Potential Role of the LTER Network in Fostering Local-to-Global Stewardship

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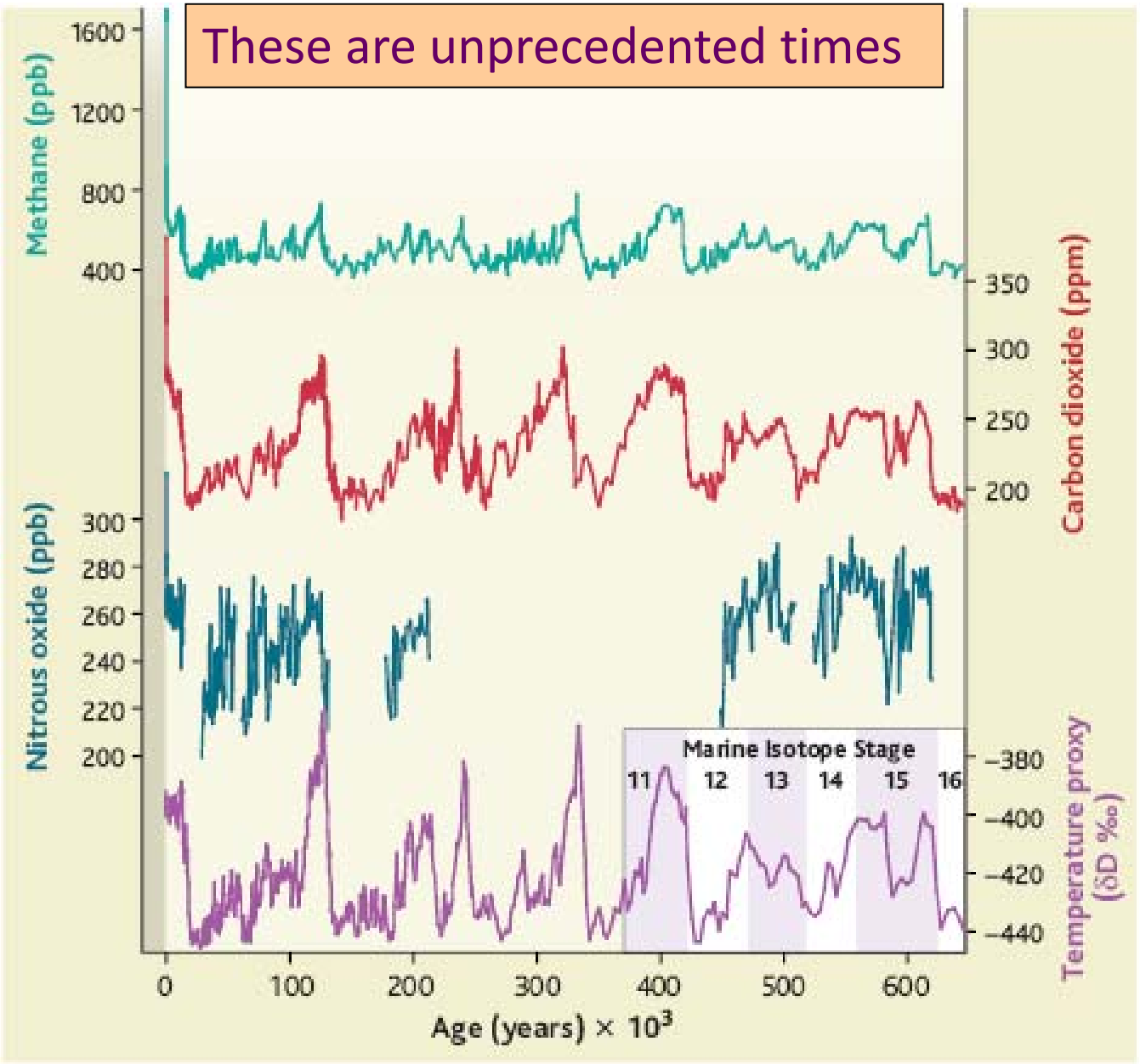
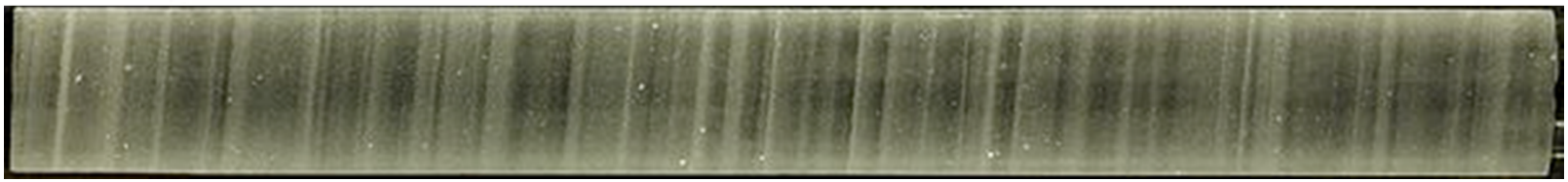
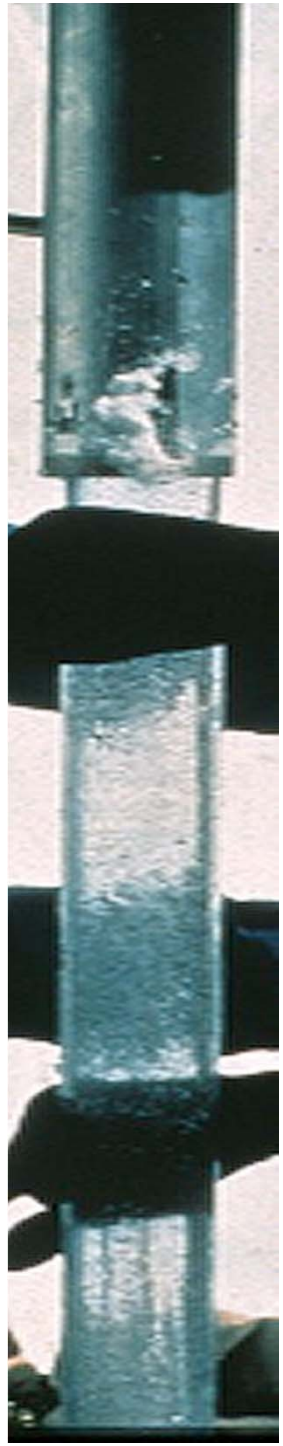
(and Scott Collins)

