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Bayreuth Center of Ecology
and Environmental Research

Landscale to Regional Scale Concerns About Human Well-Being in the Context of Global Change: Approaches to Problem Solving

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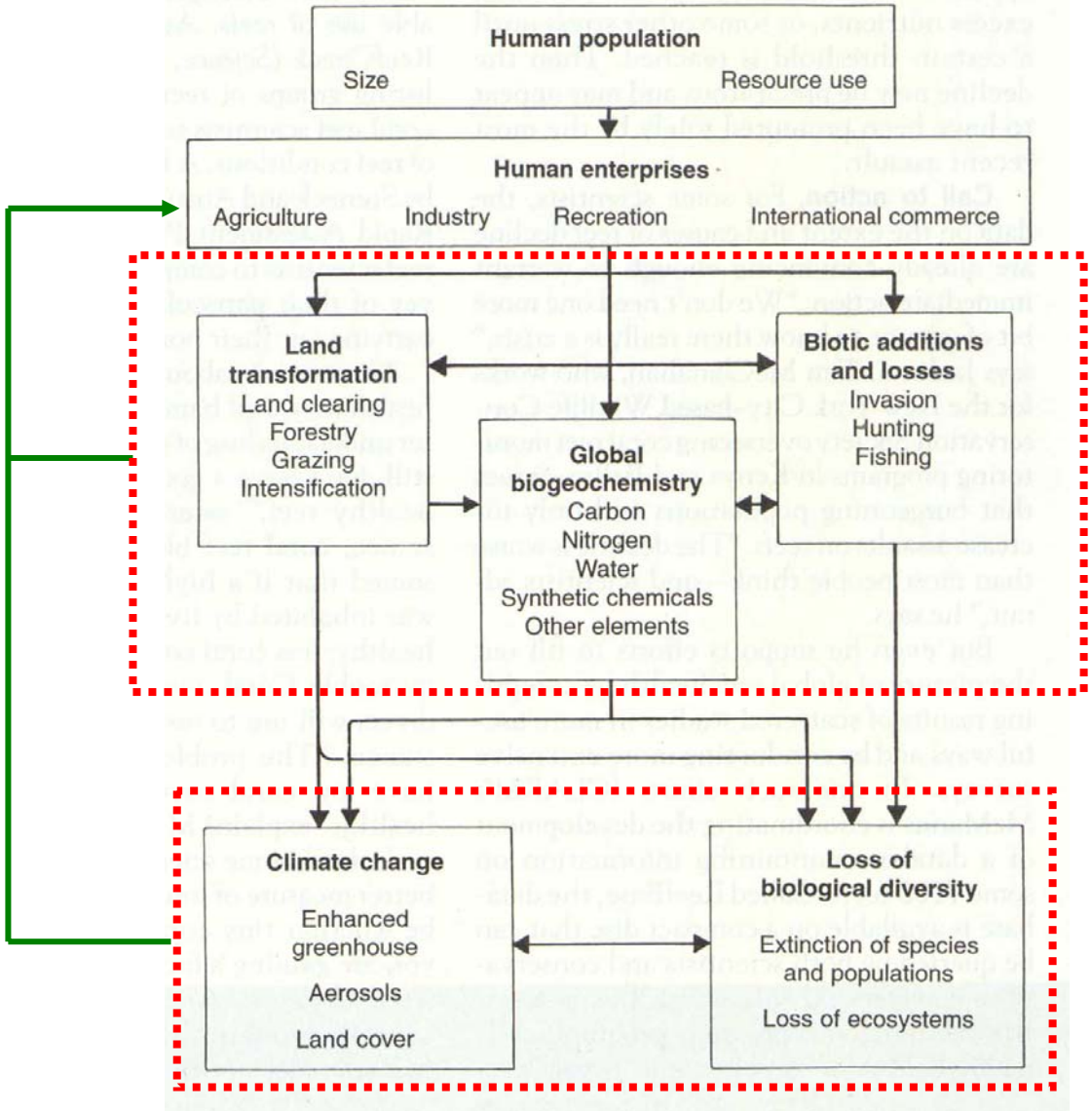
Institute of Geography, CAS – September 18, 2009
Transdisciplinarity in Environmental and Social Sciences

Human Domination of Earth's Ecosystems

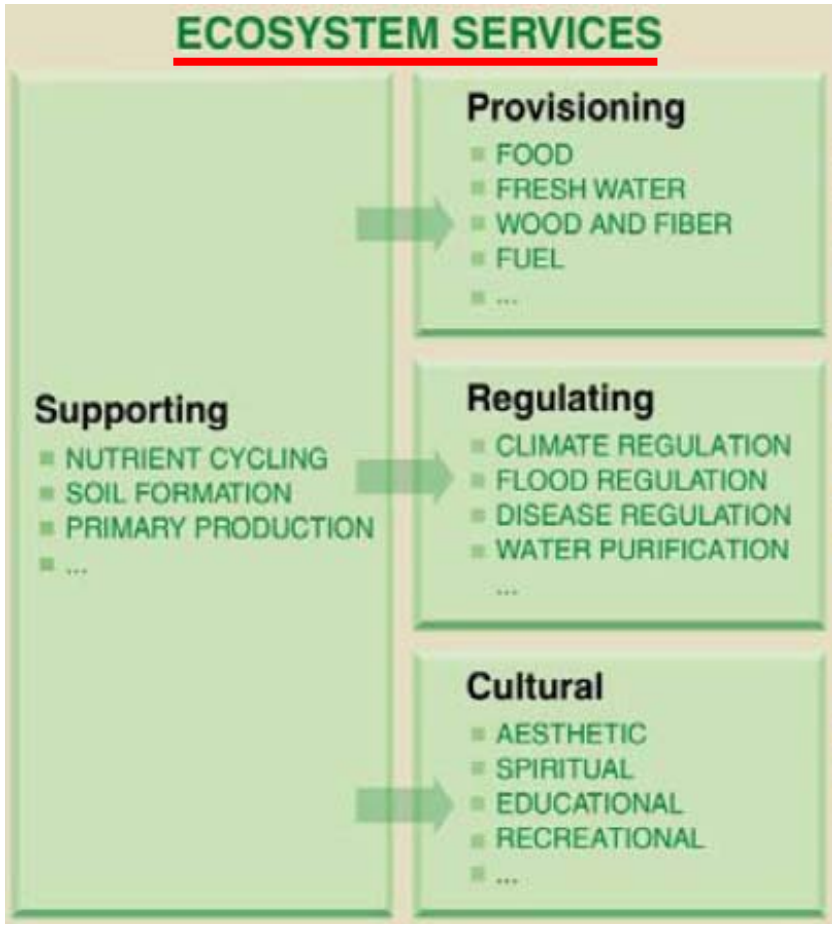
Peter M. Vitousek, Harold A. Mooney, Jane Lubchenco, Jerry M. Melillo

SCIENCE • VOL. 277 • 25 JULY 1997 • www.sciencemag.org



Millenium Ecosystem Assessment Perspective: New Need for Coupling and Transdisciplinarity

Earth´s Natural Systems



Human Well-Being

Alcamo J et al. 2003 Ecosystems and human well-being. Island Press, Washington, pp 245

www.millenniumassessment.org

"With the Age of Enlightenment humans were extracted from the environment. The separation of nature and society became a foundational principle of Western thought and provided the organizational sstructure for academic departments. Since that time, Western thought has oscillated between positions in which nature and society were treated as distinct entities, and one in which articulations between the two were examined."

I.J. Davidson-Hunt and F. Berkes 2003 in

Navigating Social-Ecological Systems

"One of the anomalies of modern ecology is the creation of two groups, each of which seems barely aware of the existence of the other. One studies the human community, almost as if it were a separate entity, and calls its findings sociology, economics and history. The other studies the plant and animal community and comfortably relegates the hodge-podge of politics to the liberal arts. The inevitable fusion of these two lines of thought will constitute the outstanding advance of the present century."

Aldo Leopold, Berlin 1935

Landscale to Regional Scale Concerns About Human Well-Being in the Context of Global Change

www.millenniumassessment.org

Problem Solving Will Require Us to Put It Back Together.

A problem of scale, focus and complexity
A question of flexibility and willingness
A dilemma of dedication

BUT, New Experimental and Program Designs

will contribute to problem solving related to global change and tight links between education and environmental policy.

