Sustainability

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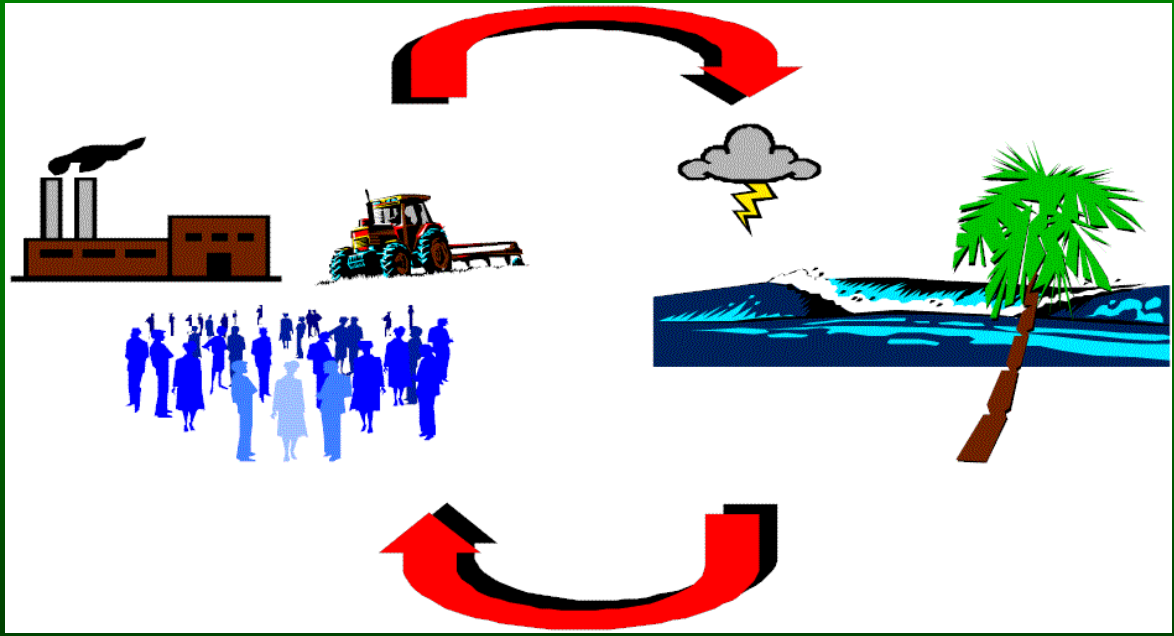
Sustainability: What Is It?

- Standard context: climate/environment
  - Sustainable development
  - Sustainable environment
  - Sustainable energy
  - Sustainable planet
- All the ideas get to
  - Interplay of natural and social systems
  - Interplay of local and global scales
- Complex systems

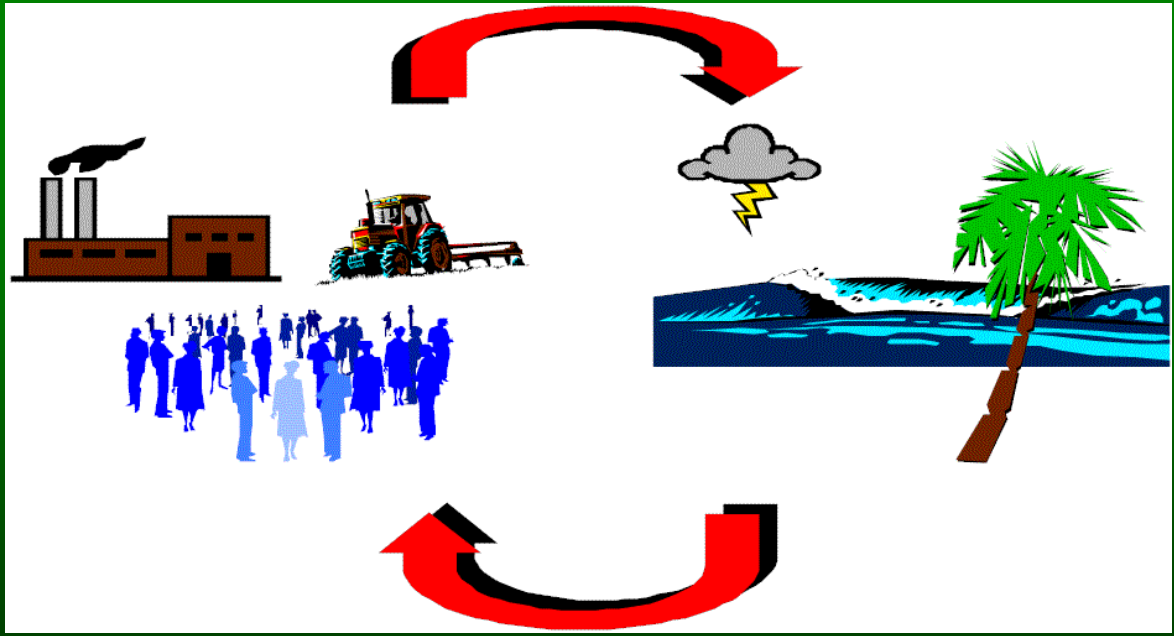
As human populations increase....