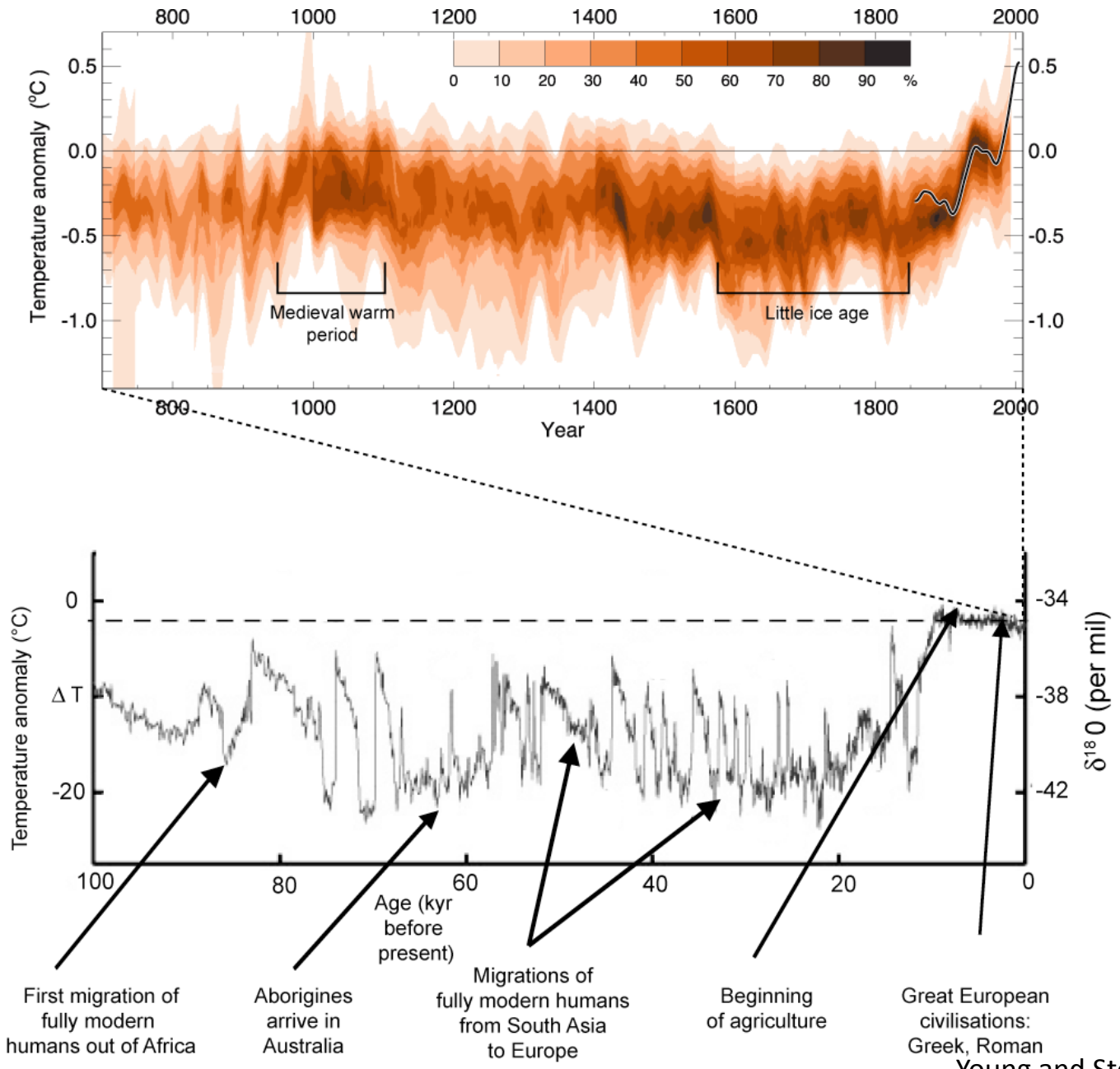
These are unprecedented times





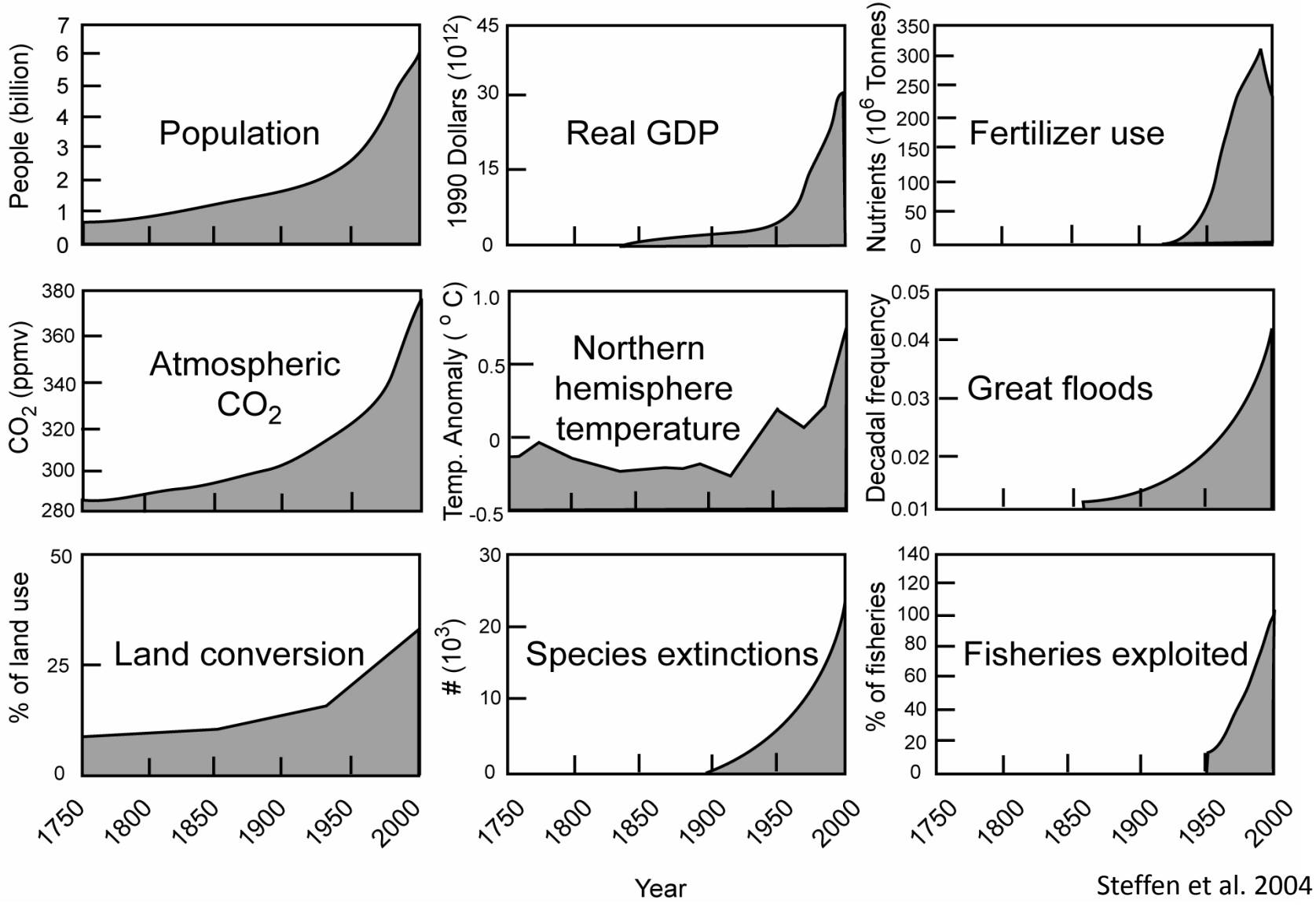


Historically, Earth's regulatory system kept climate in a "safe operating space"

