics (endogenous vs. exogenous)
    - shifts in beliefs (e.g. property prices); technology
- How can people most effectively engineer ecosystems to produce bundles of desired ecosystem services

# For more Information

Garry Peterson homepage + papers

<http://www.stockholmresilience.org/peterson>

Resilience Science weblog: [rs.resalliance.org/](http://rs.resalliance.org/)

On twitter: @resilienceSci

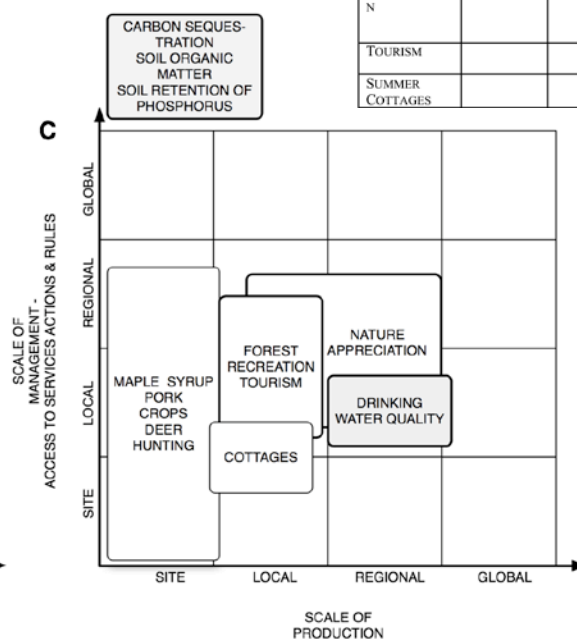
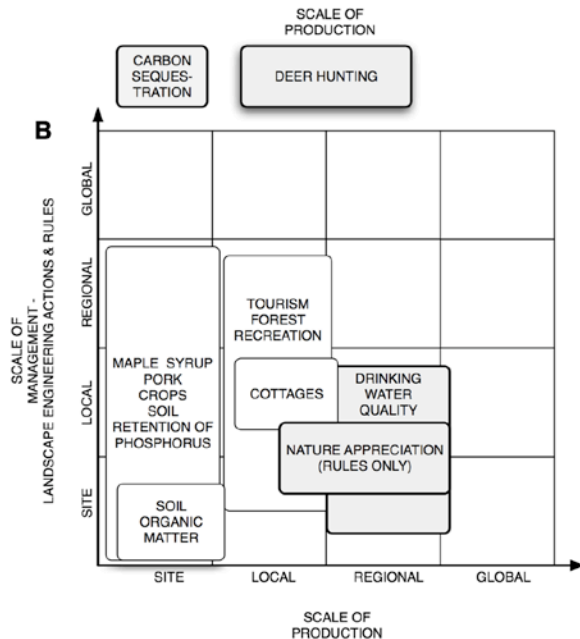
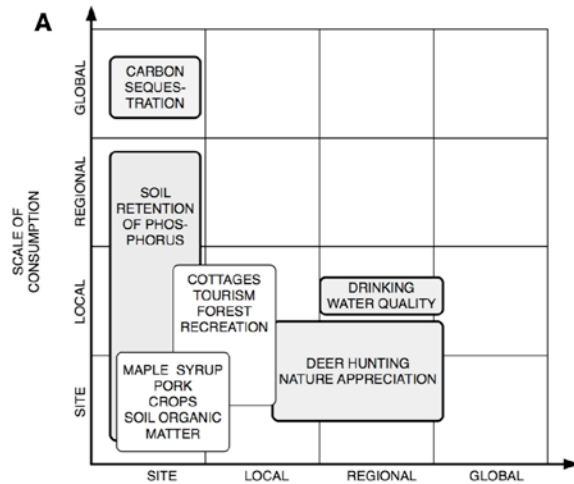
Resilience Alliance: [resalliance.org/](http://resalliance.org/)

Stockholm Resilience Centre

[www.stockholmresilience.org](http://www.stockholmresilience.org)