- Their impacts on many natural systems become more pronounced.
- Preservation of environmental quality will require conscious human action.



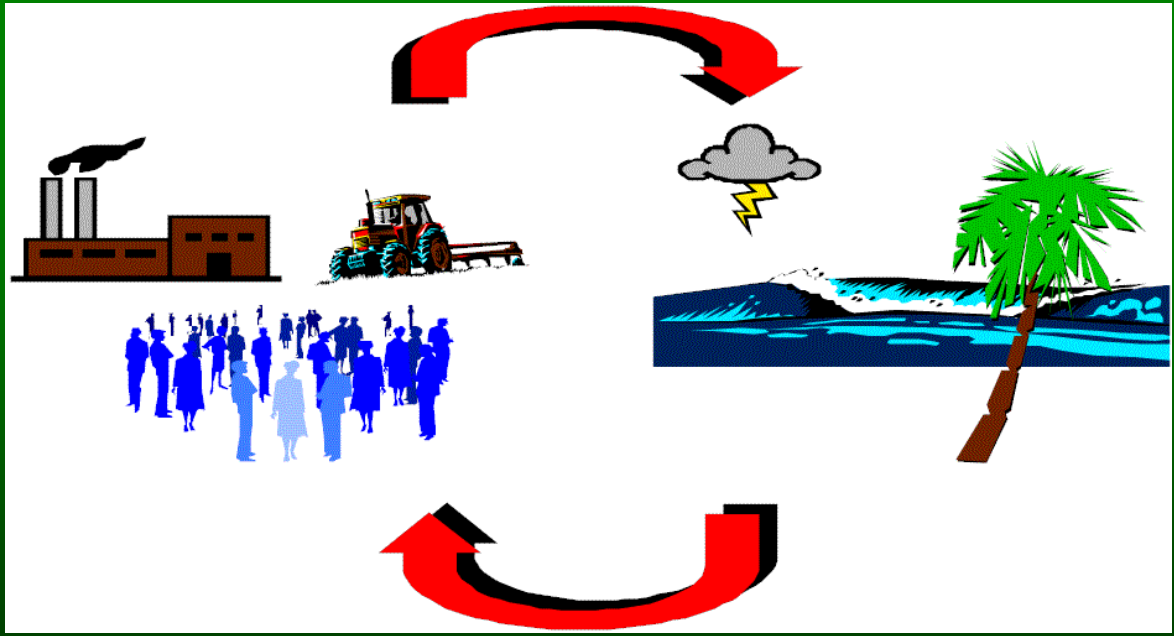
And at the same time …

- Ecosystems provide critical services to sustain human populations.
- Degradation of ecosystems will change human and social behaviors.