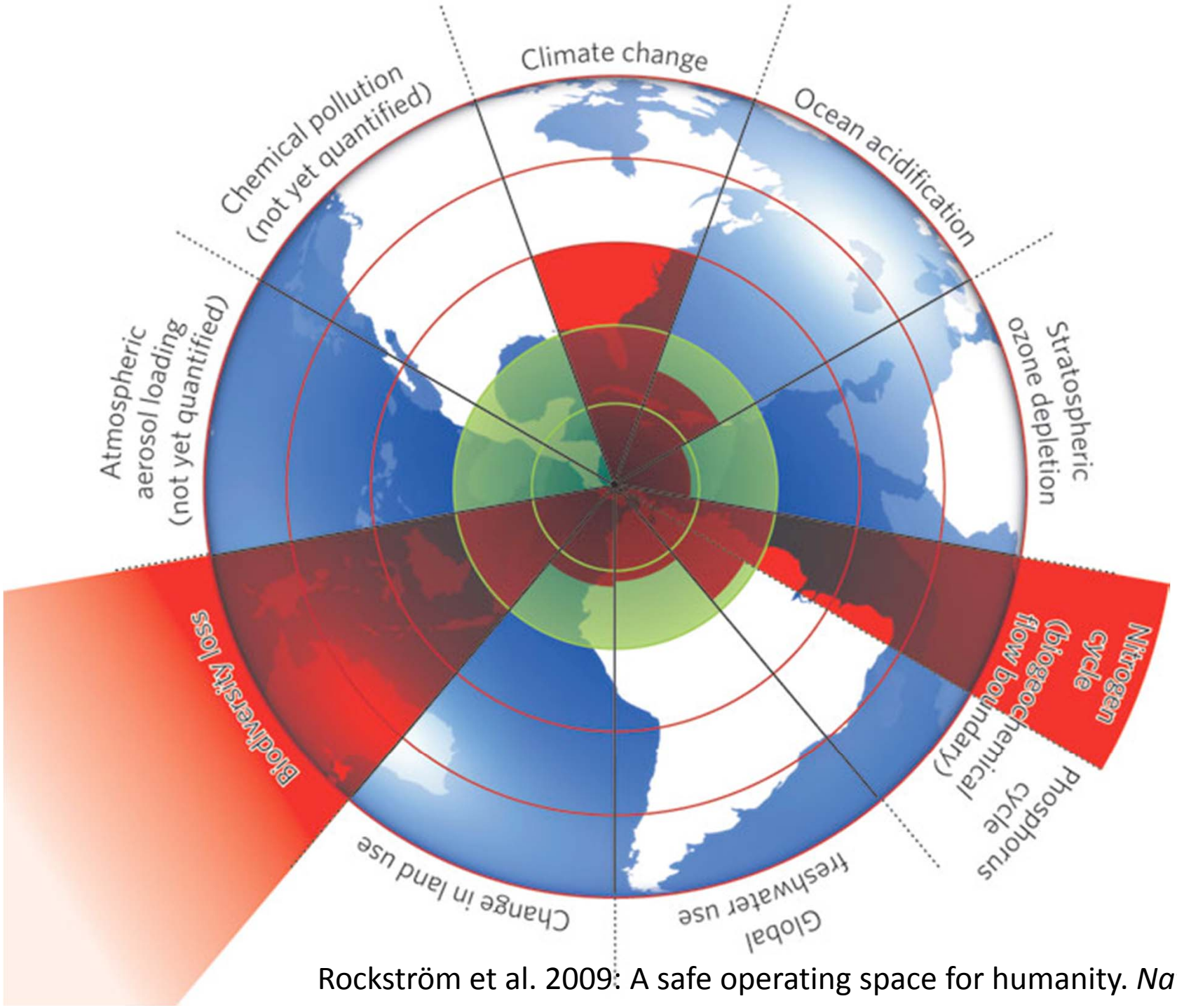


Young and Steffen 2009

Earth is experiencing directional changes in many drivers of social-ecological processes



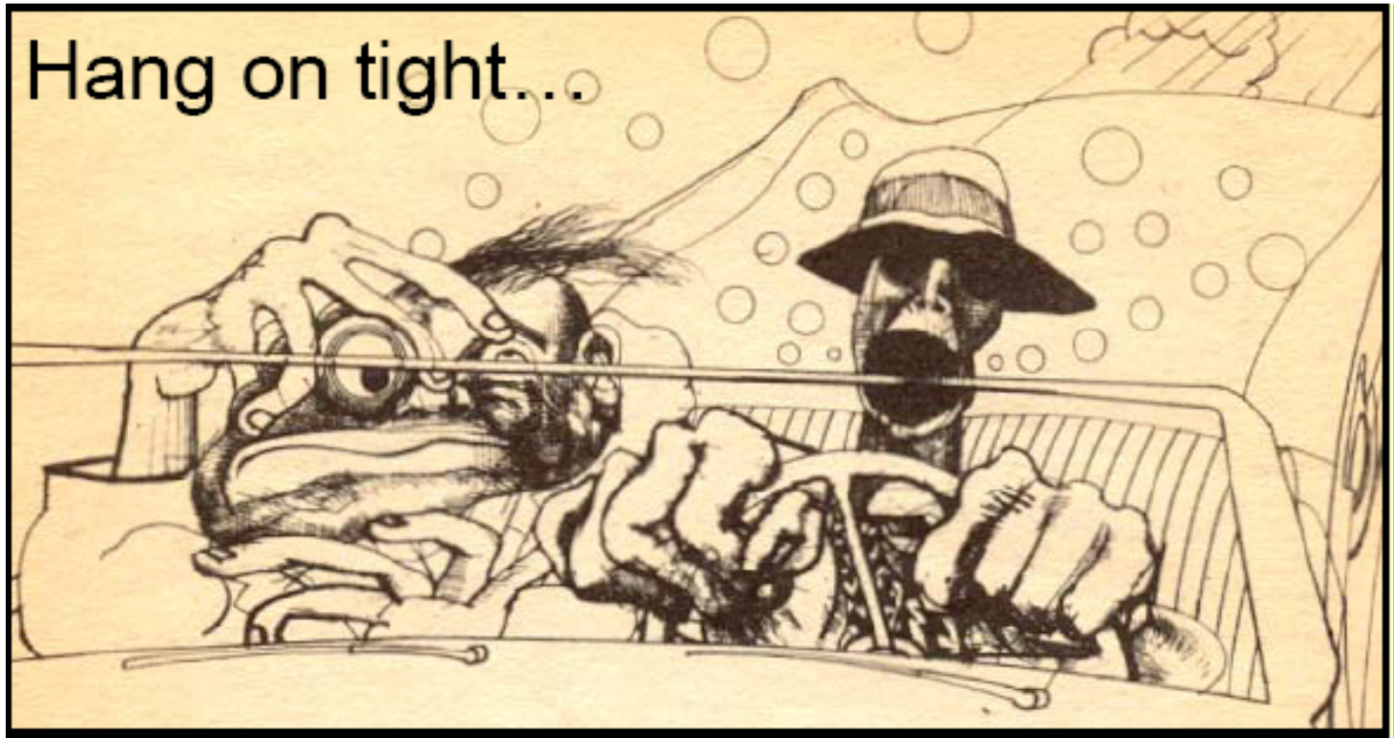
Steffen et al. 2004



Rockström et al. 2009: A safe operating space for humanity. *Nature*

We are approaching tipping points
The Earth *will* transform

- Our choice is whether we deliberately shape a transformation toward sustainability through stewardship or let transformation happen to us.



How can we fix a degrading biosphere?