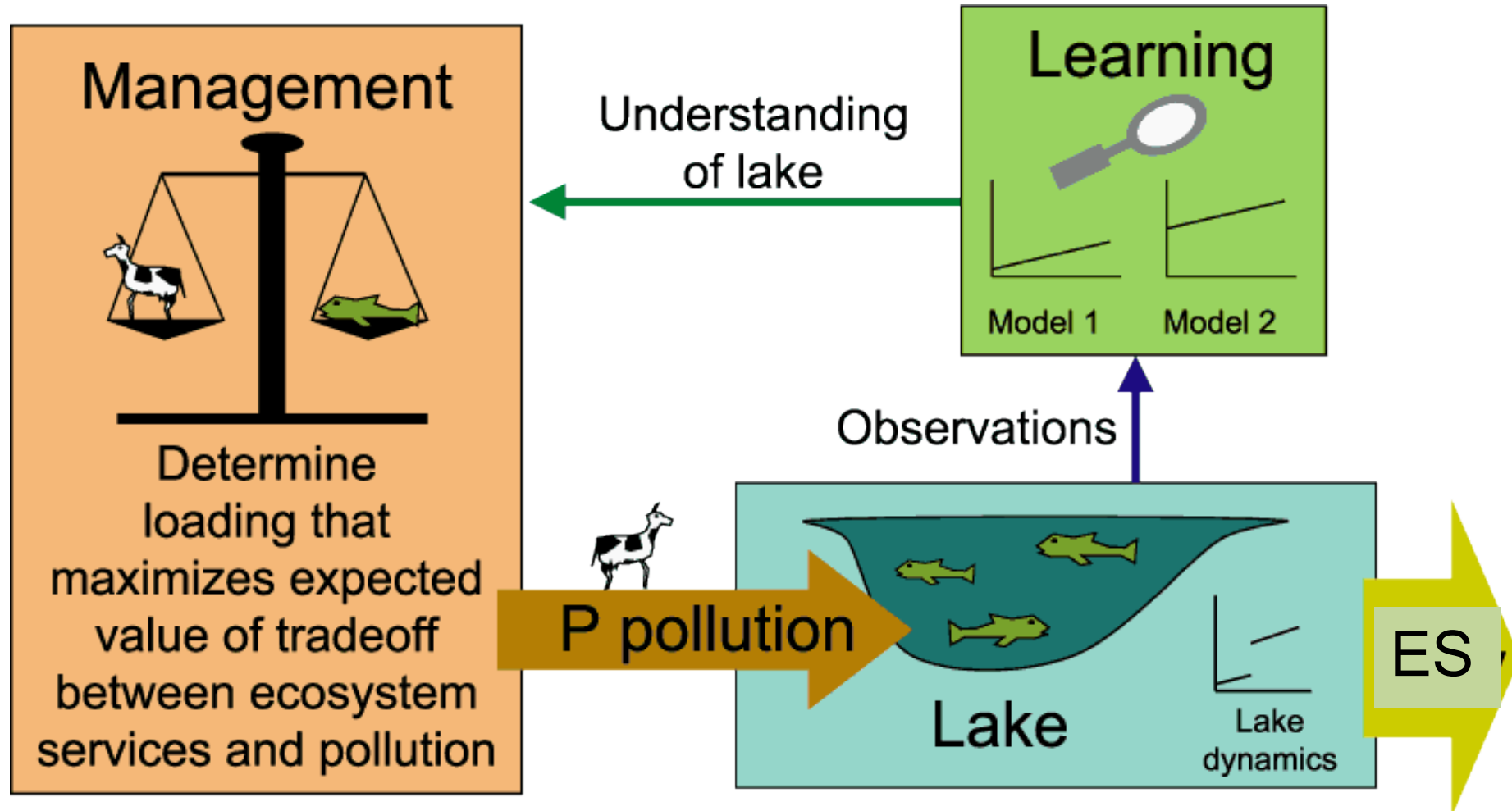
# Scales of Ecosystem service production, consumption, & management



