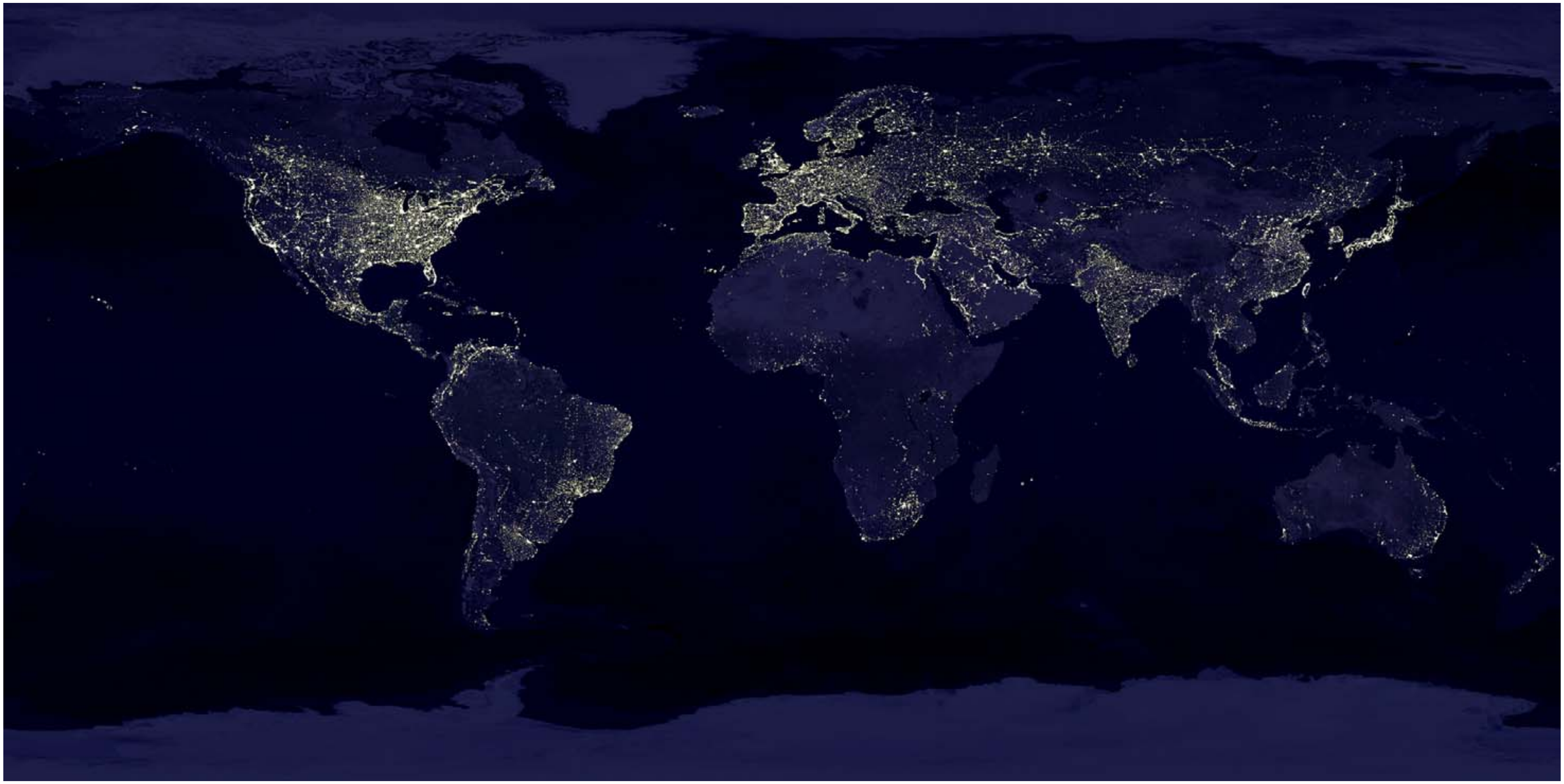
Integrated Science for Society and the Environment

Scott Collins, Ali Whitmer, Barbara Benson, Dan Childers



http://intranet.lternet.edu/planning/

A DECADE OF SYNTHESIS:
GOALS OF THE LTER PLANNING PROCESS (from the proposal):

This proposal describes an ambitious **planning activity to develop a new LTER science agenda that when implemented will use the Network to its maximum potential and take LTER science to a higher level of research collaboration, synthesis and integration.**

- **Objective 1: establish activities that will lead to multi-site, highly collaborative, integrated research initiatives that explicitly include synthesis components coupled with novel training opportunities in graduate and undergraduate education.**
- **Objective 2: evaluate LTER Network governance structure and further stimulate the culture of collaboration within the LTER Network.**
- **Objective 3: envision and develop education and training activities that will infuse LTER science into the K-12 science curriculum.**

Build on the strengths of the existing LTER Network:

- Research on
    - climate variability and climate change
    - biogeochemical cycles
    - biotic structure and dynamics

- Experience Integrating Ecology, Geosciences and Social Sciences

- Well Defined Organizational Structure

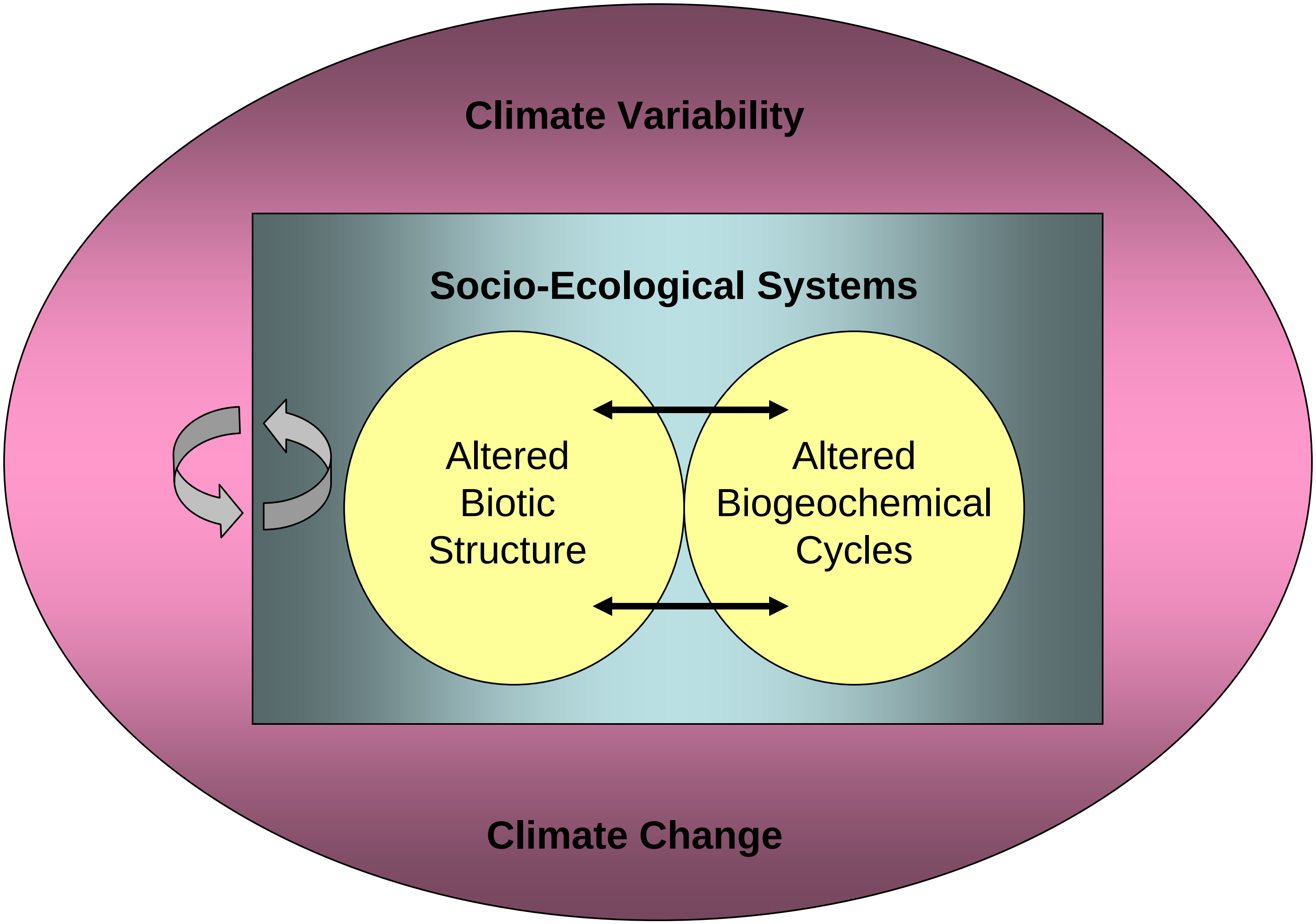
- Common Network-level Goals

- Cyberinfrastructure and Information Management

- Strong Graduate and Undergraduate Education

- Schoolyard LTER

Hierarchical structure of the LTER Planning Framework

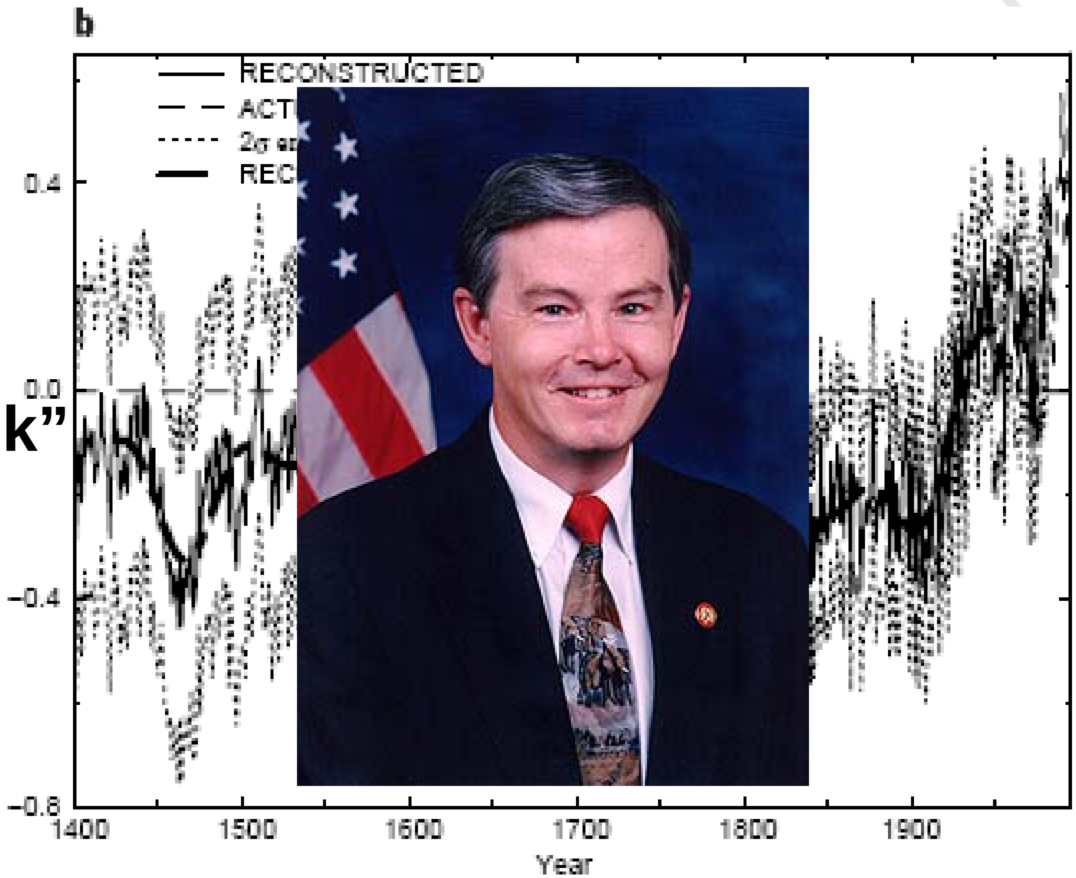


LTER has a strong history of research in these areas

Global-scale temperature patterns and climate forcing over the past six centuries