- The challenge is enormous
- We must act now
  - Can't wait until the science is "ready" before acting
  - It isn't "someone else's problem"
    - Social and ecological dynamics are at the core of solutions
    - Need basic understanding of social-ecological processes and their application to exploring solutions
    - The problem is bigger than ecology
      - Need collaborations with other disciplines and practitioners

Earth Stewardship

- Active shaping of pathways of change of social-ecological systems to enhance ecosystem resilience and human well-being
- Key features
  - Active intervention
    - Risky—best justified at local scales
  - Shaping change
  - System of people as part of nature
  - Two goals: ecosystem resilience, human well-being
    - Not people ***or*** nature, but people ***with*** nature

Chapin et al. 2011 Ecosphere

The LTER Network is well-poised to contribute to the science needed for stewardship

- Long-term observations needed to detect changes
  - Interannual variability? Trends? Thresholds?
- Experiments needed to explore responses
  - Field manipulations and models
- ISSE is a commitment to social-ecological research
  - Same conceptual framework as stewardship
  - Recognizes possibility of deliberately shaping change

LTER Priorities areas for research:

- Altered hydrological conditions
- Coastal vulnerabilities
- Ocean acidification
- Altered biogeochemical cycles
- Inland climate change
- Loss of the cryosphere
- Land-use change
- Loss of biodiversity, etc.

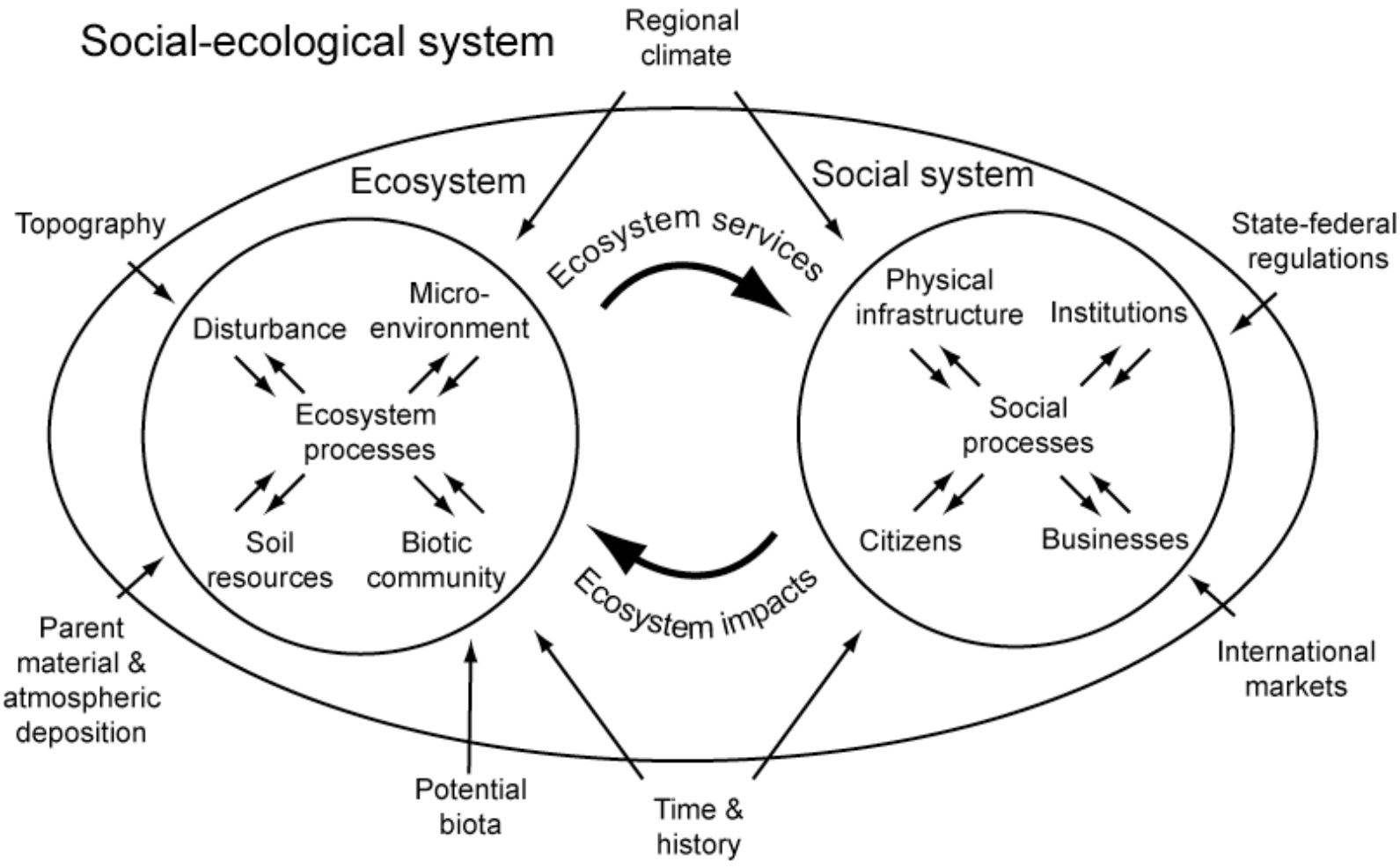
Fountain et al. 2012 BioScience

Understanding "Earth's ecosystems and how they interact with the numerous components of human-caused global change" is one of the great challenges for biology in the 21st Century. - *Lubchenco, 1998*