Objectives:

Alterred Climate

Extreme Events

Shifts in Land Use

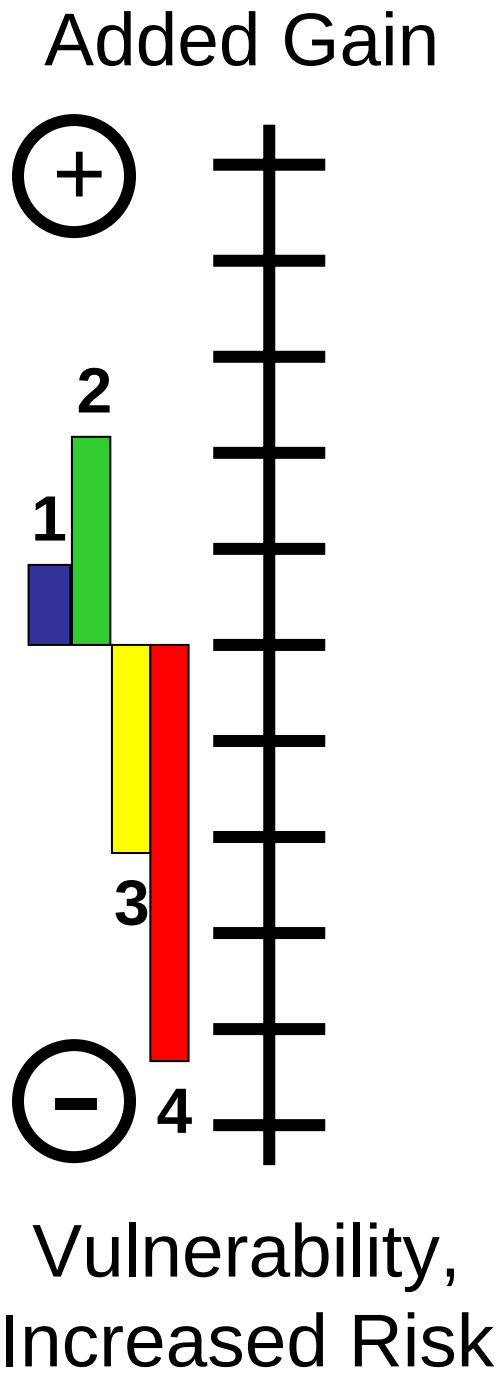
Development

Discourse and Decision-making

Change in Ecosystem Services

?

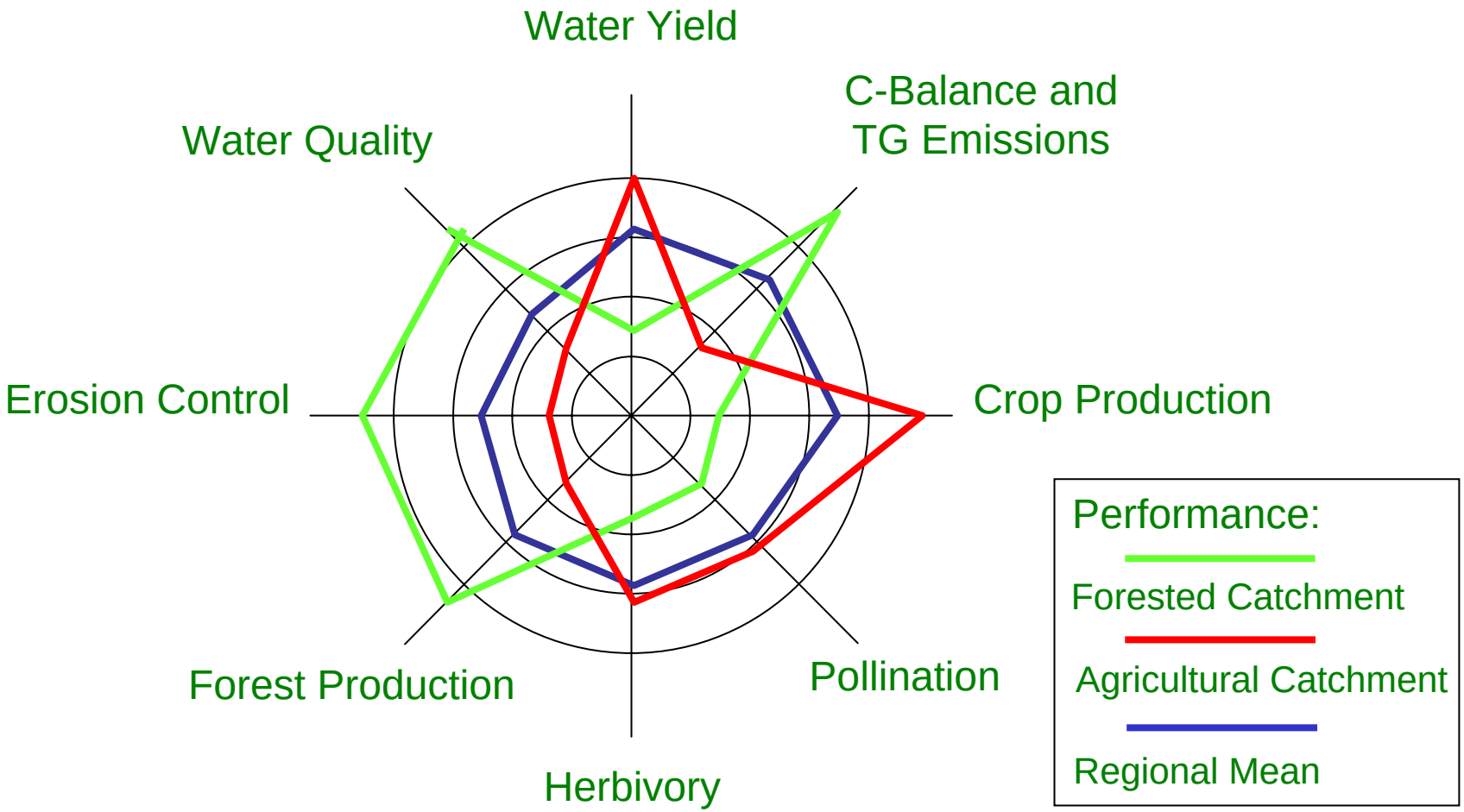
Anticipatory Adaptation with Reduced Risk



Framing the Problem – Conceptual View

Clearly we need natural science tools!

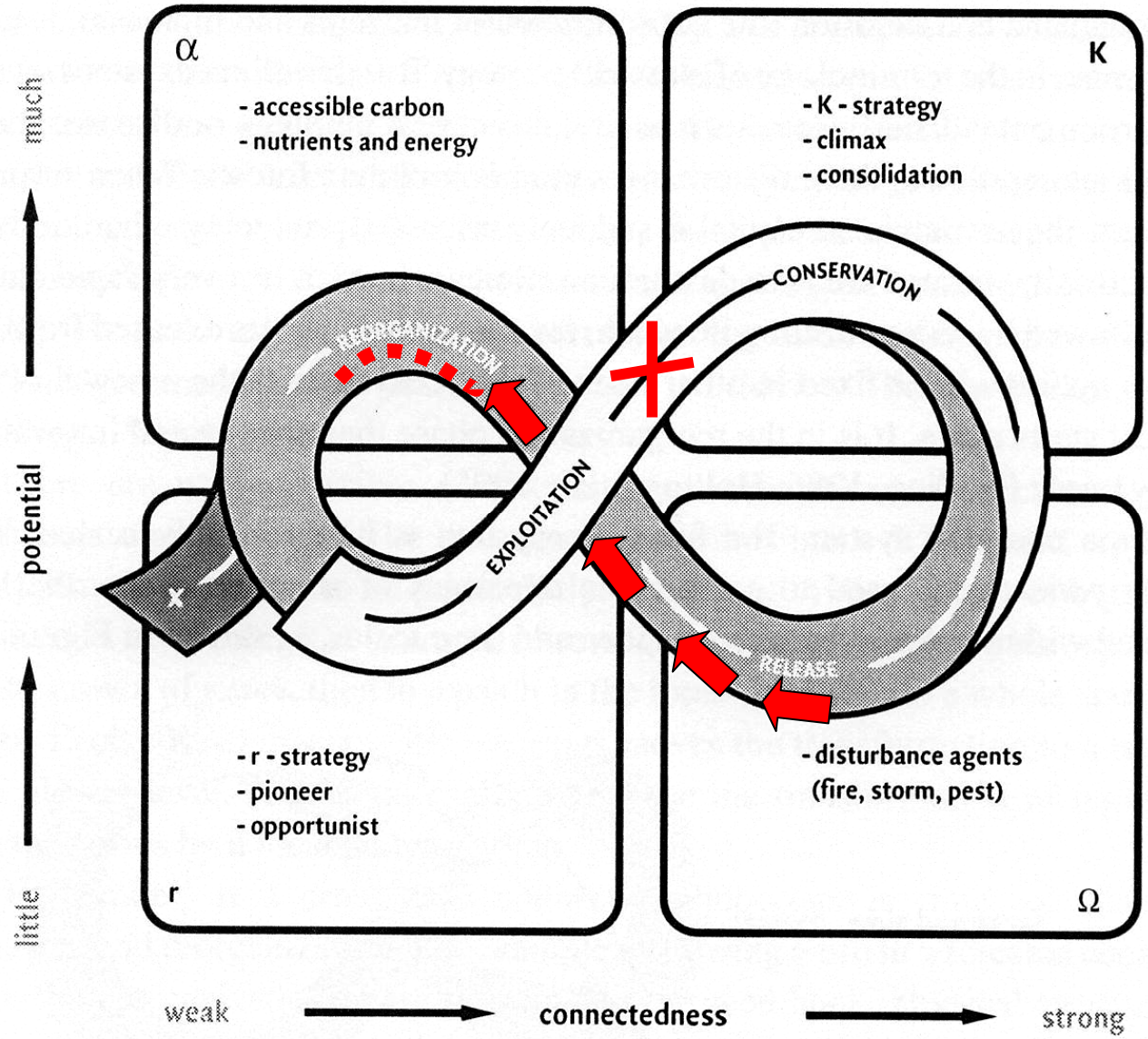
These are directed at “Ecosystem Services”



Ecosystem Services as Estimated from a Suite of Models

How do we evaluate change and future potentials?