Michael E. Mann[*], **Raymond S. Bradley**[*] **& Malcolm K. Hughes**[†]

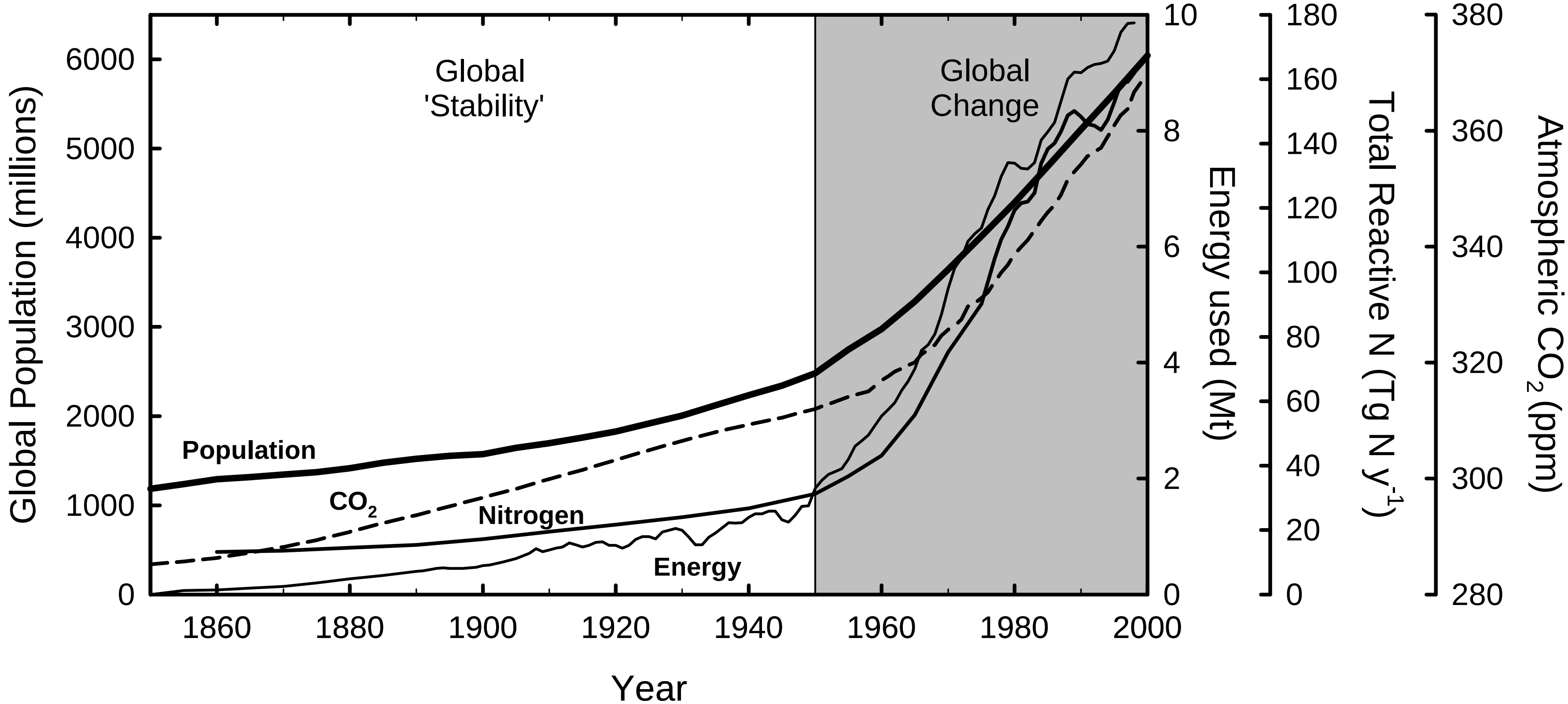
[*] *Department of Geosciences, University of Massachusetts, Amherst, Massachusetts 01003-5820, USA*
[†] *Laboratory of Tree Ring Research, University of Arizona, Tucson, Arizona 85721, USA*



"Hockey Stick"

Mann et al. 1998
Nature

Hockey Team

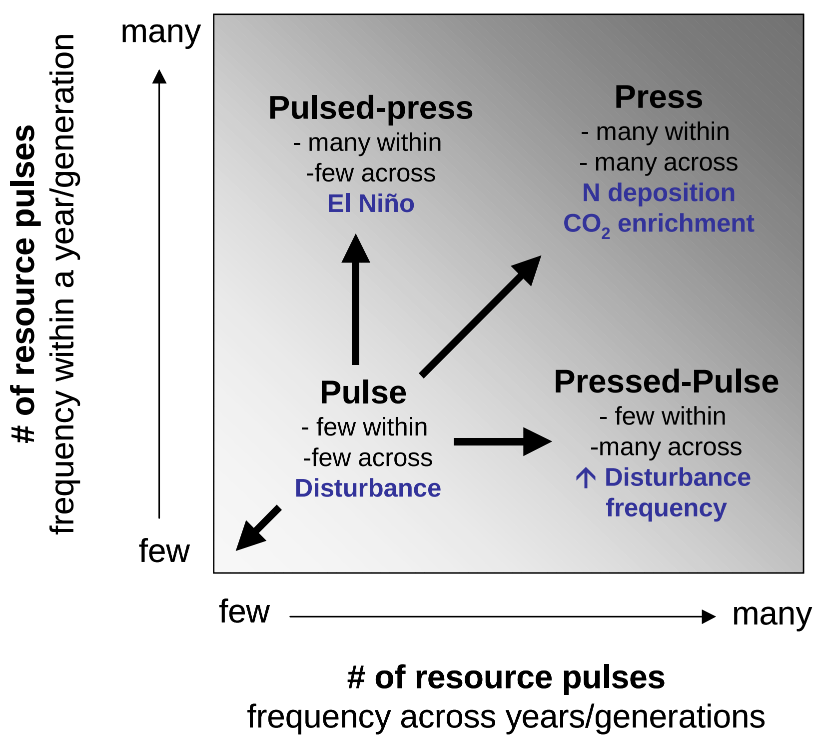


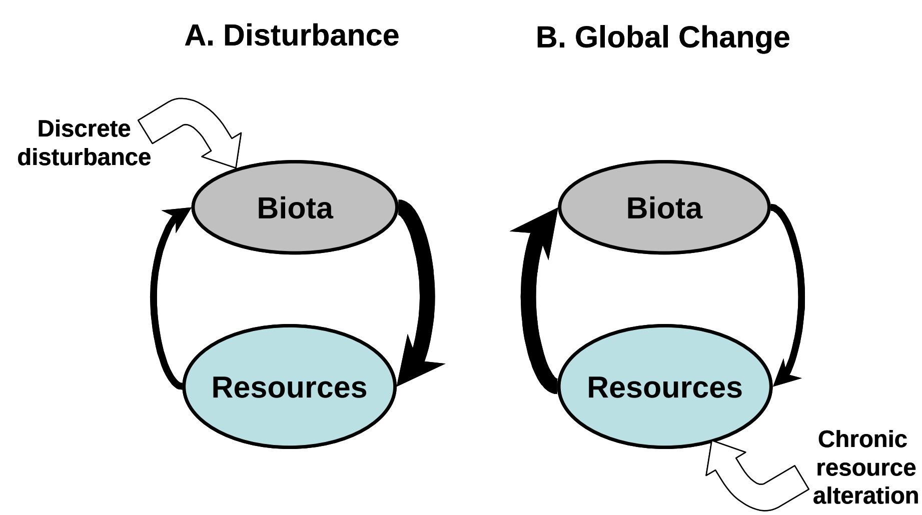
Global 'Stability'
Global Change
Population
CO_2
Nitrogen
Energy
Global Population (millions)
0
1000
2000
3000
4000
5000
6000
1860
1880
1900
1920
1940
1960
1980
2000
Year
Energy used (Mt)
0
2
4
6
8
10
Total Reactive N (Tg N y^{-1})
0
20
40
60
80
100
120
140
160
180
Atmospheric CO_2 (ppm)
280
300
320
340
360
380

Press factor – variable or driver that is applied continuously at rates ranging from low to high (e.g., atmospheric nitrogen deposition, elevated CO2). Includes changes in rates (increases, decreases) relative to some historical baseline.

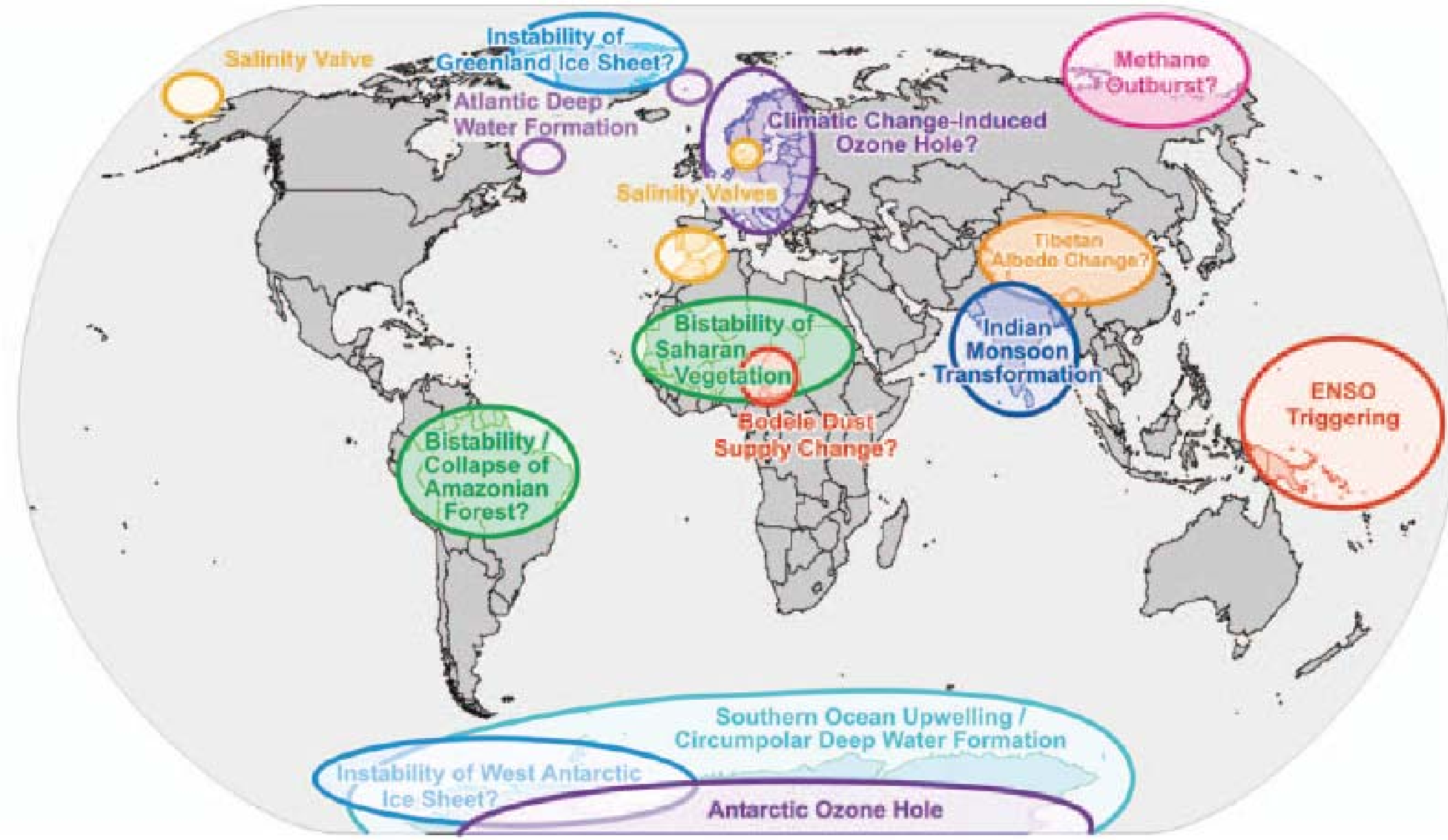
Pulse factor – variable or driver that is applied once or at periodic intervals (e.g., fire, extreme climatic events). Includes changes in the size, magnitude and frequency at which pulses occur.