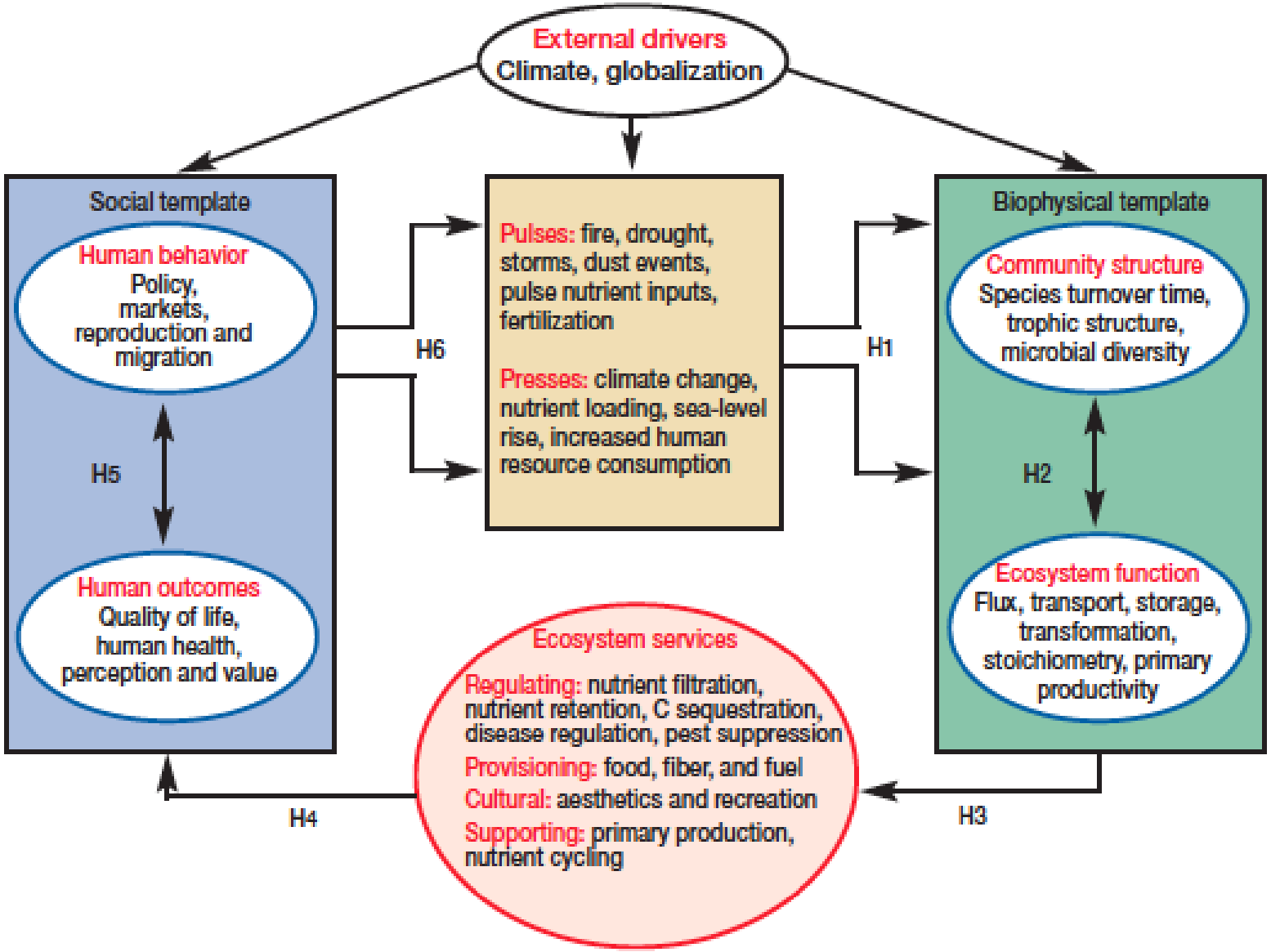
Value of long-term observations

- Provide convincing evidence of change, identify mechanisms of change, and the consequences of change
  - Greening of the Arctic
  - Cross-site comparisons (e.g., urban growth)
- Identify potential thresholds of current system
  - Mountain pine beetle
  - Changes in fire regime
  - Shrub encroachment
- Provides scientific context for exploring actions that shape change

Building a science of people with nature and a society that recognizes its role and responsibilities as part of nature



Pulse-Press Dynamics linking biophysical and social sciences through ecosystem services



Collins et al. 2011 Frontiers Ecol. Environ.

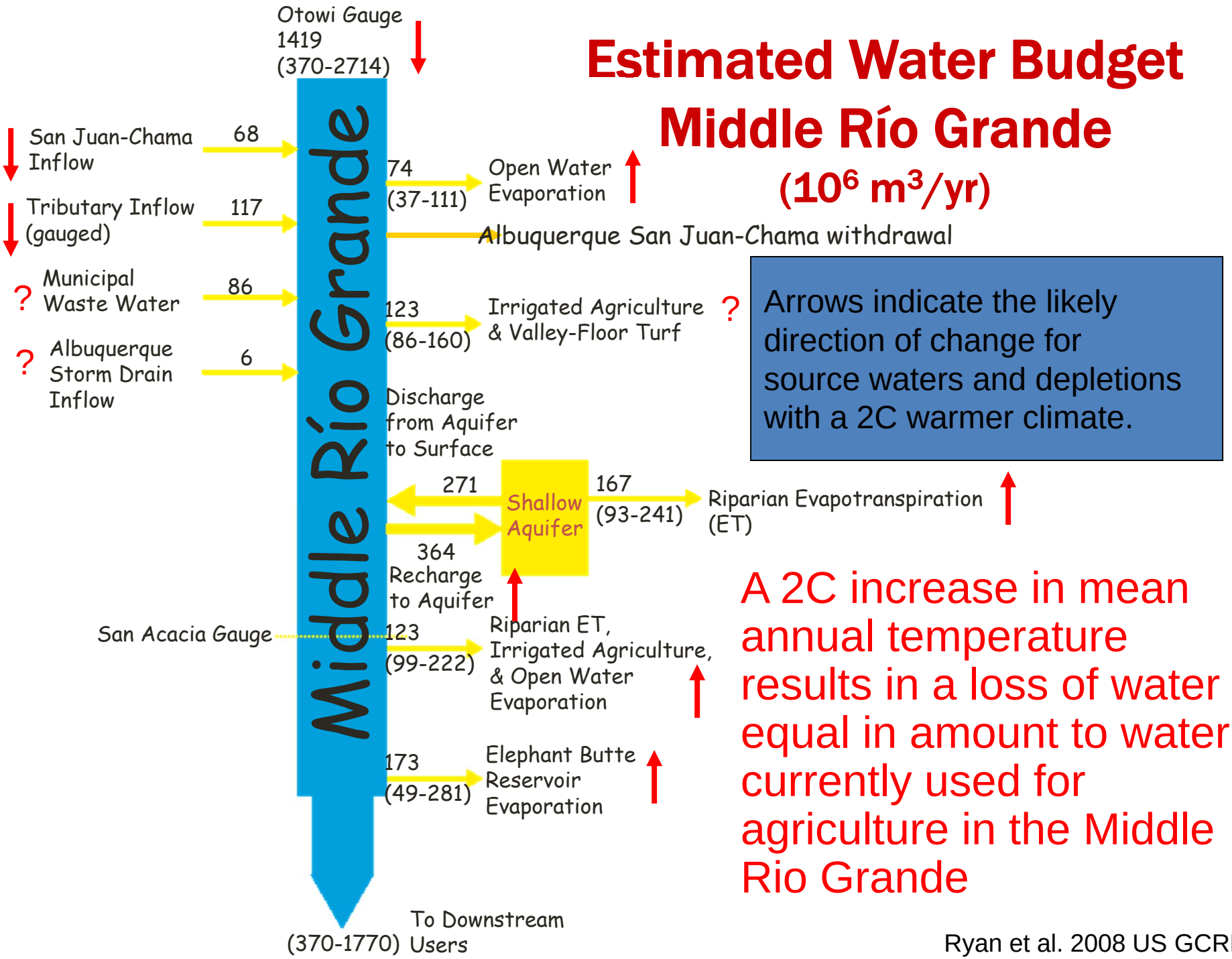
ISSE as a stewardship framework

- Extension of systems thinking to social-ecological systems
  - Some social scientists are skeptical of systems approach (so are some ecologists….)
- Explicit representation of feedbacks
  - An important contribution of LTER modeling
- Scenarios to explore alternative futures
  - Once desired outcomes are known, work backwards to potential pathways

Changes in burn depth lead to new forest types: conifer-to-deciduous transition of the boreal forest

Estimated Water Budget Middle Río Grande

(10^6 m^3/yr)



Arrows indicate the likely direction of change for source waters and depletions with a 2C warmer climate.