An important perspective on problem solving – extreme case?



Holling, C.S. 2001 Understanding the complexity of economic, ecological, and social Systems. Ecosystems 4: 390-405.

Whether exploitation or reorganization, the science tools are the same:

MODEL HIERARCHIES AND DATA BASES TO SUPPORT LANDSCAPE OR REGIONAL ANALYSES

in natural and social sciences – plus techniques for integration of the two.

Why landscape?

Big enough to be relevant – small enough to be real . . .
e.g., real data, real integrative measures, specific problems, and single cultural context.

The Tools Must Allow for a Paradigm Transition:

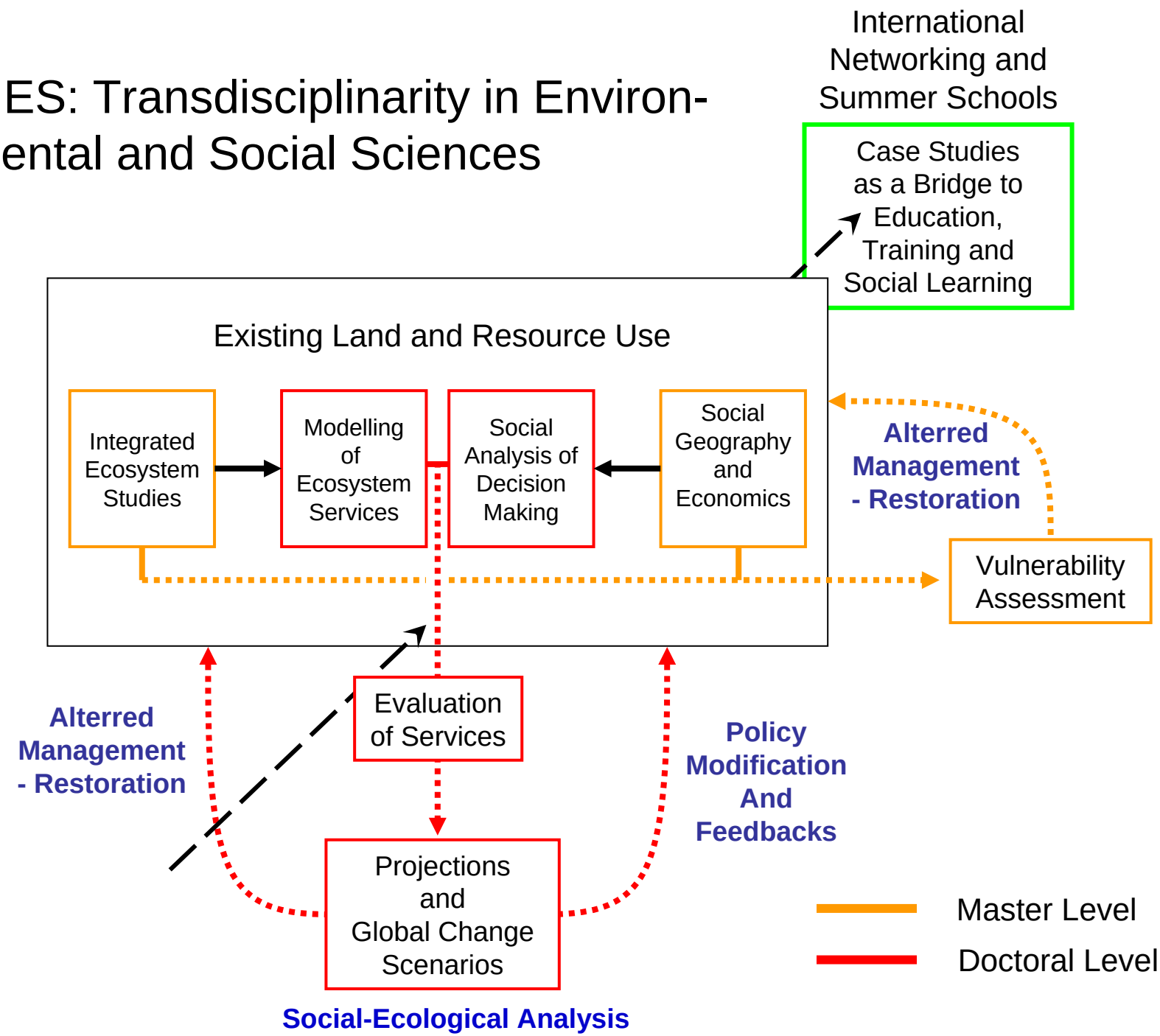
	Business as Usual: Prediction and control	**New Paradigm Orientation: Integrated adaptive regime**
Decision-Making and Policy Structure (adapted from Pahl-Wostl et al. 2007)	Centralized hierarchical governance	Polycentric and "horizontal" structure in governance
	Narrow or no stakeholder participation	Broad stakeholder participation
	Separate sector analyses leading to policy conflicts	Cross-sectoral analysis and integrated policy implementation
	Single scale focus and analysis	Multiple scale analysis
	Fragmented understanding and proprietary information	Comprehensive understanding and integration of information
	Centralized infrastructure	Decentralized infrastructure
Required Educational Support Structure	Disciplinary science	***Transdisciplinary education***
	Exposure to model evaluations	***Broad training in modelling***
	Examination of sensitivities to limited driver variables	***Complex scenario development and study***

ENVIRONMENTAL PROBLEM SOLVING IN RELATION TO GLOBAL CHANGE

AND TRANSITION TO THE NEW PARADIGM IN RESOURCE MANAGEMENT

REQUIRES A TRANSDISCIPLINARY COMPONENT IN ENVIRONMENTAL EDUCATION, TRAINING AND RESEARCH

TIES: Transdisciplinarity in Environmental and Social Sciences



What types of case studies would

we learn from?

Perhaps there are two levels in complexity?

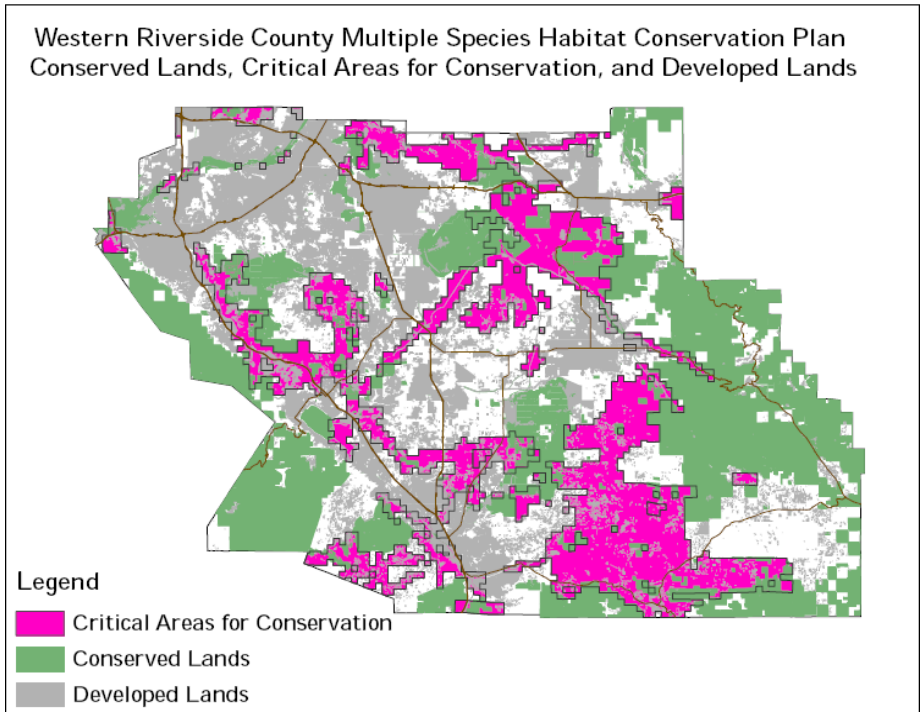
Example 1: Correlative Vulnerability Assessments (Endangered Species and Multi-species Planning)