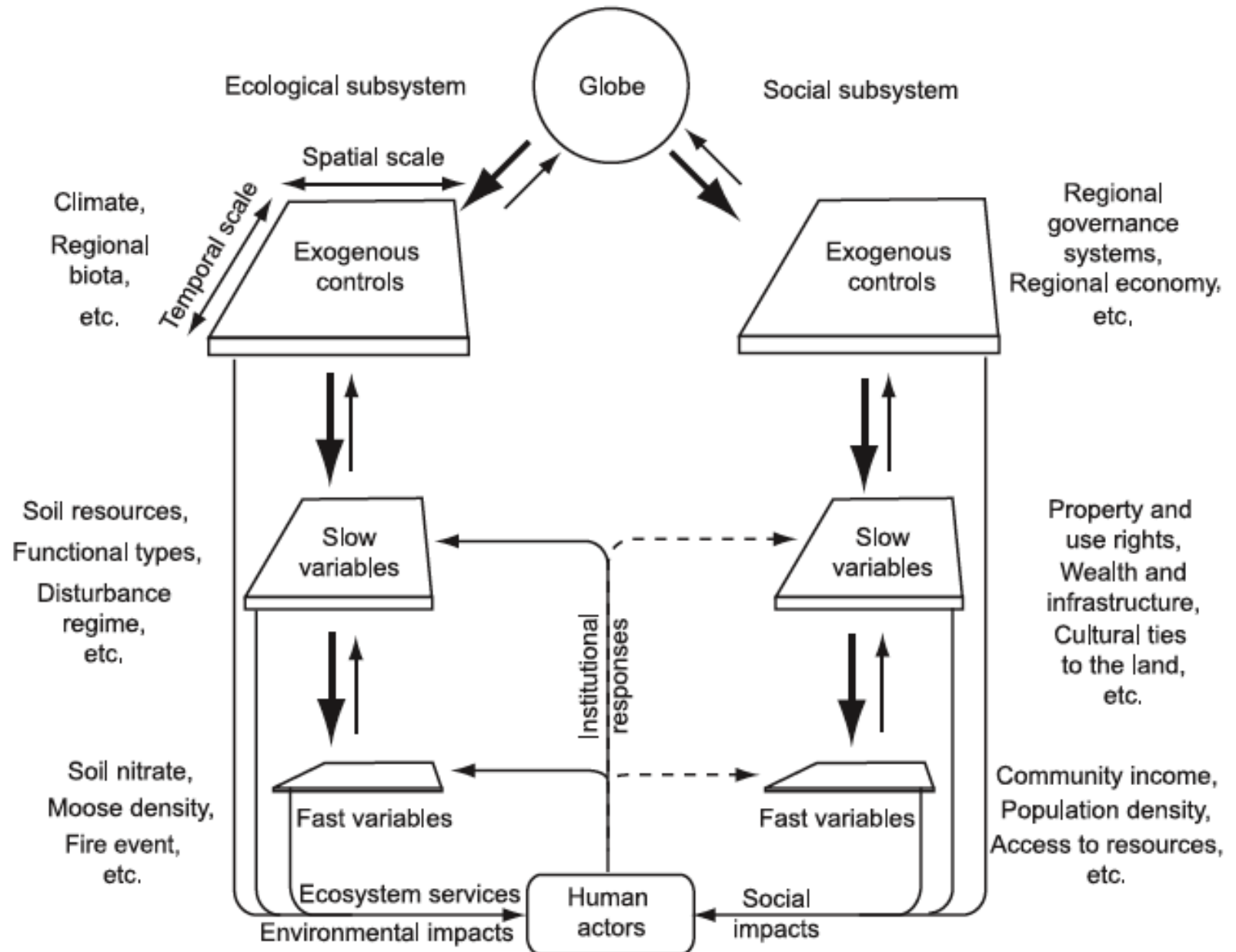
ECOSYSTEM SERVICE	Scale Production = Scale Benefits	Scale Production < Scale Benefits	Scale Production > Scale Benefits	Scale Management Actions ≠ or > Scale Production	Scale Management Rules ≠ or > Scale of Production	Interactions between ecosystem services where processes occur at different scales	Trade-offs observed		
							1Km	3Km	9Km
CROP PRODUCTION	✓					Nature App, Deer hunting	Deer hunting, tourism, maple syrup, forest recreation, nature appreciation	Deer hunting, tourism, maple syrup, forest recreation, nature appreciation	All, except (...)
PORK PRODUCTION	✓					Nature App		Nature appreciation	All except (...)
DRINKING WATER	✓								
MAPLE SYRUP PRODUCTION			✓			Nature App, Deer hunting			
DEER HUNTING			✓	✓		Forest Rec, Maple Syrup, Nature App, Crop production			
NATURE APPRECIATION			✓			Maple syrup, Forest Rec, Tourism, Deer hunting, Crop and Pork production			
TOURISM			✓			Nature App, Deer hunting			
SUMMER COTTAGES			✓	✓					

(Raudsepp-Hearne & Peterson In Prep)

# Social-Ecological Model of the Adaptive Ecosystem Management of Lake Eutrophication



# Conceptualized cross-scale social-ecological dynamics





# Framework to Analyze the Robustness of Social-ecological Systems from an Institutional Perspective