Concept from Bender et al. 1984. Perturbation experiments in community ecology: Theory and practice. Ecology 65(1):1-13.





Global Change Tipping Points



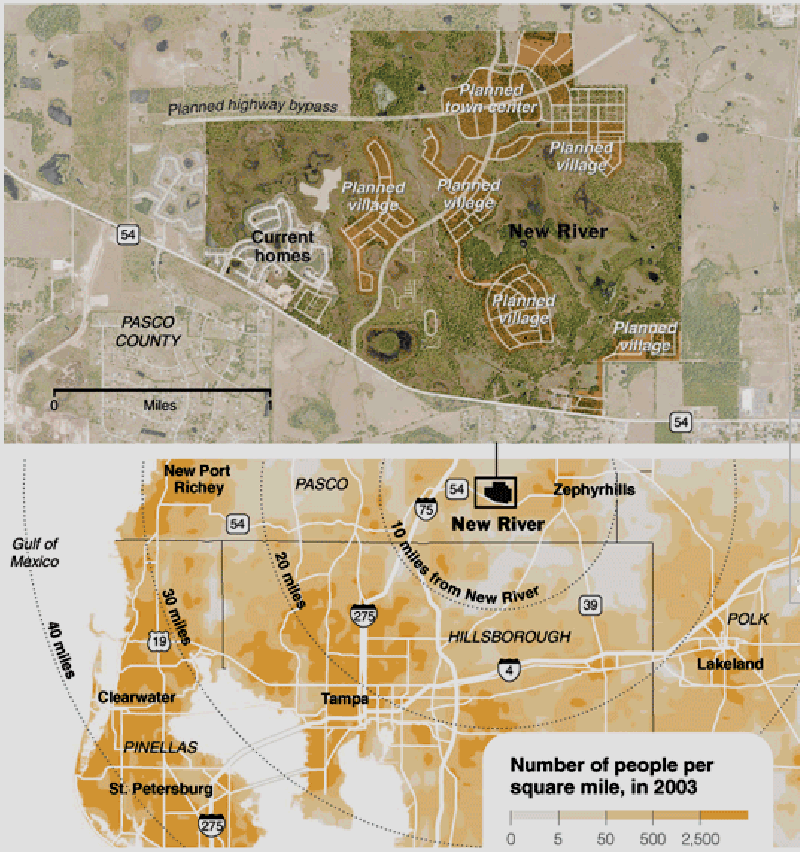
Global Climate Change Tipping Points produced by climatologist Hans Joachim Schellnhuber and published in Nature (Kemp 2005).

Ecosystem Tipping Points

CHALLENGE: Identify causes and consequences of ecosystem tipping points in North America

On the Edge of the Exurbs

Over the next decade, New River is expected to grow to 4,800 housing units, and include a 200-acre town center with offices and commercial space. Today it has about 400 homes.



Demographics of buyers of KB homes in New River

INCOME: 27% ($40,000 to $60,000); 35% ($60,000 to $80,000); 14 ($80,000 to $100,000); 14 ($100,000 to $120,000); 11 ($120,000+)

AGE: 18% Under 30; 46 30 to 40; 23 40 to 50; 13 50+

RACE: 38% Hispanic; 24 White; 16 Black; 5 Nat. Amer.; 16 Other

EDUCATION: 10% High school or less; 41 Some college; 44 College graduate; 5 Advanced degree

FAMILY TYPE: WITH CHILDREN — 64% Married or living together; 10 Single or divorced. NO CHILDREN — 21 Married or living together; 5 Single/div.

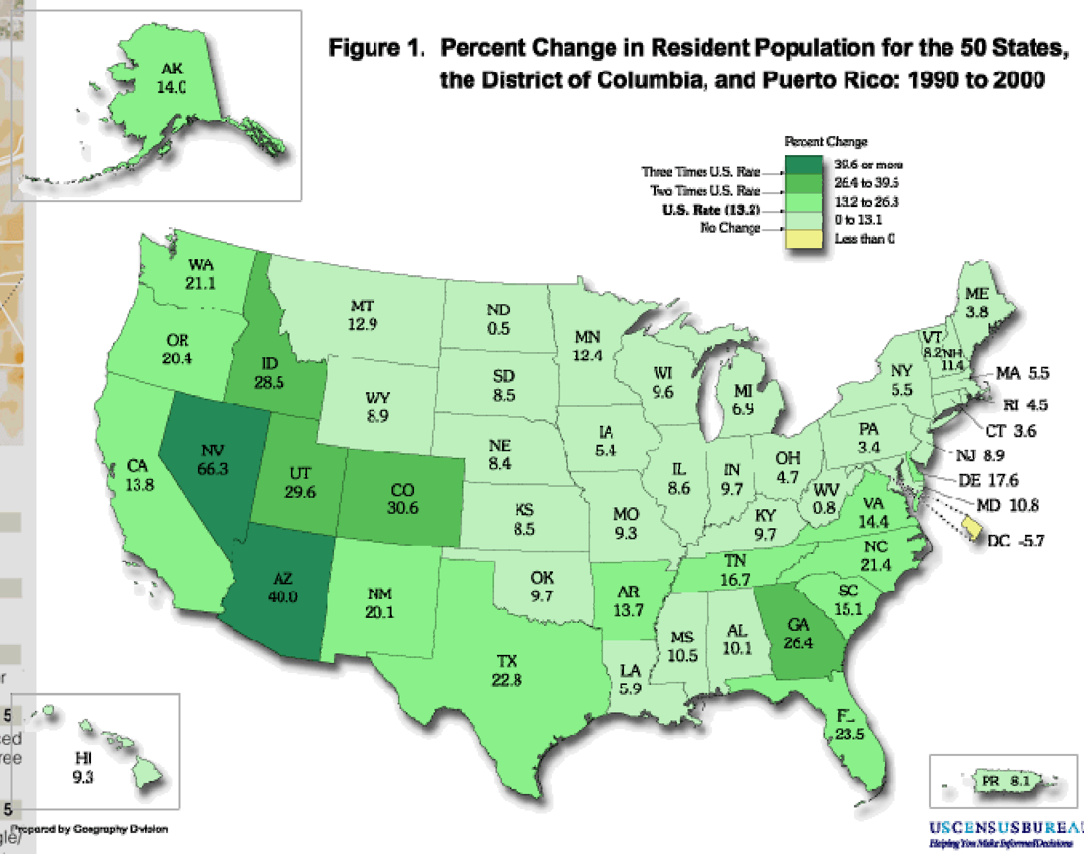
Sources: KB Home; ORNL LandScan 2003/UT-Battelle L.L.C. The New York Times; satellite image from DigitalGlobe via Google Earth

Main drivers:

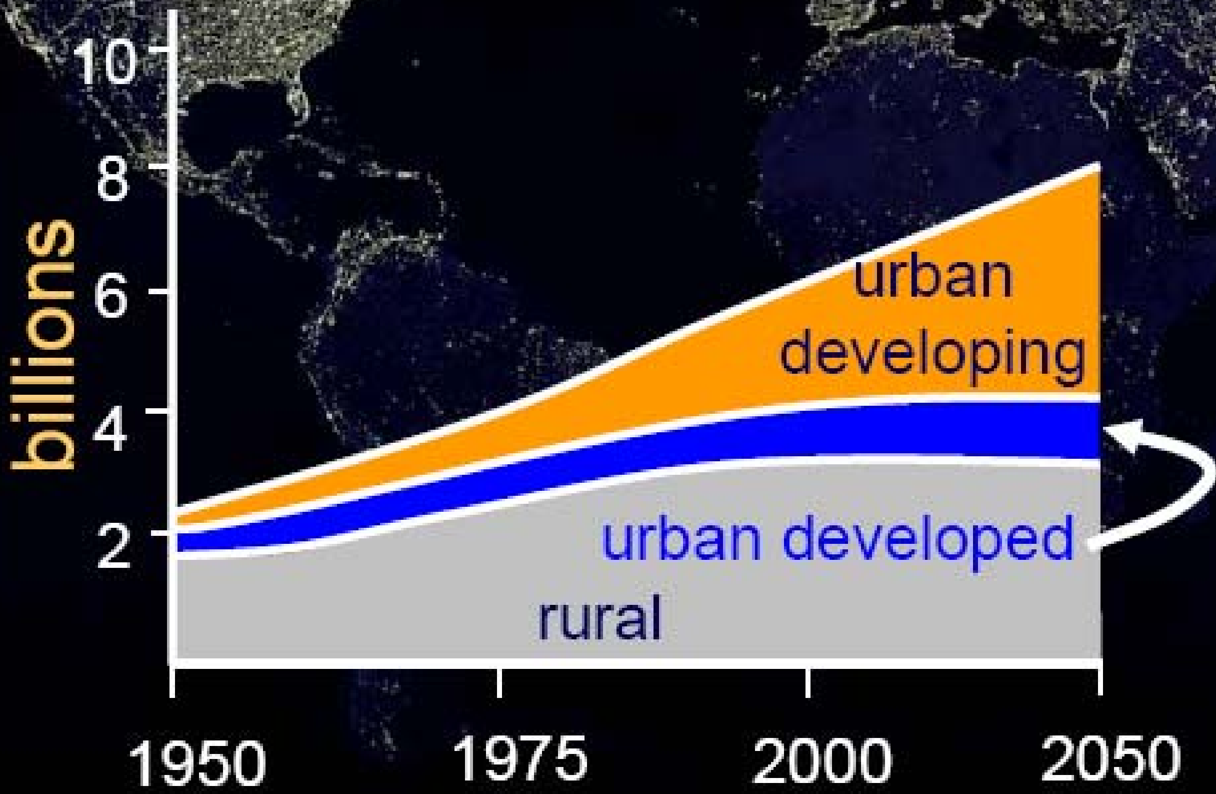
Human Population Change

Human Consumption

Figure 1. Percent Change in Resident Population for the 50 States, the District of Columbia, and Puerto Rico: 1990 to 2000