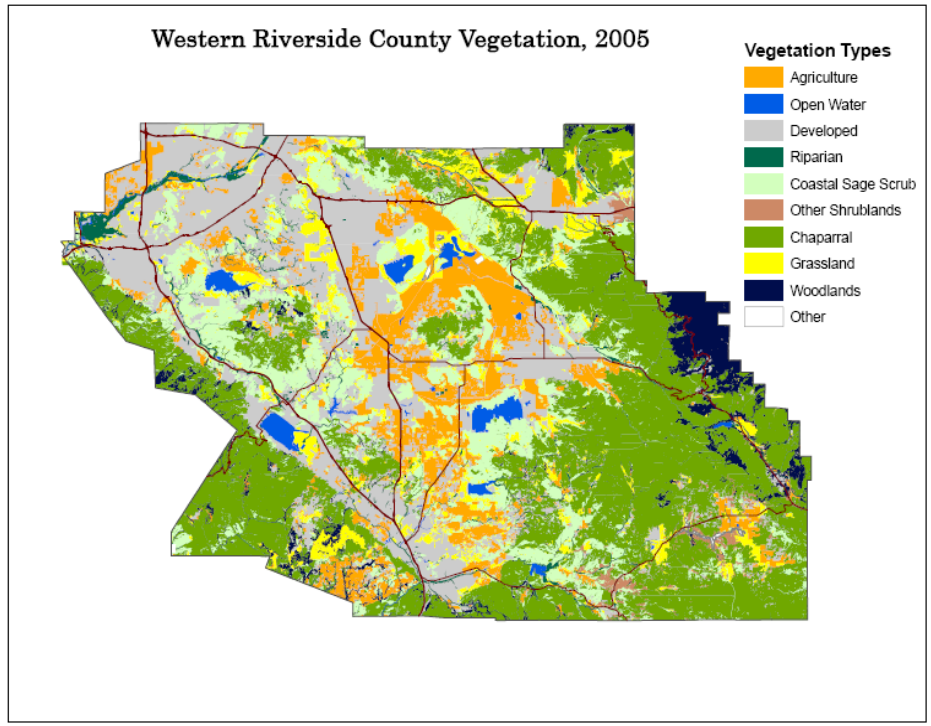
Example 2: Social-Ecological Analyses (TERRECO)

Learning by doing in social-ecological systems!

Correlative Vulnerability Assessment:

Multi-species Habitat Conservation Plans (MSHCPs)





Rate of Development Requires Immediate But Science-based Problem Solutions

Correlative Vulnerability Assessment:

MSHCP – Multi-species Habitat Conservation Plans

Human Systems Indicators

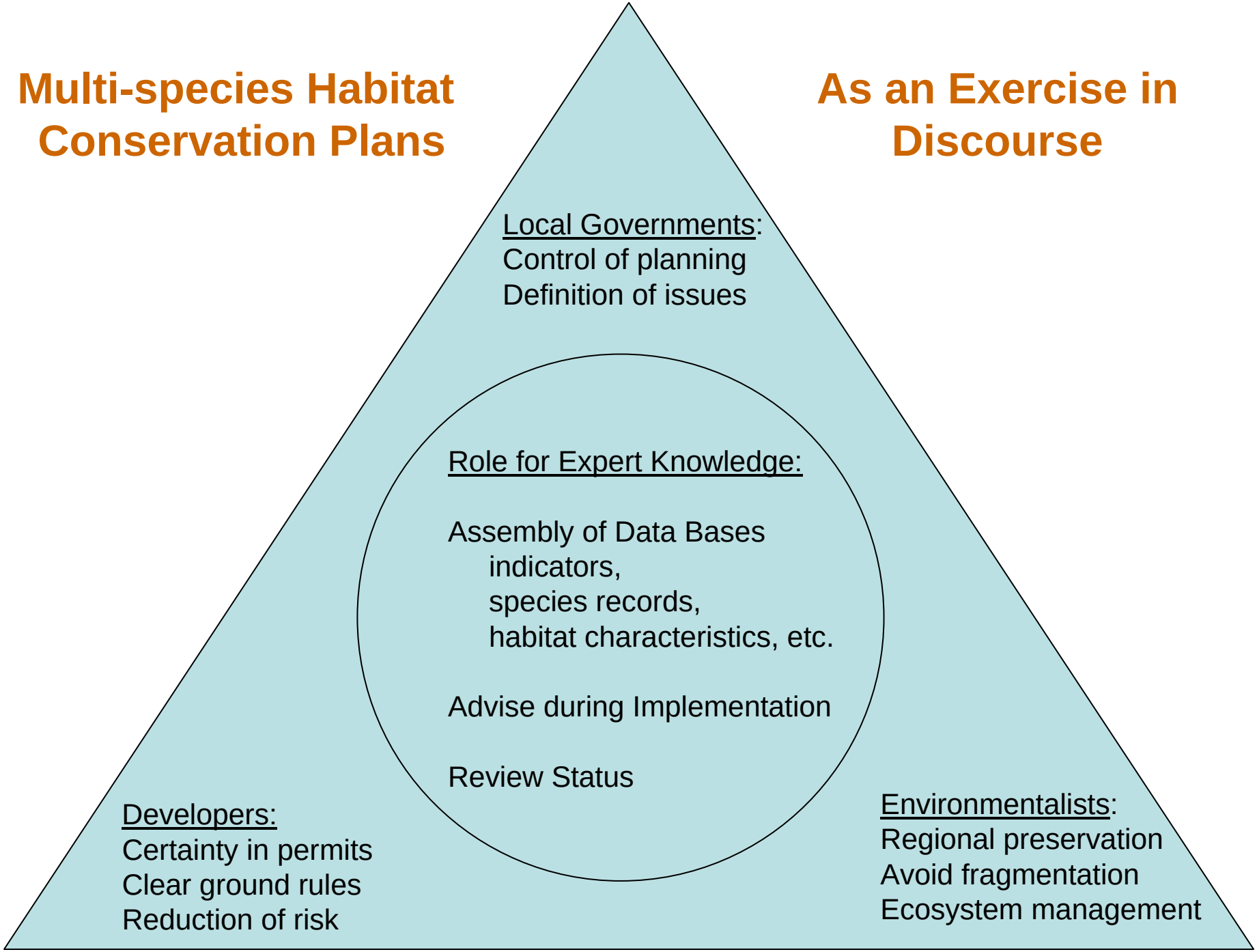
- Air quality
- Ground and surface water quality
- Sedimentation
- Hazardous materials
- Solid waste
- Land use and urbanization
- Per capita water use
- Human population density
- Energy use
- Solid waste generation
- GRP per capita

Ecosystem Services

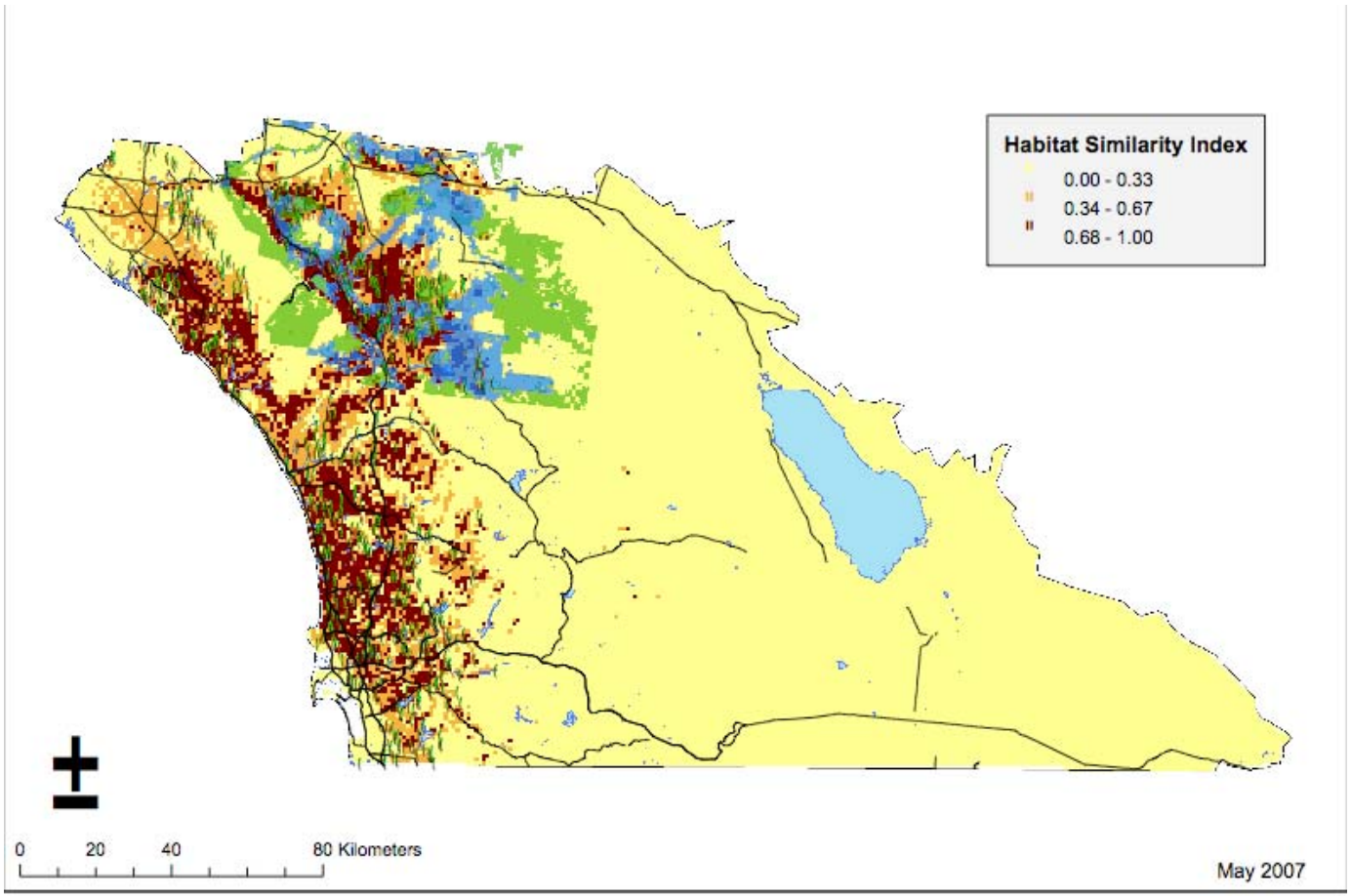
- Gas regulation
- Climate regulation
- Disturbance regulation
- Water regulation
- Water supply
- Erosion control
- Soil formation
- Nutrient cycling
- Waste treatment
- Pollination
- Biological control
- Refugia
- Food production
- Raw materials
- Genetic resources
- Recreation
- Cultural expression