A 2C increase in mean annual temperature results in a loss of water equal in amount to water currently used for agriculture in the Middle Rio Grande

Ryan et al. 2008 US GCRP

Scenario studies

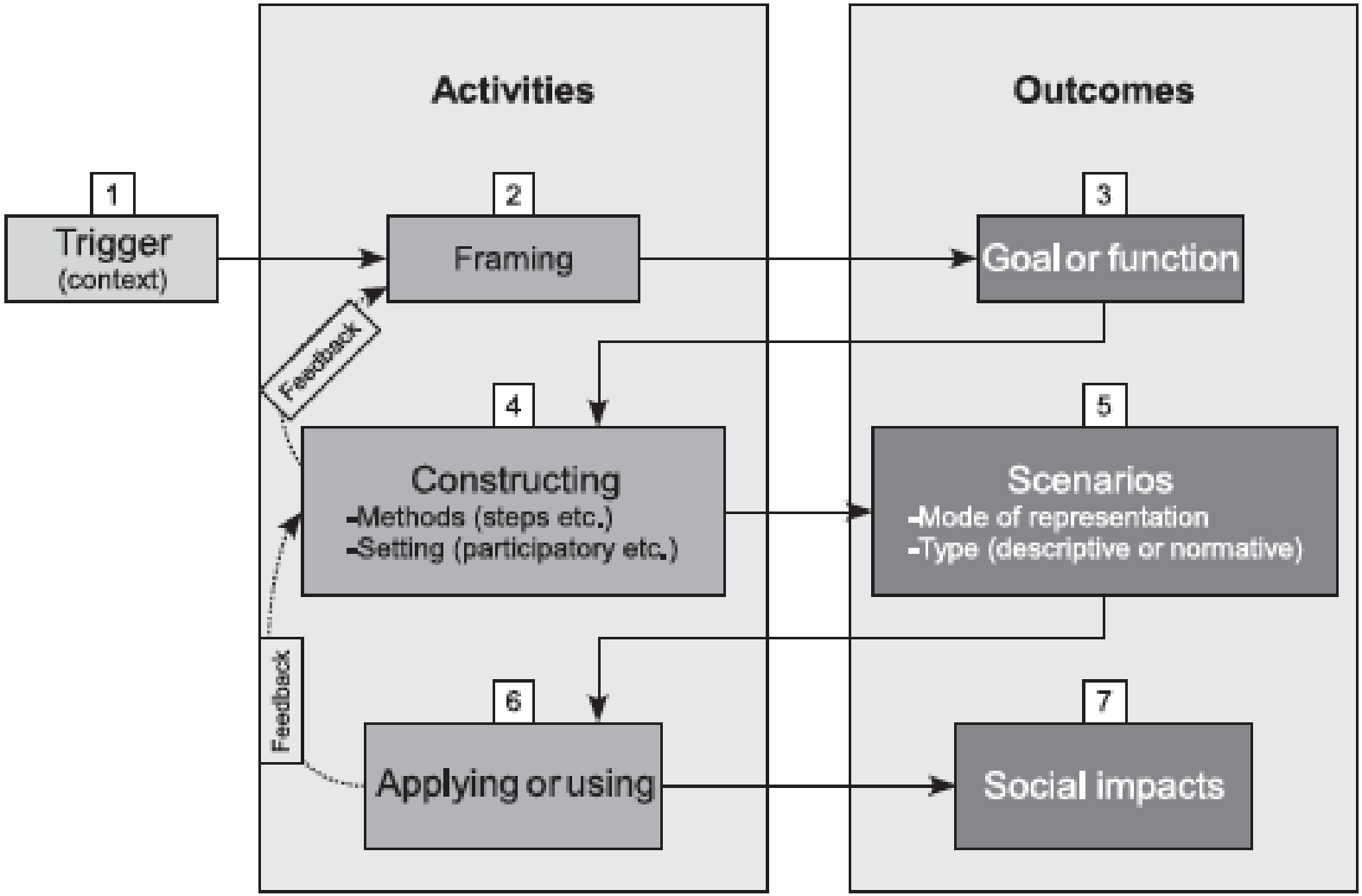
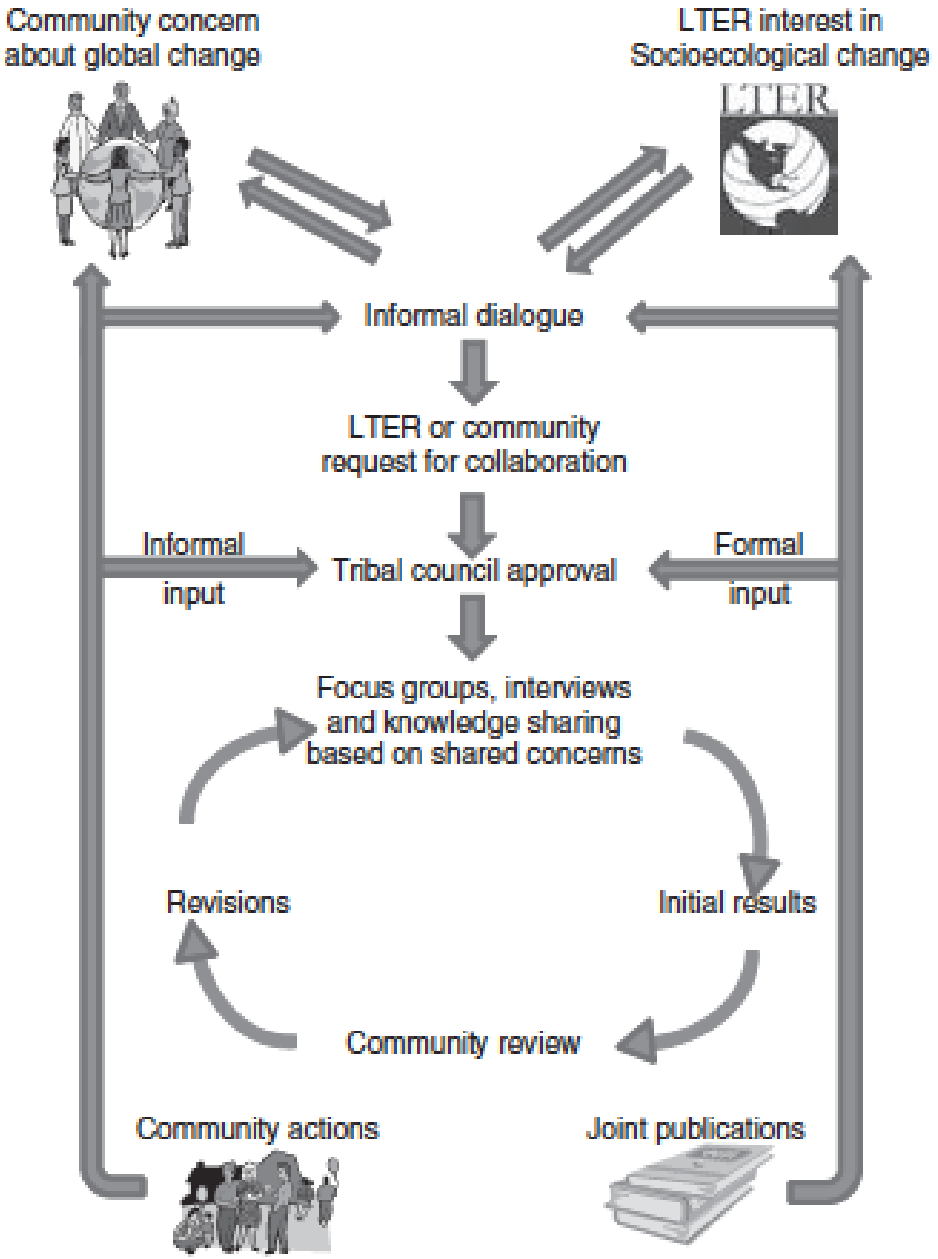
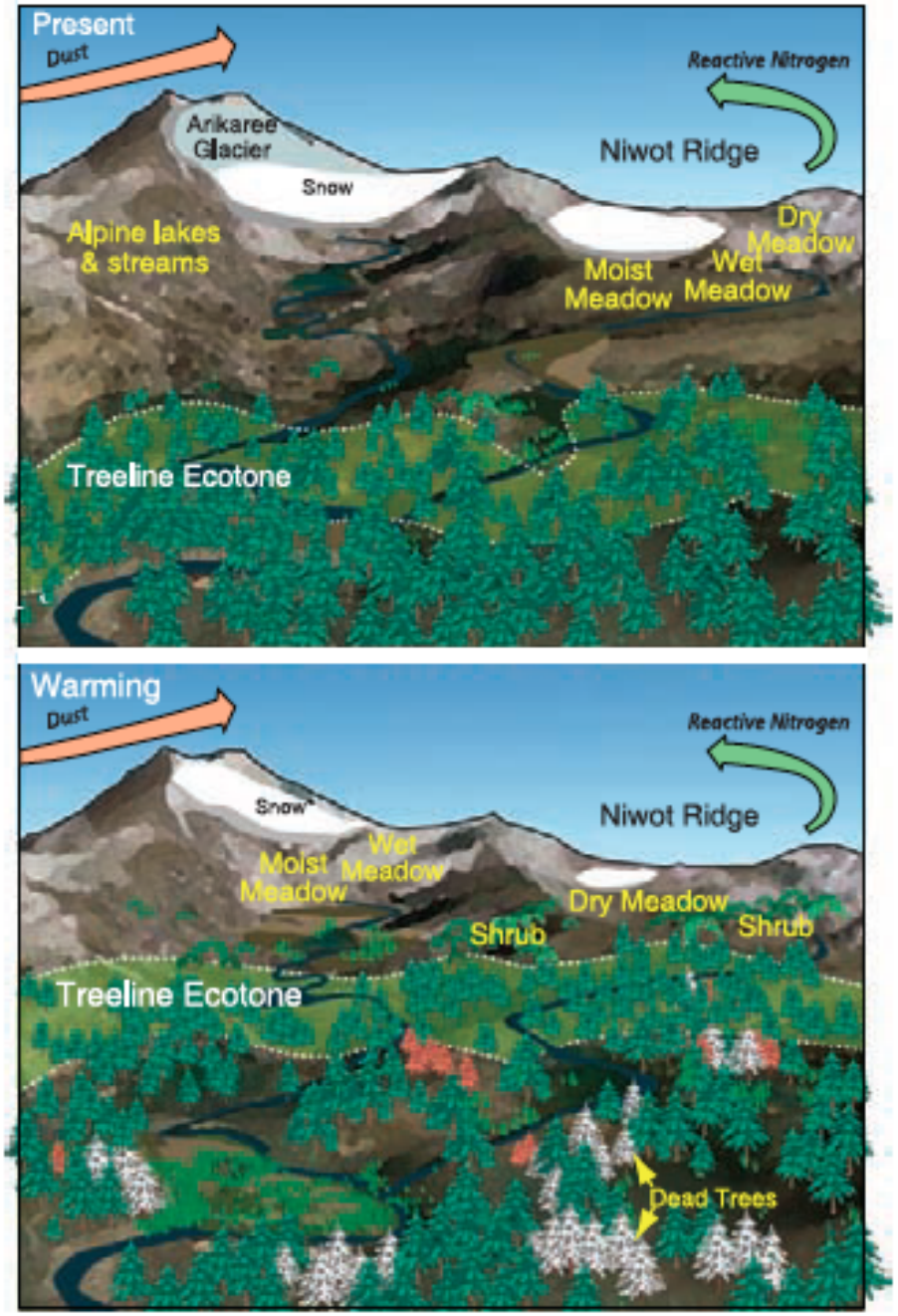