The problem of urbanization: the future



Source: World Resources Institute 1996

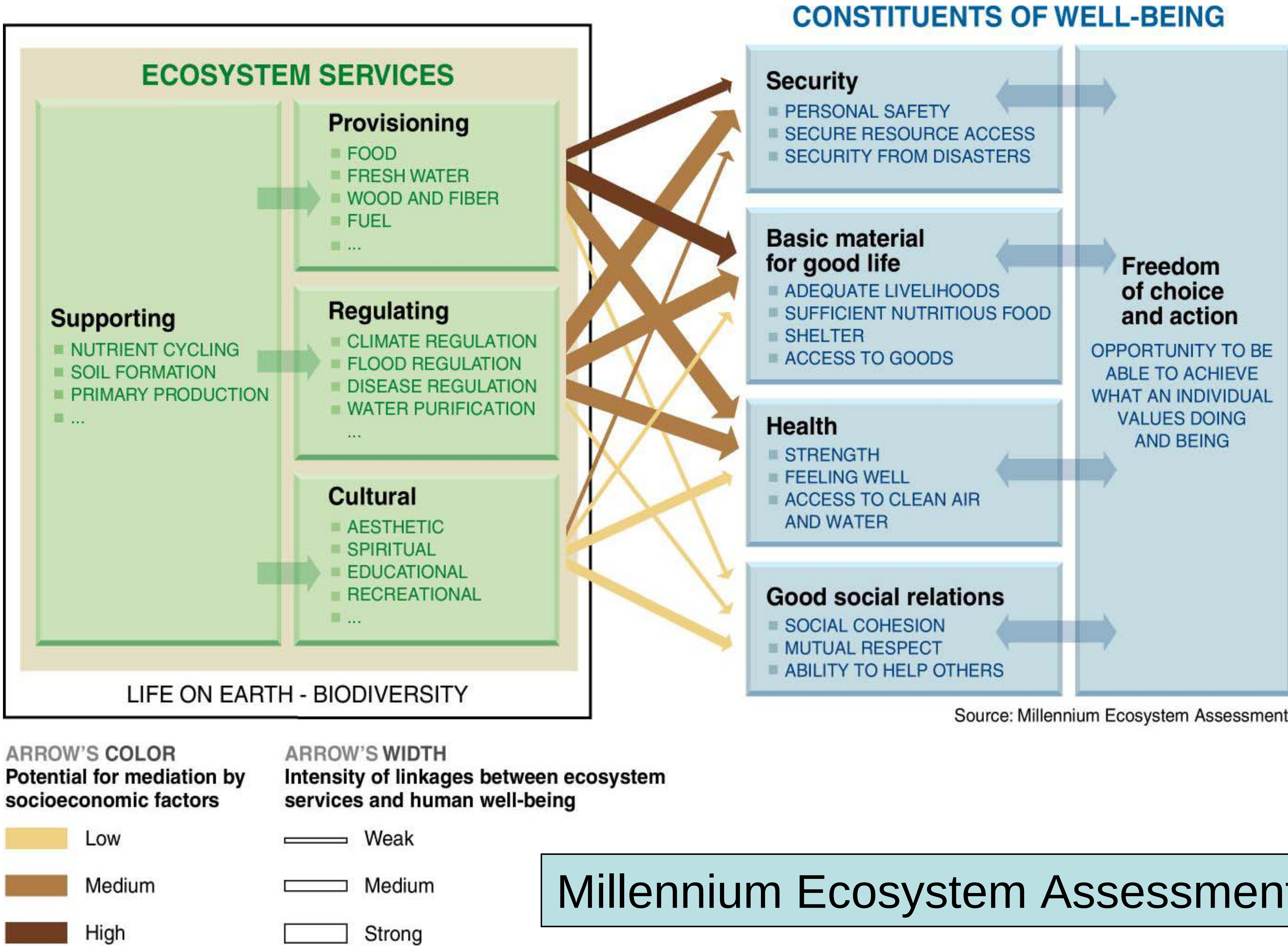
Urban population[1]:

1800 – 2%
1900 – 12%
2000 – 47%
2050 – 60%

Megacities[2]:

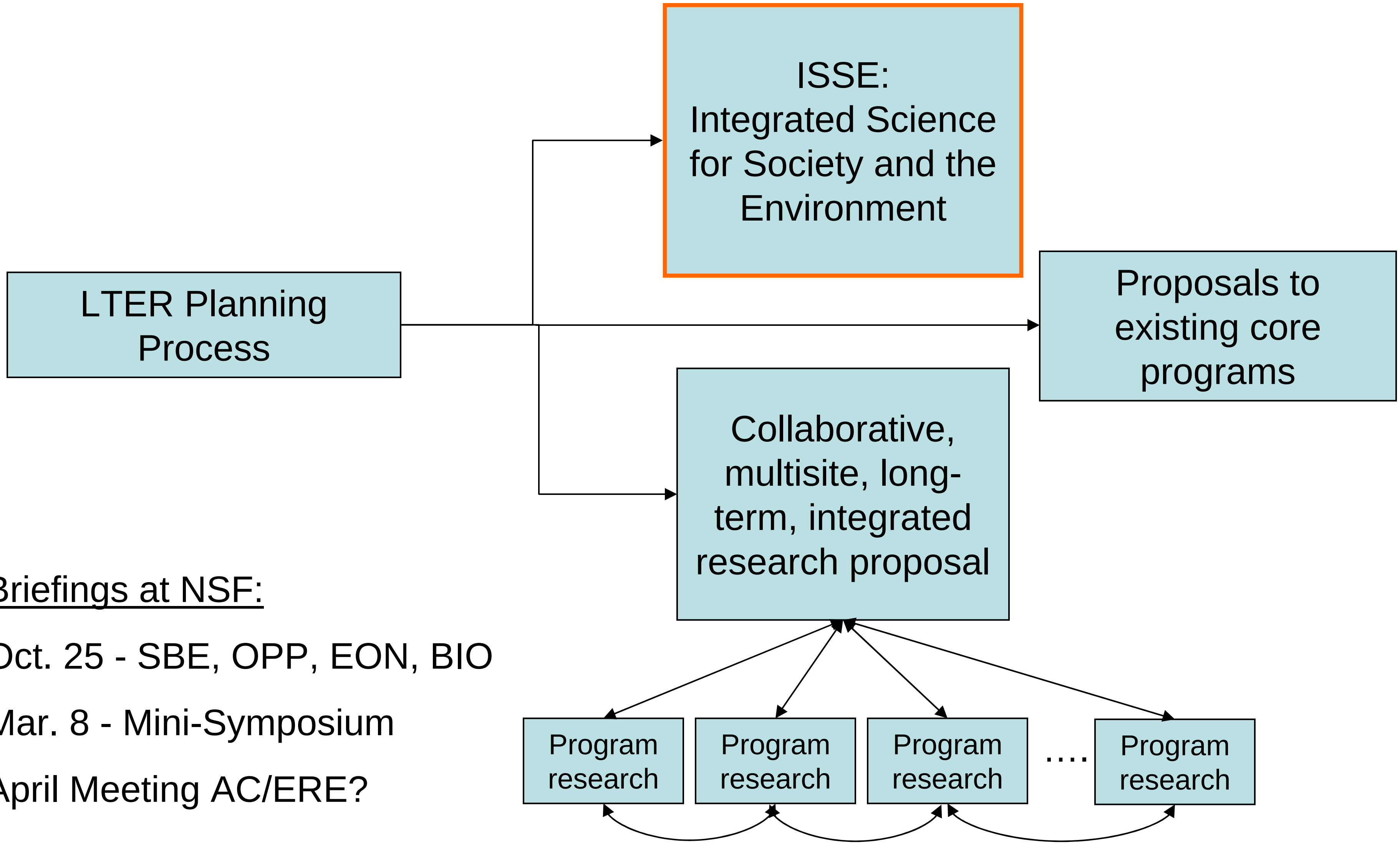
1950 – 1
2000 – 19
2015 – 60

Sources: [1] Cohen 2003 *Science*
[2] IHDP Report 2005



Millennium Ecosystem Assessment

Outcomes of the Planning Process



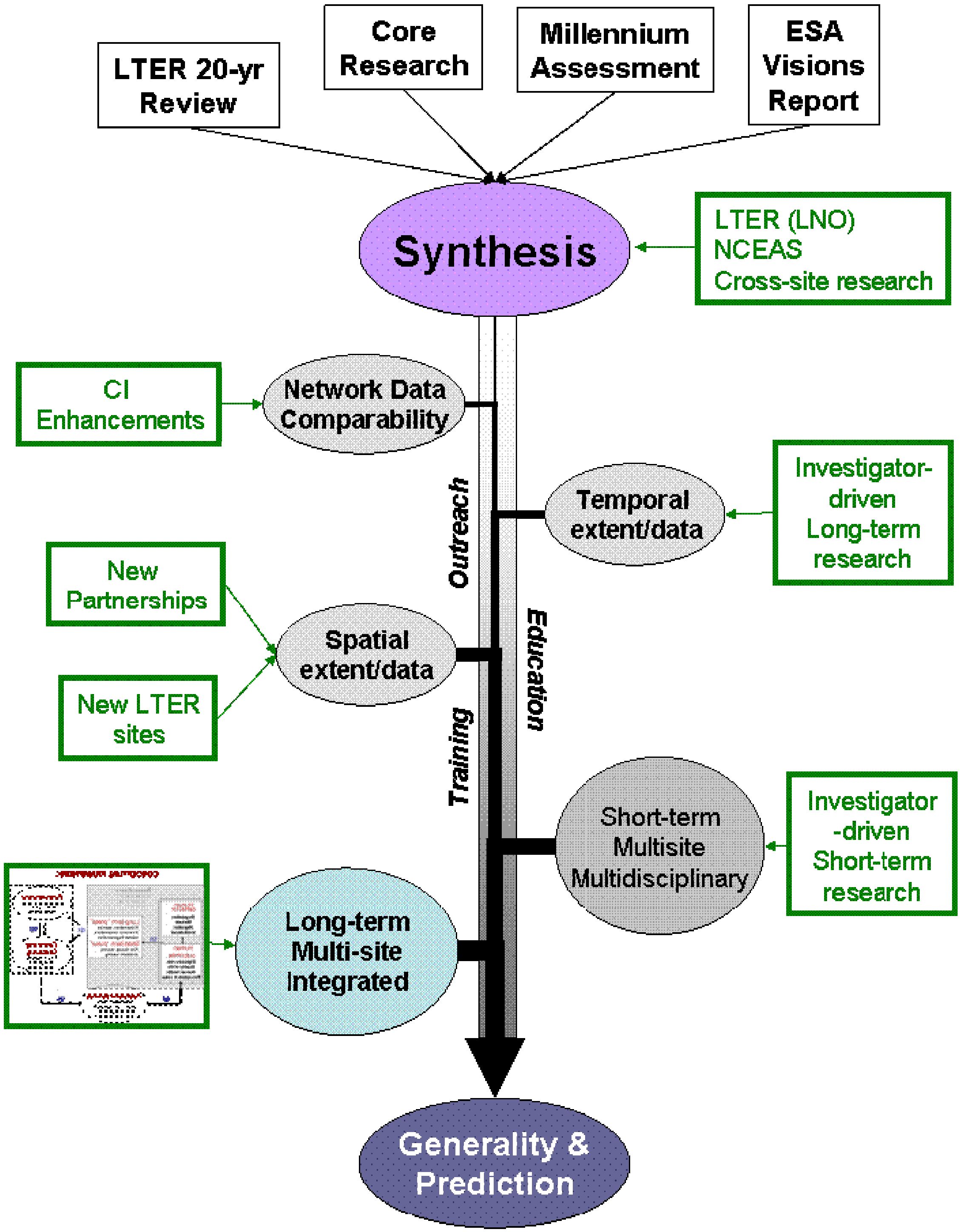
Briefings at NSF:

Oct. 25 - SBE, OPP, EON, BIO

Mar. 8 - Mini-Symposium

April Meeting AC/ERE?