Multi-species Habitat Conservation Plans

As an Exercise in Discourse



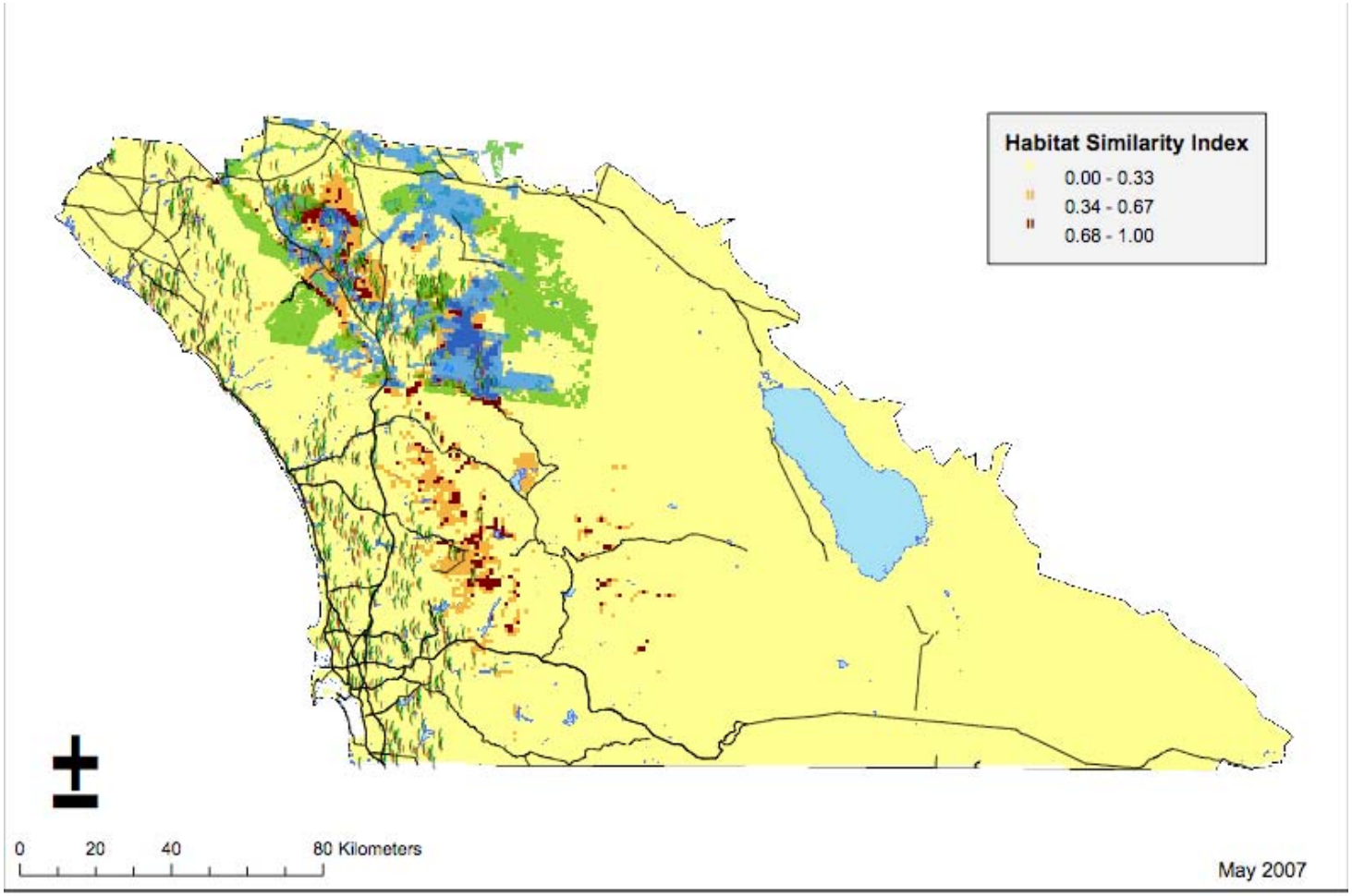
Greater science input is desired – but it may be a shot in the dark!!!



California Gnatcatcher

Model Run 3, PV2: WRC MSHCP & Current Climate Conditions
(Climate Only Variables)

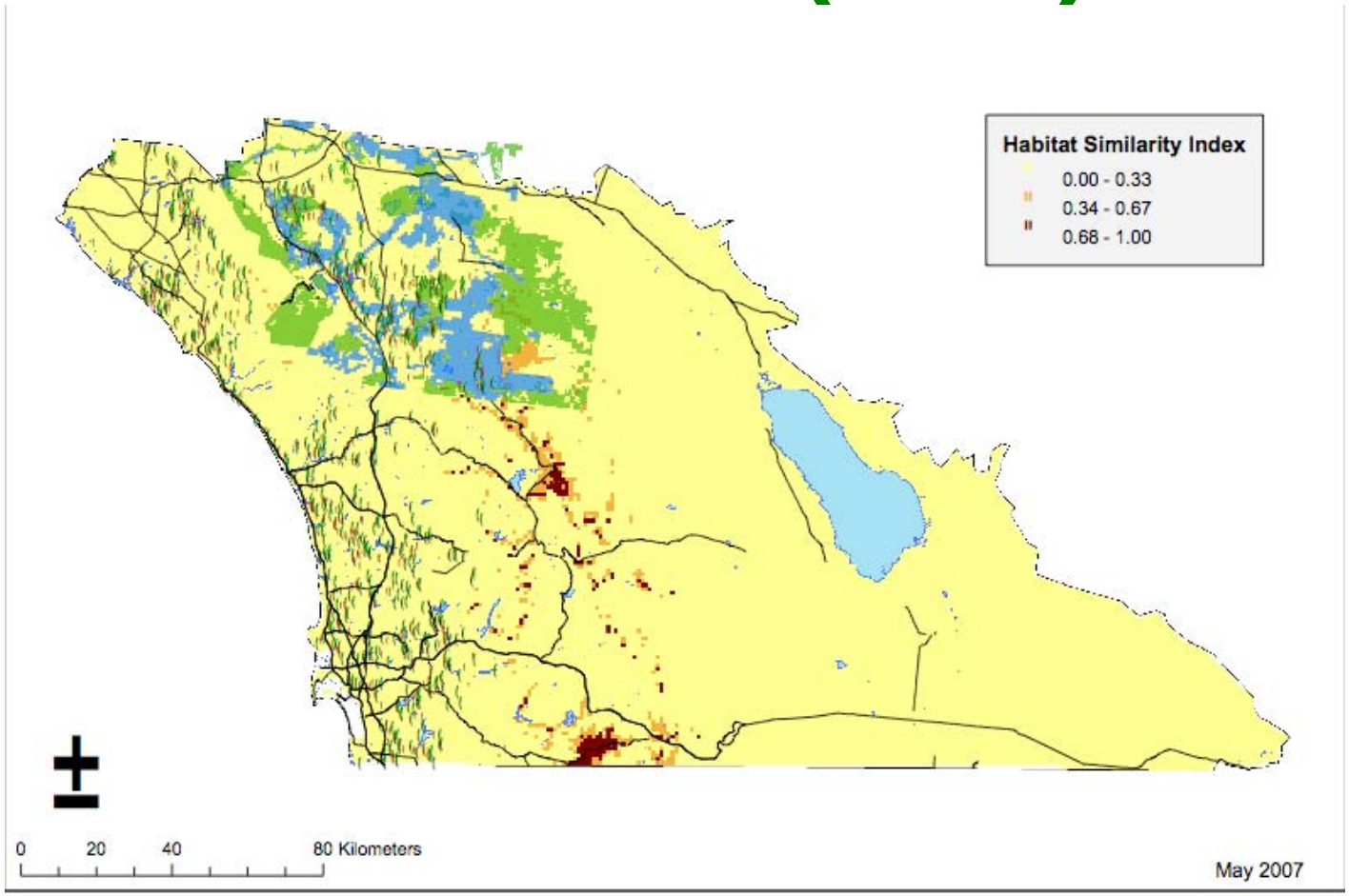
CGT + 1º F (2030)