Figure 1. Analytical framework for evaluating diverse forms of scenario studies conducted throughout the US Long Term Ecological Research Network.

Thompson et al. 2012



Driscoll et al. 2012 BioScience



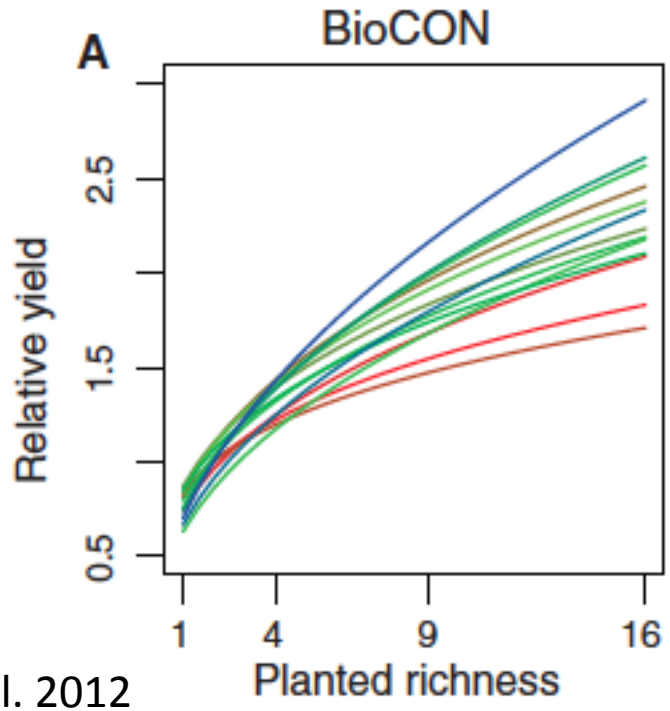
Robertson et al. 2012 BioScience

Long-term global change experiments

Knapp et al. 2012 BioScience

Experiments to explore responses

- Large-scale experiments are risky
  - e.g., global climate change
- Ecosystem-scale experiments identify plausible outcomes
  - Lake eutrophication
  - Fire-grazing interactions
  - Climate manipulations
  - Forest-harvest treatments