Integrated Science for Society and the Environment: a broadly based funding initiative



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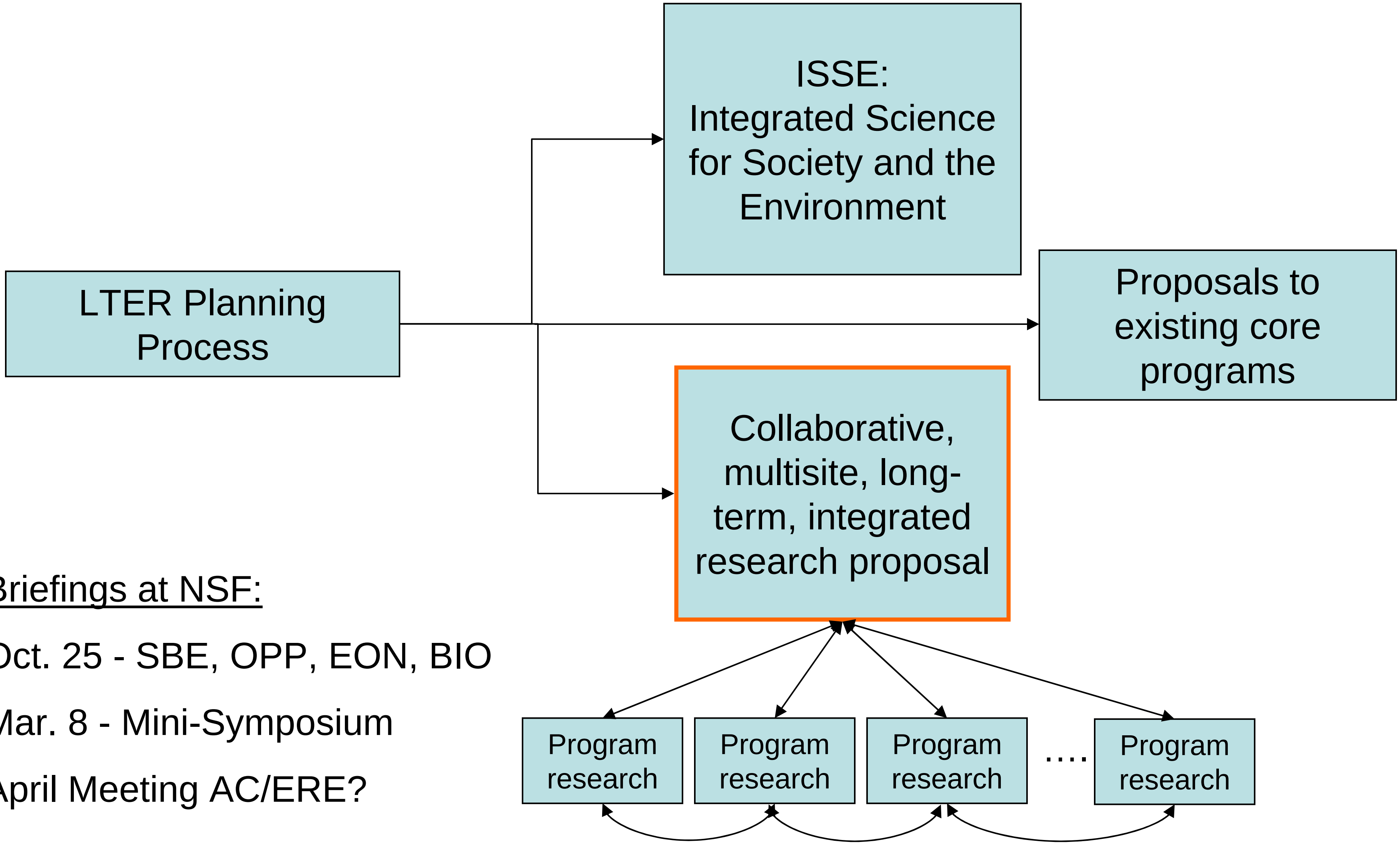

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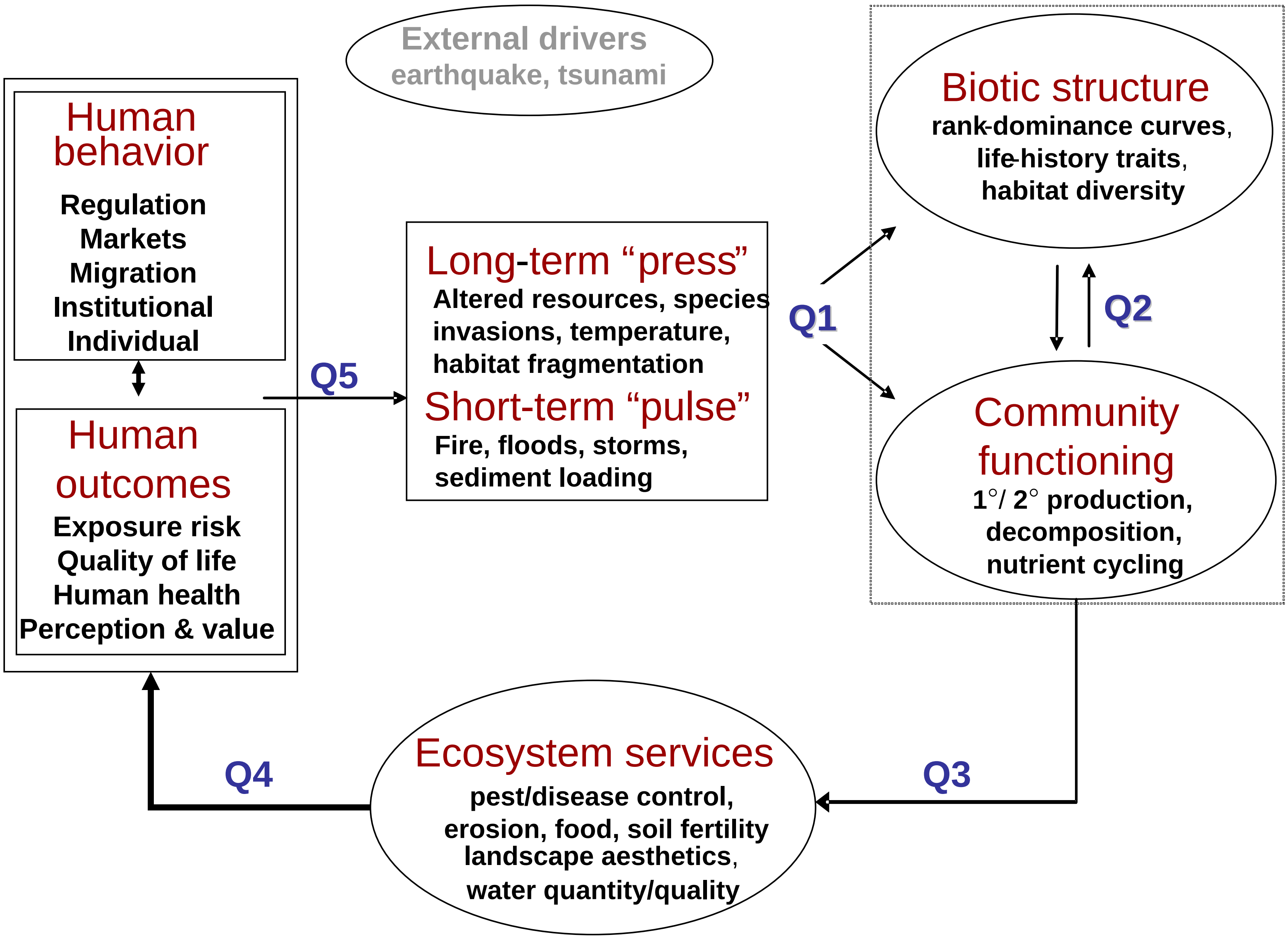
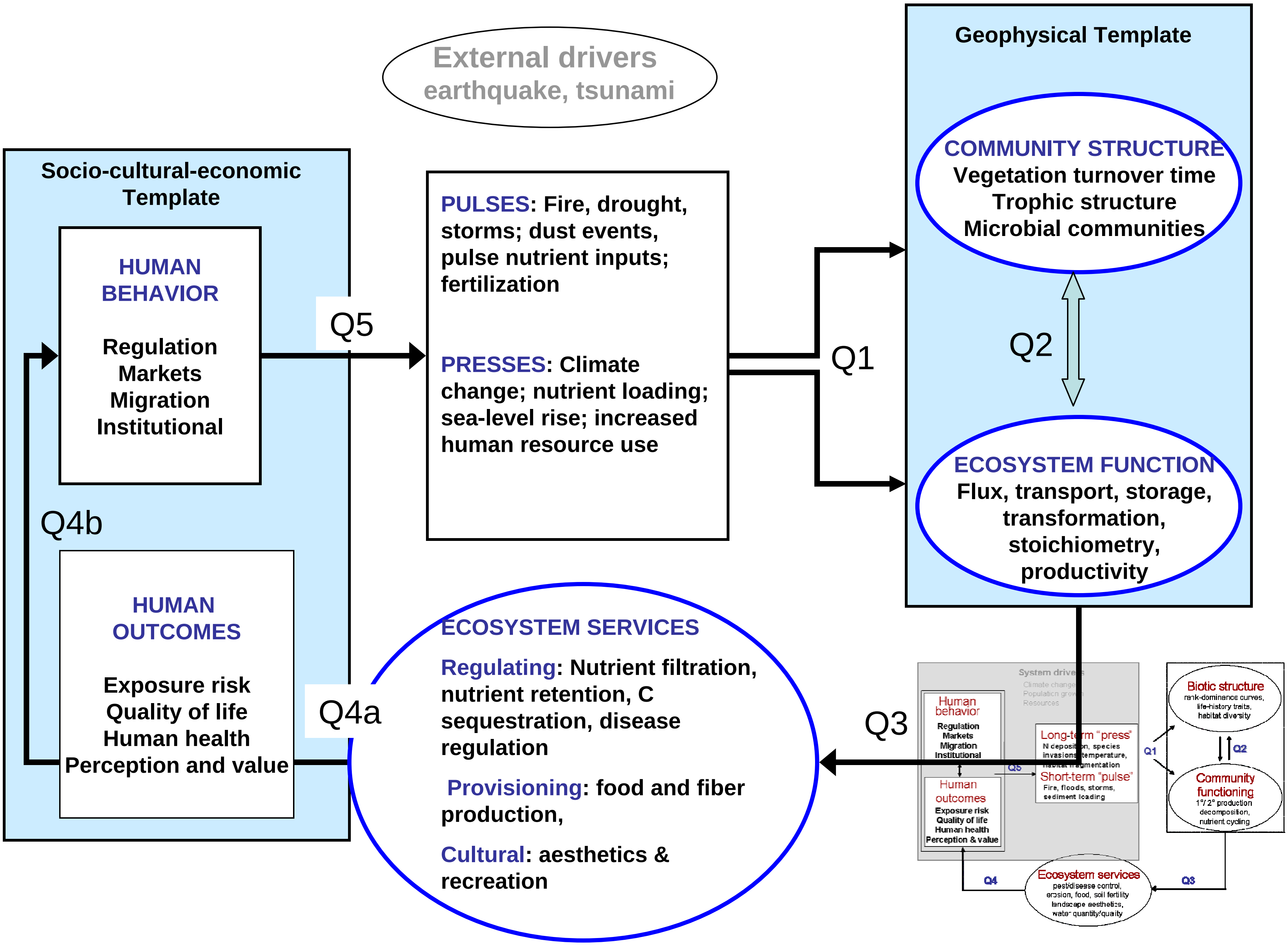
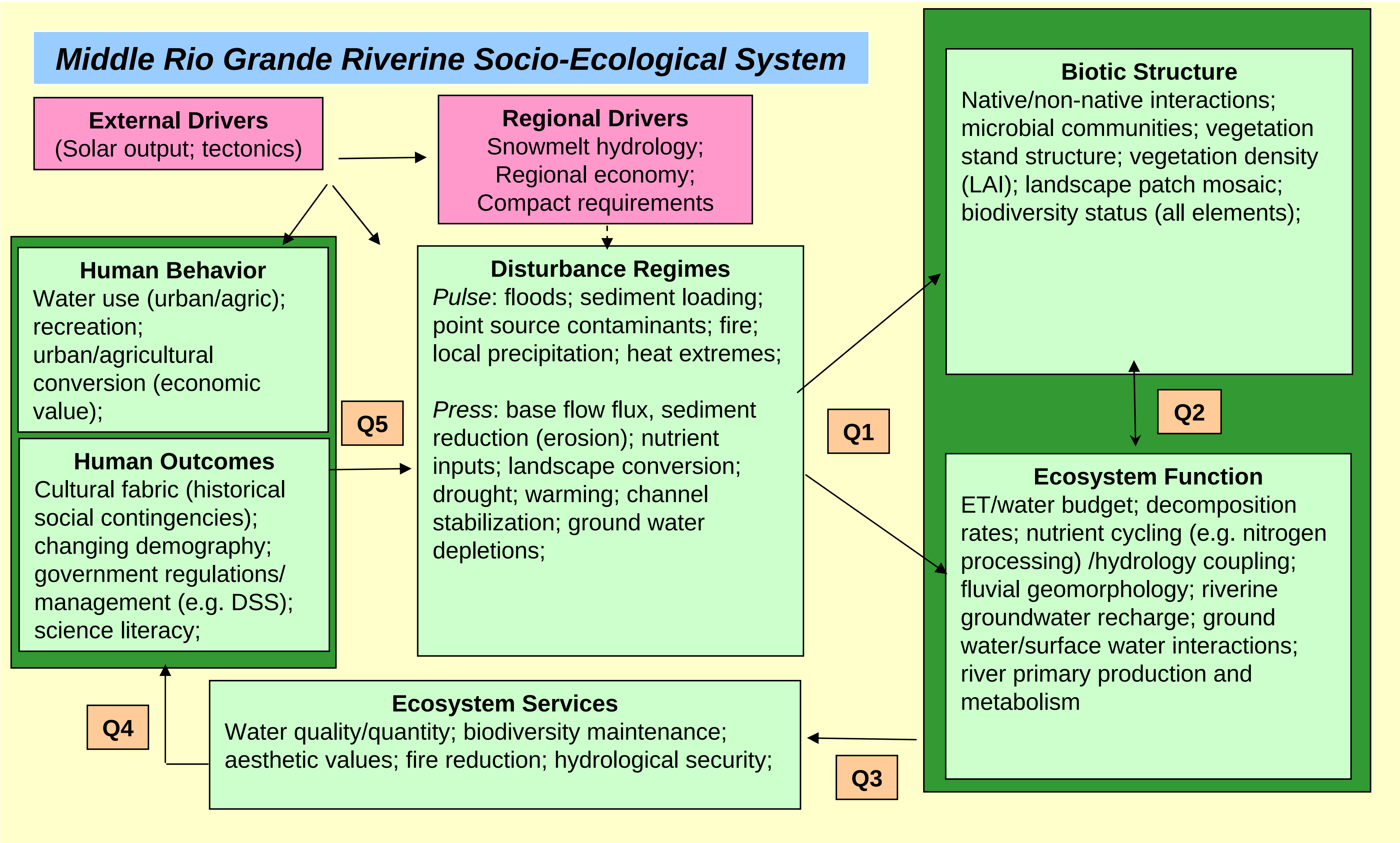
CONCEPTUAL FRAMEWORK