California Gnatcatcher

Model Run 3, PV2: WRC MSHCP & Temperature Increased 1°F with No Change in Precipitation
(Climate Only Variables)

CGT + 3º F (2080)

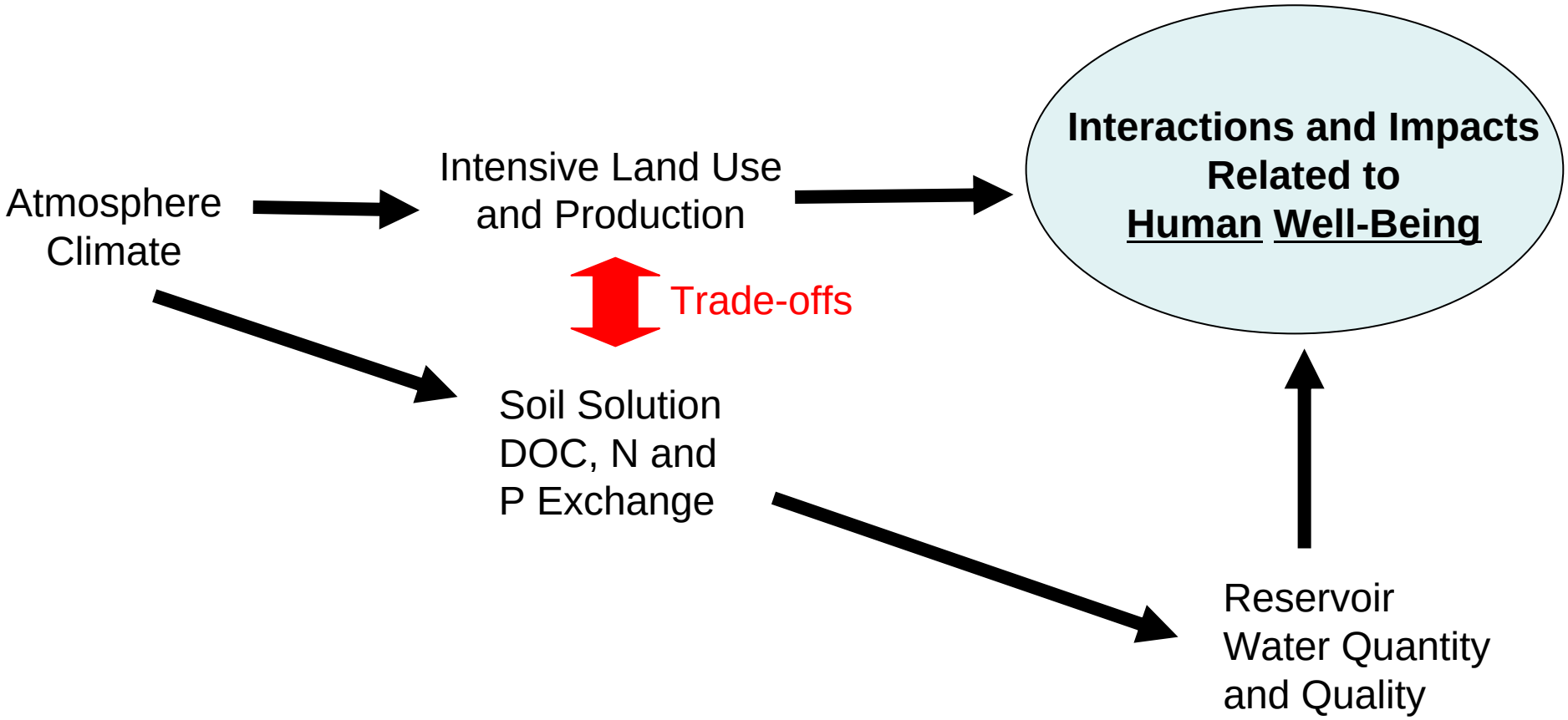


California Gnatcatcher

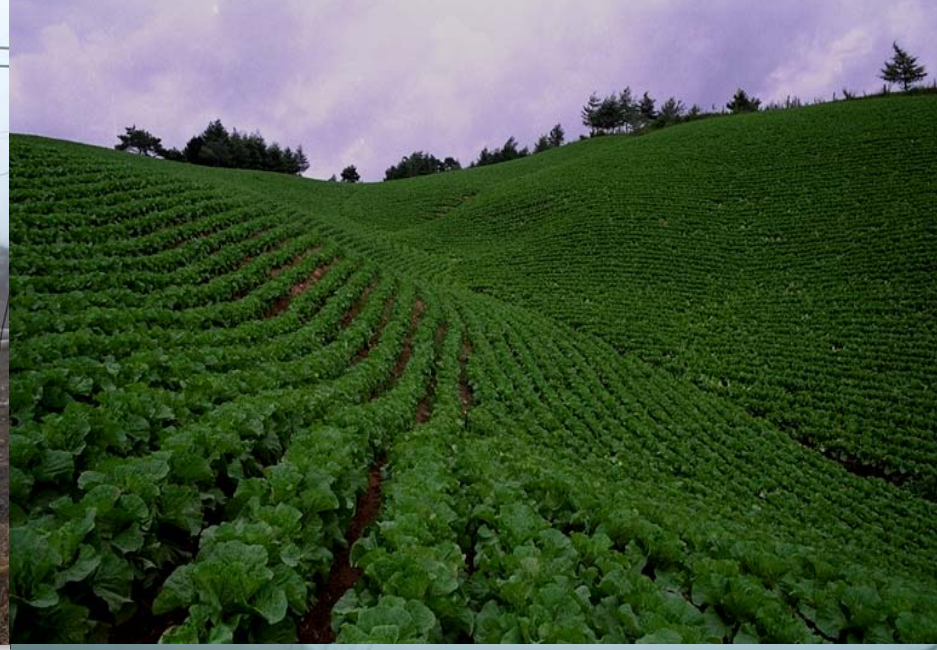
Model Run 3, PV2: WRC MSHCP & Temperature Increased 3°F with No Change in Precipitation
(Climate Only Variables)

But the ecosystems and additional actions are uncertain!

Social-Ecological Analysis of Ecosystem Services:




2003. 4. 11



HUMAN ALTERATION OF THE GLOBAL NITROGEN CYCLE: SOURCES AND CONSEQUENCES

PETER M. VITOUSEK,[2] JOHN D. ABER,[3] ROBERT W. HOWARTH,[4] GENE E. LIKENS,[5] PAMELA A. MATSON,[6] DAVID W. SCHINDLER,[7] WILLIAM H. SCHLESINGER,[8] AND DAVID G. TILMAN[9]

Ecological Applications, 7(3), 1997, pp. 737–750

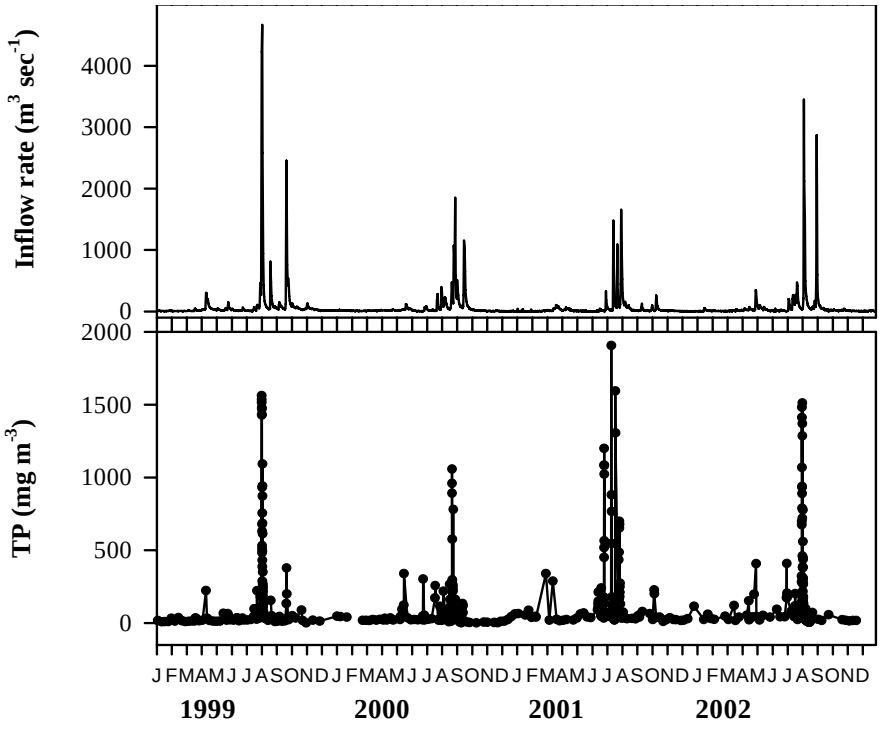
Riverine N Flux Compared to Pre-industrial