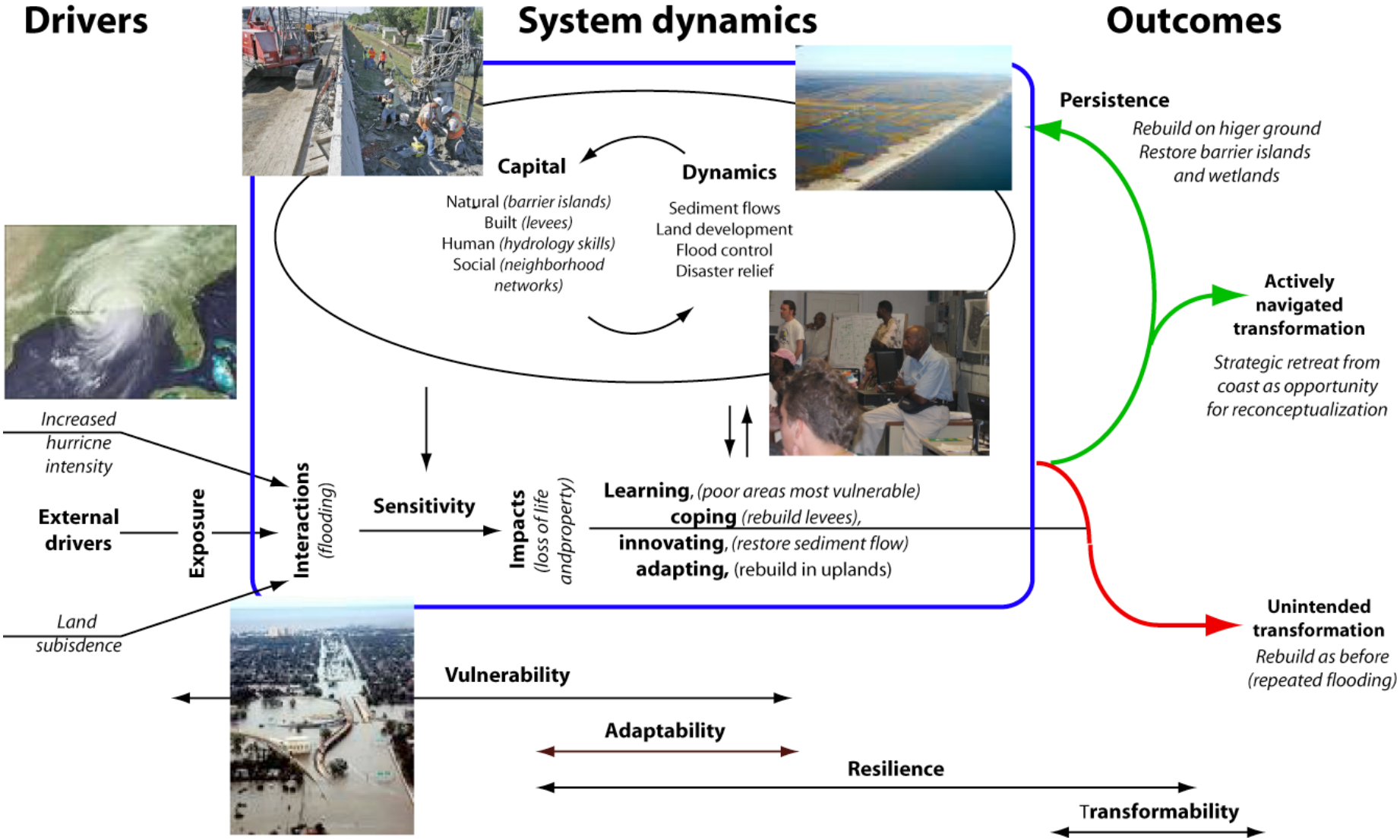


Reich et al. 2012

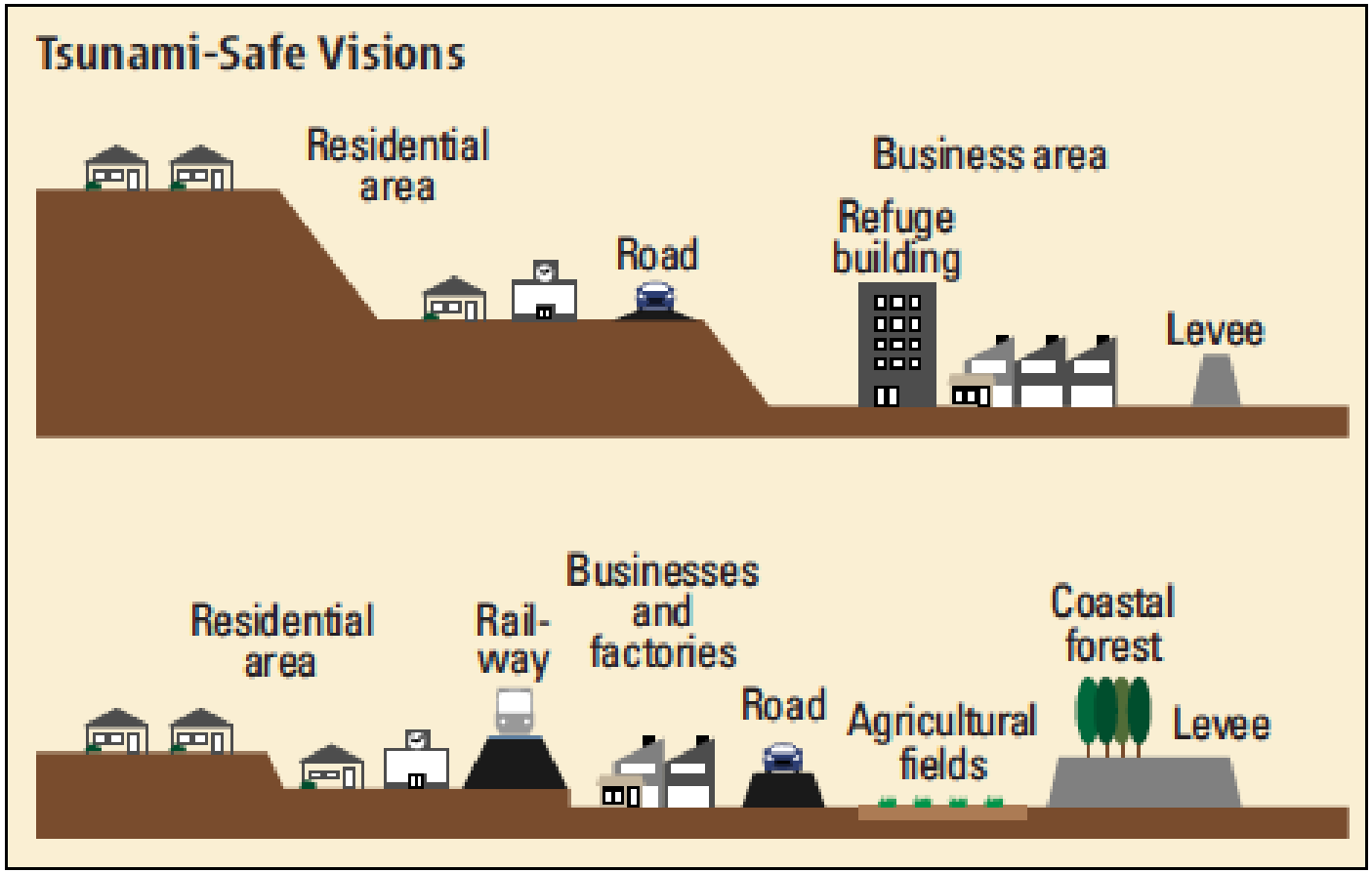
Modeling to extend results

- Modeling identifies plausible outcomes where experimentation is not feasible or insufficient
  - Climate feedbacks from thawing permafrost
  - Linking LIDET to carbon storage
  - Drought effects on net ecosystem exchange

Systems approach to Hurricane Katrina: Choosing whether to transform



Systems approach to the Japan tsunami: Choosing whether to transform



Common sense. Moving homes, schools, and hospitals to higher ground (*top*) or behind a series of barriers (*bottom*) will make cities more tsunami-resistant.

Broad strategy of Earth Stewardship

- Build the science
  - Engage multiple disciplines and practitioners
  - Define the science needed
    - science of people and nature**
  - Identify scenarios of change and intervention points
- Apply the science to sustainability issues
  - Engage key stakeholders
  - Communicate the science needed to support a social movement

The Arts

Earth Stewardship: The Argus Initiative

"…potential solutions should consider multiple problems and sectors simultaneously through institutions at many scales rather than addressing each problem separately….."

Chapin et al. 2011 Ecosphere

Conclusions

- We can substantially improve the relationship between society and the biosphere
- Stewardship provides guidelines for sustainability in times of rapid change
- LTER has the temporal perspective and tradition of systems thinking to inform stewardship
- LTER can provide the observations, experiments, and modeling that inform decisions about how to shape the future of a rapidly changing planet