Framework Questions

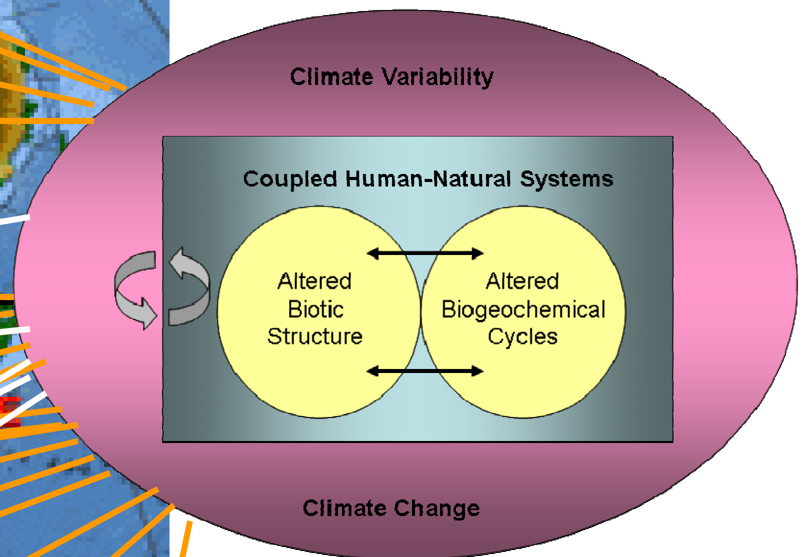
- **Q1:** How do long-term press disturbances and short-term pulse disturbances ***interact*** to alter ecosystem structure and function?
- **Q2:** How can biotic structure be both a ***cause and consequence*** of ecological fluxes of energy & matter?
- **Q3:** How do altered ecosystem dynamics affect ecosystem services?
- **Q4:** How do changes in vital ecosystem services ***feed back*** to alter human behavior?
- **Q5:** Which human actions influence the frequency, magnitude, or form of press and pulse disturbance regimes across ecosystems, and how do these change across ecosystem types?

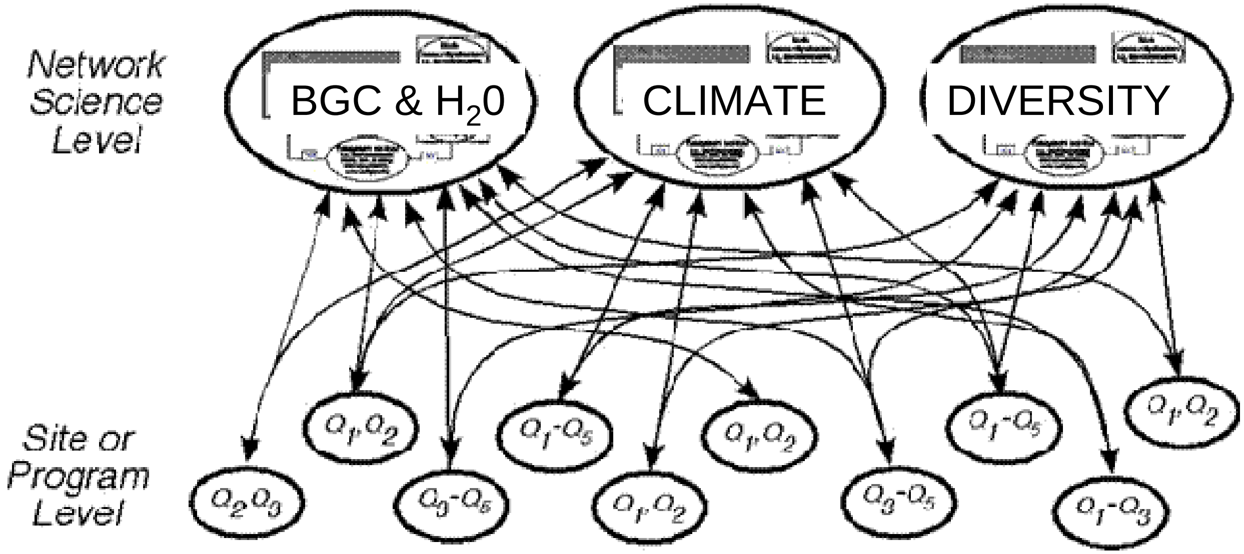

External drivers
earthquake, tsunami
Socio-cultural-economic Template
HUMAN BEHAVIOR
Regulation
Markets
Migration
Institutional
Q5
PULSES: Fire, drought, storms; dust events, pulse nutrient inputs; fertilization
PRESSES: Climate change; nutrient loading; sea-level rise; increased human resource use
Q1
Geophysical Template
COMMUNITY STRUCTURE
Vegetation turnover time
Trophic structure
Microbial communities
Q2
ECOSYSTEM FUNCTION
Flux, transport, storage, transformation, stoichiometry, productivity
Q4b
HUMAN OUTCOMES
Exposure risk
Quality of life
Human health
Perception and value
Q4a
ECOSYSTEM SERVICES
Regulating: Nutrient filtration, nutrient retention, C sequestration, disease regulation
Provisioning: food and fiber production,
Cultural: aesthetics & recreation
Q3
Human behavior
Regulation
Markets
Migration
Institutional
Human outcomes
Exposure risk
Quality of life
Human health
Perception & value
Q5
Short-term "pulse"
Fire, floods, storms, sediment loading
Q1
Biotic structure
rank-dominance curves, life-history traits, habitat diversity
Q2
Community functioning
1°/ 2° production decomposition, nutrient cycling
Q4
Ecosystem services
pest/disease control, erosion, food, soil fertility landscape aesthetics, water quantity/quality
Q3



Q1: How do long-term flow regulation and short-term flow variability (floods, droughts, and river drying) interact to alter the Rio Grande riverine corridor?
Q2: How are feedbacks between water availability, decomposition, nutrient cycling, and fluvial geomorphology (ecosystem processes) and vegetation structure, patch dynamics, biodiversity, and microbial communities (biotic structure) affected by flow regulation and flow variability?
Q3: How do changing river and riparian ecosystems affect the regional water budget, channel characteristics, water quality, fire regime, and biodiversity?
Q4: How does the human population along the Middle Rio Grande respond to decreased water availability and quality, increased fire frequency, biodiversity losses, non-native species, and competing water demands?
Q5: How do humans decisions and actions affect flow characteristics of the managed riverine corridor and responses to floods, fire, drought, and drying?