Labrador & Hudson's Bay	no change
Southwestern Europe	3.7-fold
Great Lakes/St. Lawrence basin	4.1-fold
Baltic Sea watersheds	5.0-fold
Mississippi River basin	5.7-fold
Yellow River basin	10-fold
Northeastern US	11-fold
North Sea watersheds	15-fold
Republic of Korea	17-fold

Korean fertilizer application according to Kim B. et al.:

1980 = 230 kg ha^{-1} yr^{-1}
1994 = 450 kg ha^{-1} yr^{-1}
Plus imported animal feed

Complex Terrain and Ecological Heterogeneity (TERRECO) - A question requiring social-ecological analysis



Comparison of export coefficients from agricultural land in different watersheds (kg yr^{-1} km^{-2})

Watershed	TN	TP	Reference
The North Han River	680	53	Lee et al.(2001)
The South Han River	680	52	
The Kyung-an Stream	700	54	
Standard export coefficient of paddy field	1949	193	Korean Ministry of Environment(1996)
Standard export coefficient of dry field	2201	113	
The Palmi-ri Stream (paddy field watershed)	2920	292	Shim(1998)
The Palmi-ri Stream (dry field watershed)	6205	146	
The Young-san River	894	80	Cha et al.(1999)
Virginia, USA	270	30	Ritter(1988)
The Mandae Stream in 2003	4785	1318	This study
The Mandae Stream in 2004	8794	1120	This study

From Kim, B. et al. 2007

Social-Ecological Analysis:

TERRECO – Critical Ecosystem Services in Mountain Regions

Human Systems Indicators

- Air quality
- Ground and surface water quality
- Sedimentation
- Hazardous materials
- Solid waste
- Land use and urbanization
- Per capita water use
- Human population density
- Energy use
- Solid waste generation
- GRP per capita

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- Gas regulation
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- Biological control
- Refugia
- Food production
- Raw materials
- Genetic resources
- Recreation
- Cultural expression

TERRECO Focuses on a Transdisciplinary Evaluation of Ecosystem Services

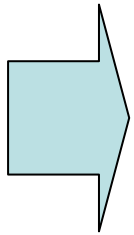
Evaluations via:

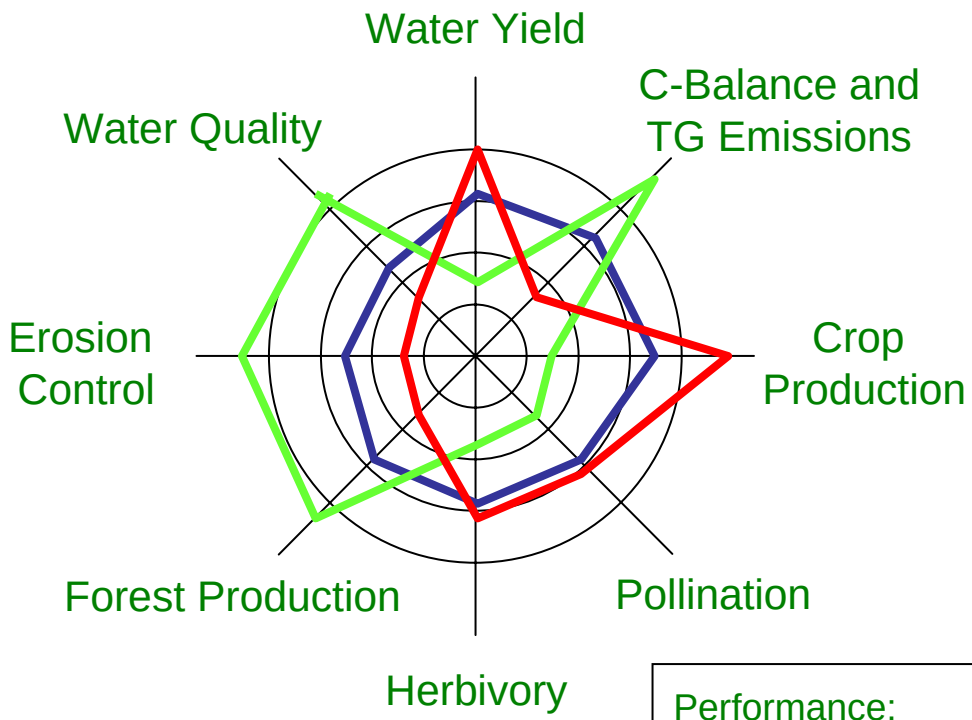
Statistical Models

Process-based Models

Phenomenological Models

Physically-Based Models





Trade-offs in Production vs. Water Yield and Water Quality

Performance:

Forested Catchment

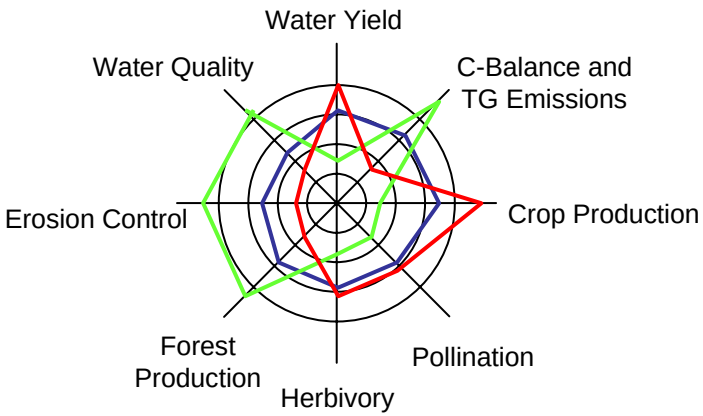
Agricultural Catchment

Regional Mean

The critical question to focus on within the science community is -

How do we evaluate change and future potentials?