US Long-term Ecological Research Network (LTER)





Resource and Amenity-Based Migration and Land Use Dynamics

1. human settlement and development patterns in relation to natural resources and aesthetic and biodiversity amenities.

2. evolution of human attitudes and values as both ecosystems and human communities change over time.

3. experimental market ecology to examine institutional structures that affect ecosystems over time.

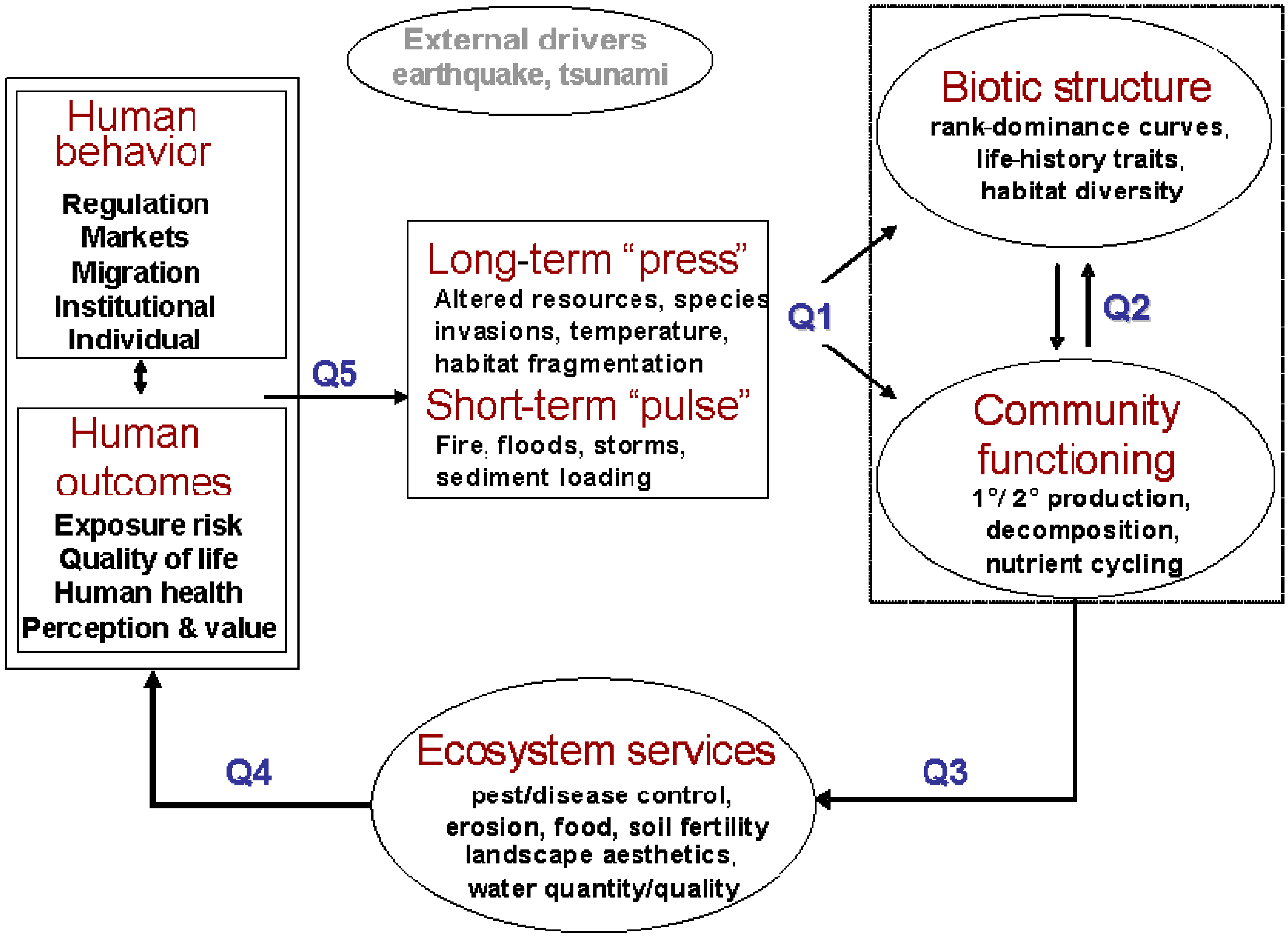
Overarching Question:

How do changing climate, biogeochemical cycles, and biotic structure affect ecosystem services and dynamics with feedbacks to human behavior?

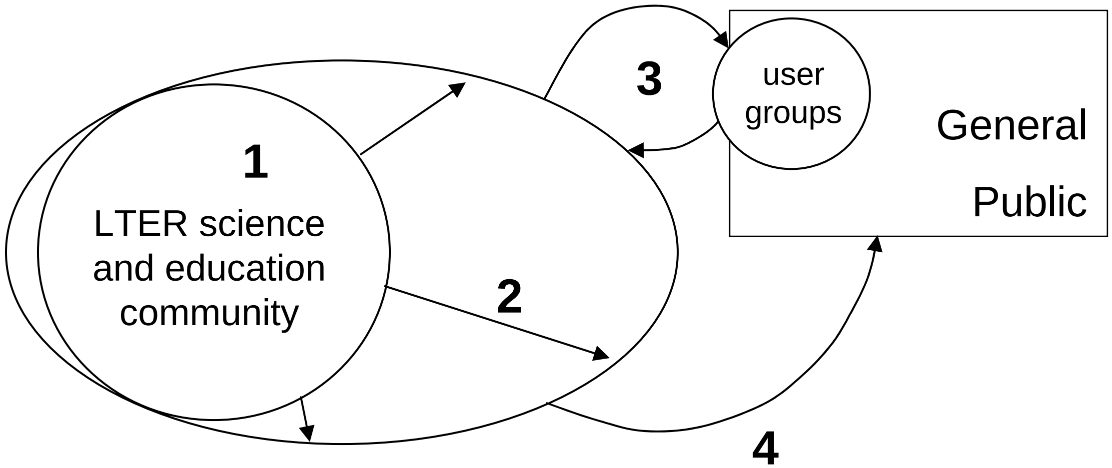
Important attributes of this research:

- Multivariate
  - Expansion beyond univariate-based understanding to studying interactive effects of multiple stressors: we can model and manipulate these at multiple sites over long time frames and identify commonalities in ecosystem responses.
- Interdisciplinary
  - People are typically viewed as drivers of change, but only infrequently as response variables - we will develop reciprocal models of causality that explicitly incorporate human behavior as both a cause and consequence of ecosystem change.
- Cross-site and cross-habitat
  - multiple sites will allow us to identify the most important underlying processes through a combination of observation, modeling and experimentation

Integrating Research and Education



Addressing these questions will require a new interdisciplinary research approach. This new approach can be effective only if its implications are understood by citizens, educators, and policymakers.



1. Support the future vitality of the LTER research and education program by assuring it has the human capital needed for success.

2. Expand our community to reflect the diversity of our society and to include a broader range of skills, expertise, and disciplines.

3. Communicate with and bring user perspectives into our community.

4. Improve environmental literacy through formal and informal education systems.

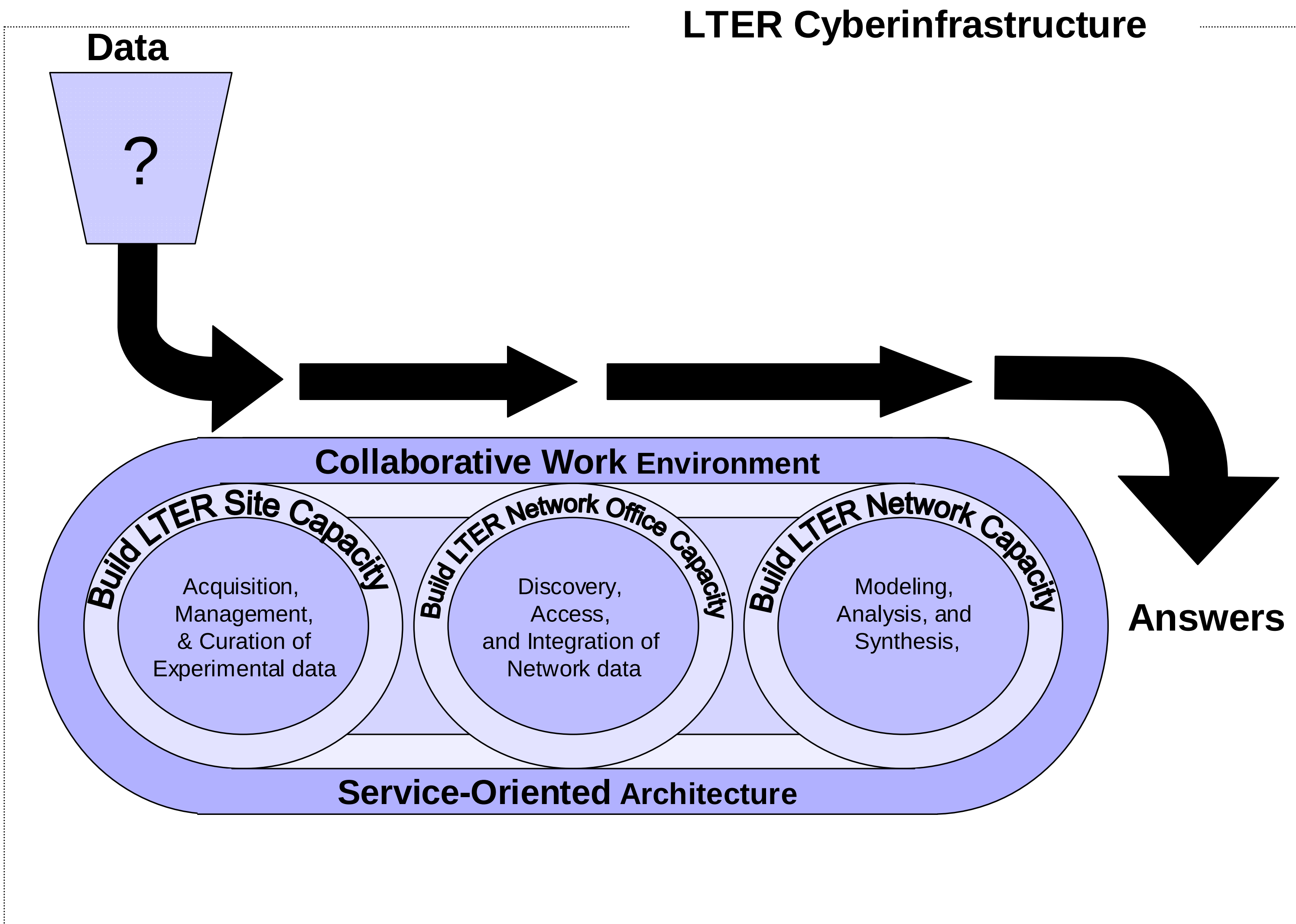
Cyberinfrastructure Planning within the LTER Network Planning Grant