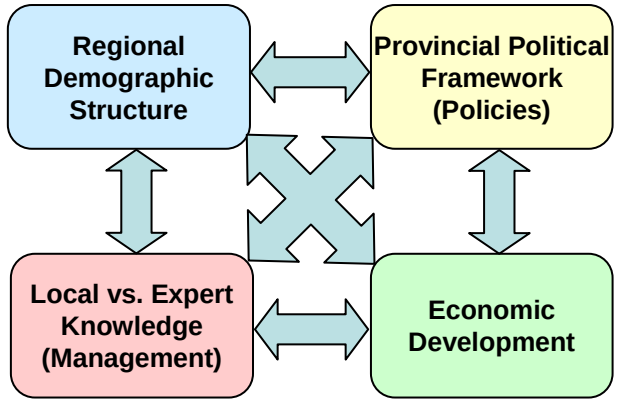
Performance of Ecosystems

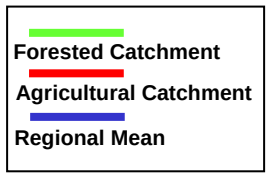


Capacity Building with Basic Data

Regional Land Use

Social – Ecological Framework





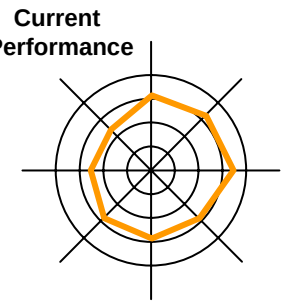
Step I

Step II

Transition between Current Evaluations and Future Projections

Social – Ecological Analysis – A Focus on Scenario Evaluations

Development of Scenarios: Future Climate and Land Use



Climate

Regulatory Regime

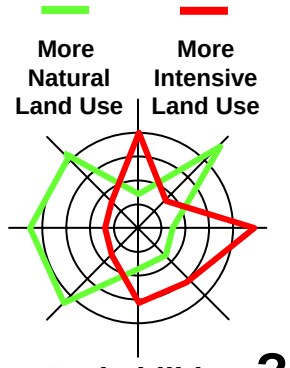
Economic Framework

Nature Perception

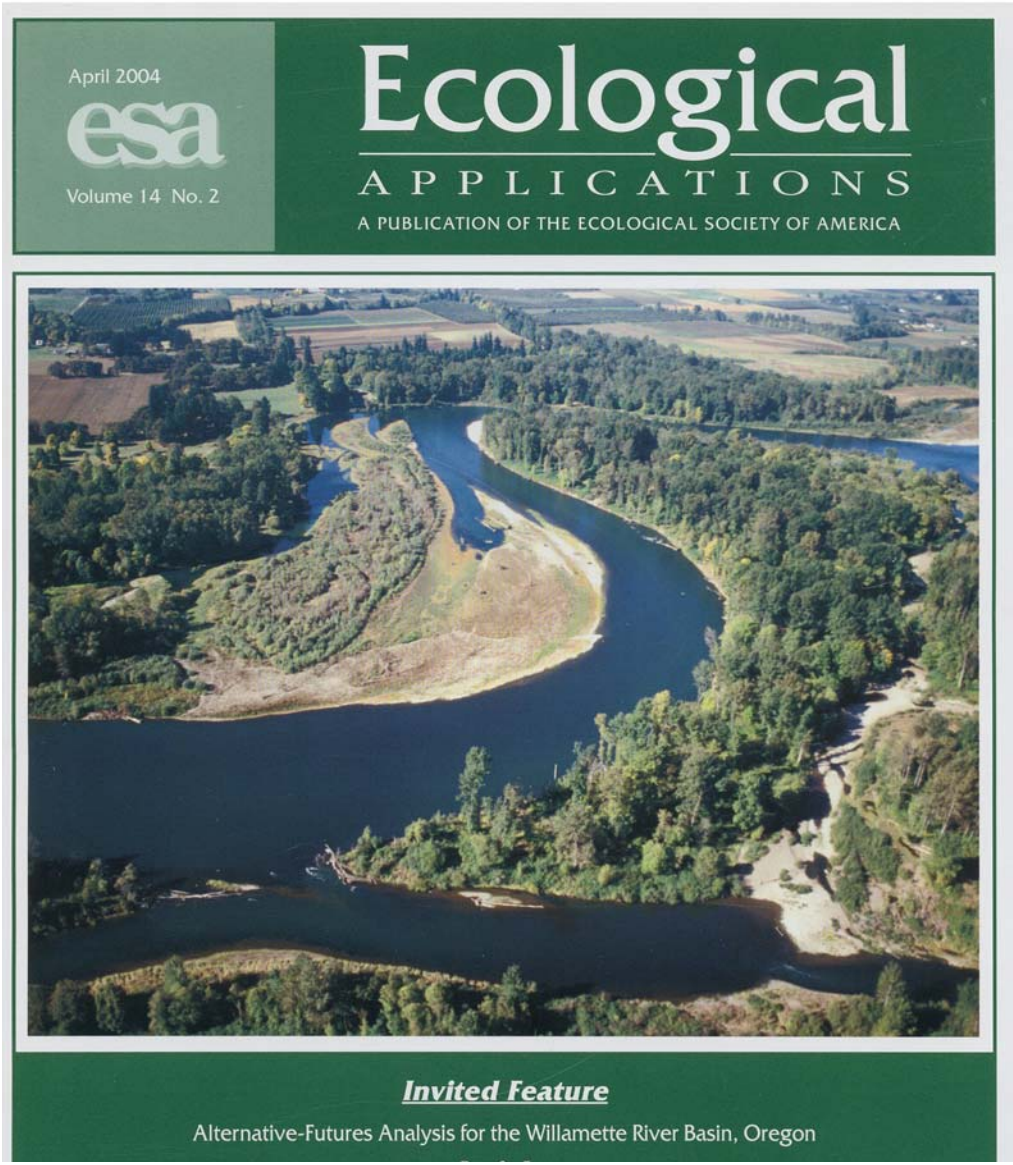
Altered Ecosystems

Objective Discourse

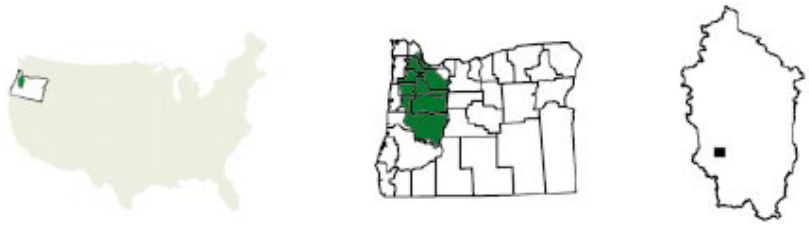
Agent-Based Modelling



Probabilities ?



Hulse DW, Branscomb A, Payne SG (2004) Envisioning alternatives: using citizen guidance to map future land and water use. Ecological App. 14: 325-341



TERRECO - Alternative Futures Methodology

While there are variants, alternative future projects have four common parts:

(1) defining future scenario assumptions,

(2) depicting spatially explicit alternatives through land and water allocation models using parameters from scenario assumptions,

(3) modeling the effects of alternative land and water use patterns on key natural and cultural resources (termed ‘‘evaluation’’ modeling), and

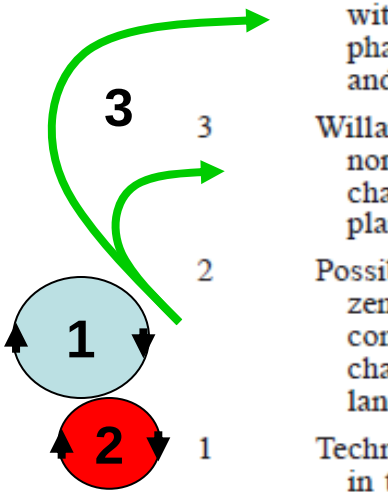
(4) producing synthesis products which characterize the differences between the alternatives.

Hulse DW, Branscomb A, Payne SG (2004) Envisioning alternatives: using citizen guidance to map future land and water use. Ecological Applications 14:325-341

Stakeholder Involvement in a Citizen-Guidance Futures Approach

TABLE 1. Stakeholder involvement structure used by the Pacific Northwest Ecosystem Research Consortium (PNW-ERC).

Level	Group	Outreach and feedback strategy
4	Entire population of Willamette River Basin (WRB), ~1.97 million people.	One-time, eight-page newspaper insert to 465 000 households.
3	Willamette Valley Livability Forum (WVLF), ~100 governor-appointed civic and community leaders from throughout the Willamette Basin. Charged with developing future vision for the valley; emphasis on co opment, transportation, and livabilit	Quarterly forums over 3-yr period; conference format presentations and break-out sessions; electronic voting to review and refine PFWG scenario assumptions.
3	Willamette Restoration Initiative (WRI), 27 governor-appointed public and private sector citizens charged with developing state-sanctioned recovery plan for threatened salmon in WRB.	Quarterly presentations over 2-yr period, critiques of PFWG Conservation 2050 scenario assumptions.
2	Possible Futures Working Group (PFWG), 20 citizens chosen by PNW-ERC based on expertise, constituenc presentation; charged wi e scenarios for 2050 land and water use in WRB.	Monthly meetings over 2.5-yr period; presentations by researchers and others to PFWG; received advice from technical expert groups.
1	Technical expert groups, groups of 2–30 specialists in transportation, agriculture, forestry, urban development equirements.	Sporadic meetings, conference calls, and e-mailings on one or more questions; provided specific quantities for scenario assumptions, and judgments on habitat area requirements and future land and water use practices.



Testing

Designers

Technical Input

Politically plausible scenarios, scientifically researchable alternatives, and capacity for community based environmental planning!

Hulse DW, Branscomb A, Payne SG (2004) Envisioning alternatives: using citizen guidance to map future land and water use. Ecological Applications 14:325-341

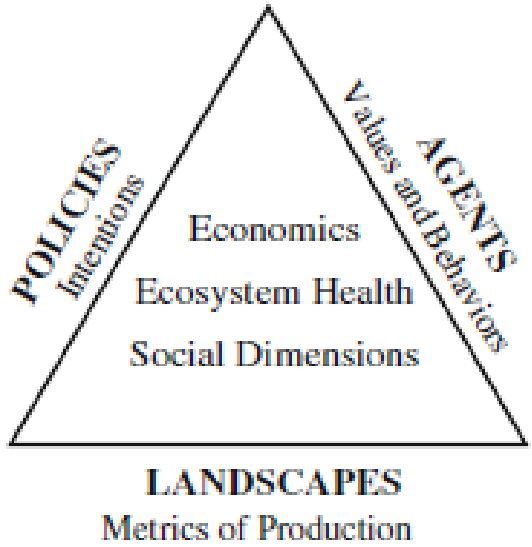
(c) Plan Trend 2050

(d) Development 2050

Hulse DW, Branscomb A, Payne SG (2004) Envisioning alternatives: using citizen guidance to map future land and water use. Ecological Applications 14:325-341

Evoland Model – http://evoland.bioe.orst.edu

Explore-and-Test Methodology



Polygon-based GIS maps
Spatially explicit landscape patterns and attributes
Parameter value probability distributions
A range of potential outcomes, but the question is plausibility

Hulse DW, Branscomb A, Enright C, Bolte J (2008) Anticipating floodplain trajectories: a comparison of two futures approaches. Landscape Ecology, DOI 10.1007/s10980-008-9255-2

The Long-term Vision for Social-Ecological Analyses