Barbara Benson
James Brunt
Don Henshaw
John Porter
John Vande Castle

Goals: Cyberinfrastructure (CI) Planning

- engage computer and information scientists to address the new integrative challenges presented by the expanding spatial, temporal and interdisciplinary scope of LTER network science
- provide cross-fertilization between LTER CI planning and that of other concurrent efforts within and beyond the ecological science community

LTER Cyberinfrastructure Strategic Plan



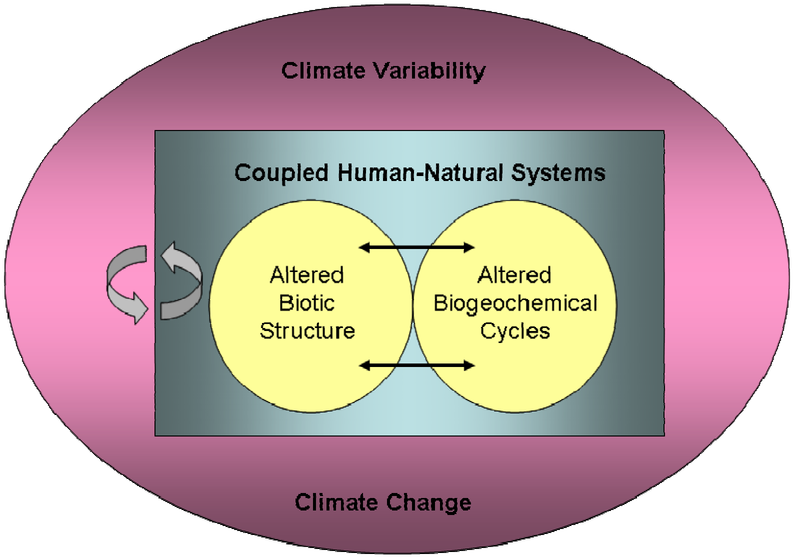
http://intranet.lternet.edu/planning/files/5/53/CI_Strategic_Plan_2.3.pdf

September 15, 2006

Integrating CI into socio-ecological research requires a program of workforce training and education

RECENT STEPS:

- Program Representatives meeting in Aug 2006
  - presented site ideas
  - began integration of multi-site research
- Submit revised initiatives document for comment
- Society Endorsement of ISSE
- All Scientist Meeting
  - flesh out proposal
  - multi-site integration, phase II
  - Begin transition to LTER SC
- STFAC meeting Oct 2006
- SC Meeting May 2007
- Proposal July 2007



GOAL during the All Scientists Meeting: Continue to develop detailed multi-site research plan

Program Reps meeting:

- Feedback from sites
- Coordinate activities during ASM

“Topical Question” Workshops: Bring your ideas

- Social science (Thursday 1:30-3:00PM)
- Altered biogeochemical and water cycles (Friday 9:30 AM -12:00 PM)
- Climate change and variability (Friday 3:30 - 5:30 PM)
- Altered biotic structure (Saturday 9:30 AM -12:00 PM)

Synthesis Workshops:

- Altered biogeochemical and water cycles synthesis (Friday 3:30 – 5:30)
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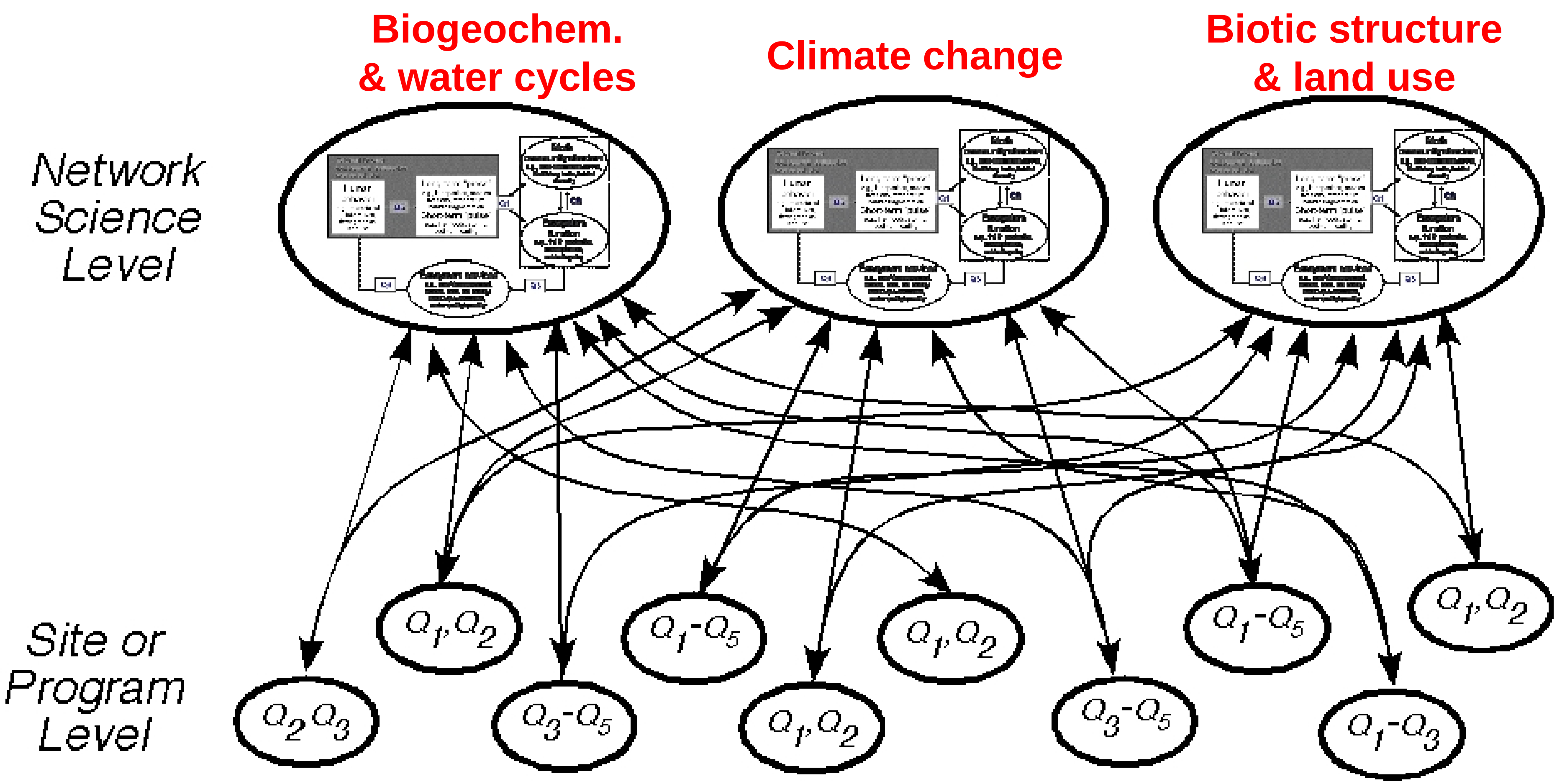
Moving to the next hierarchical level of science, education, CI, and social influence



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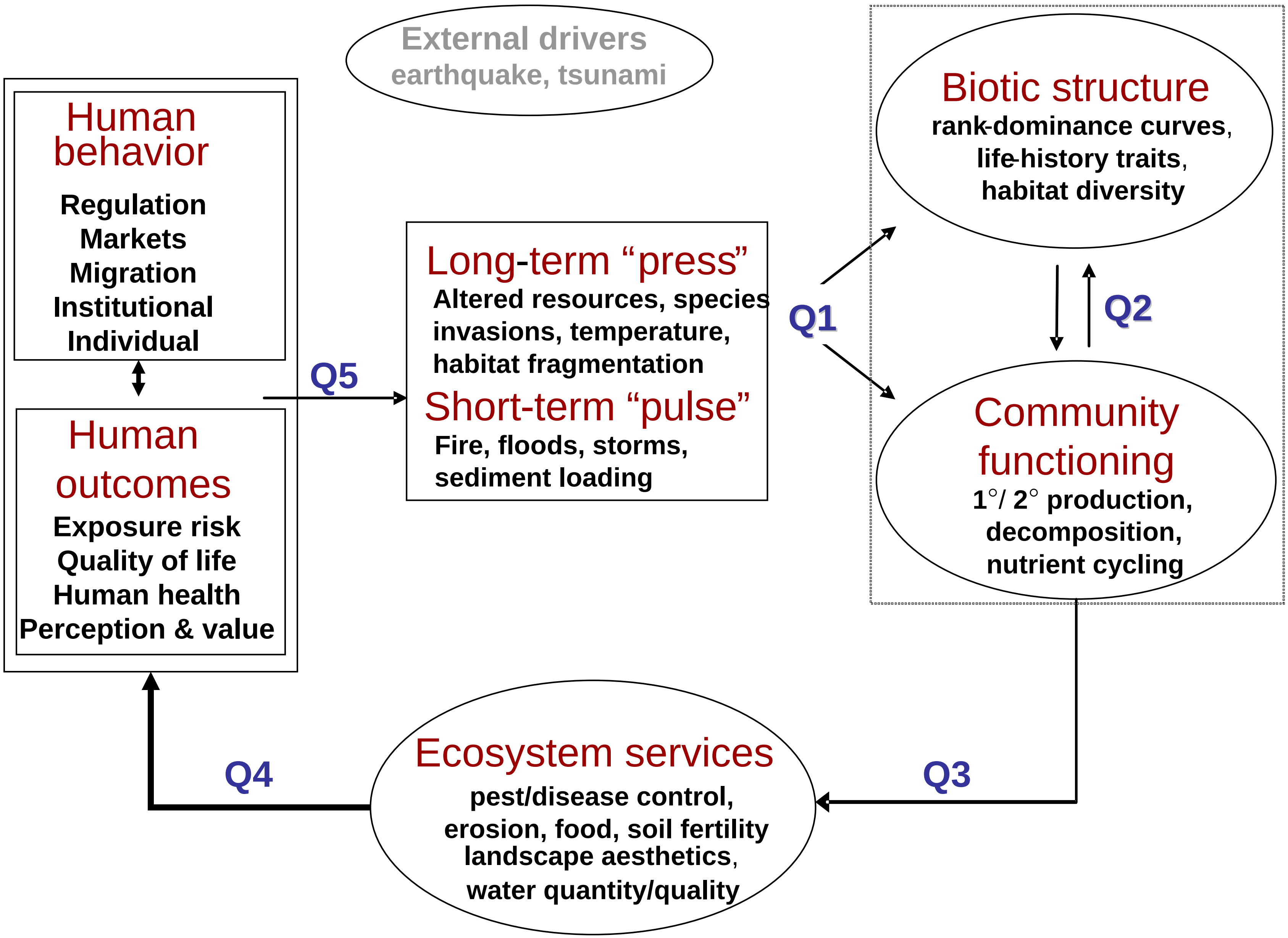

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