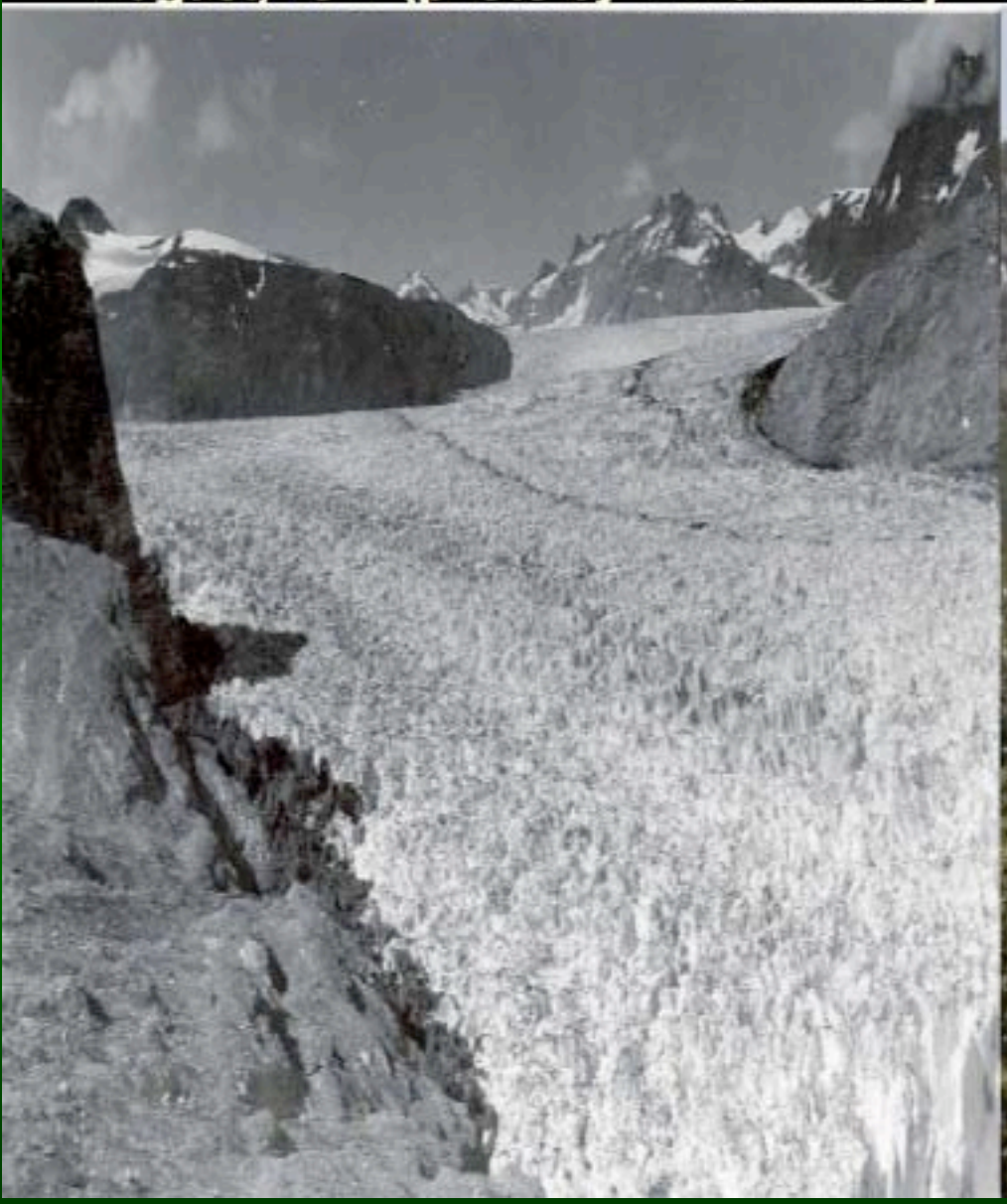
And one more critical factor...

- Local/regional actions and ecosystems have impact on global outcomes.
- Global influences constrain local options for action.

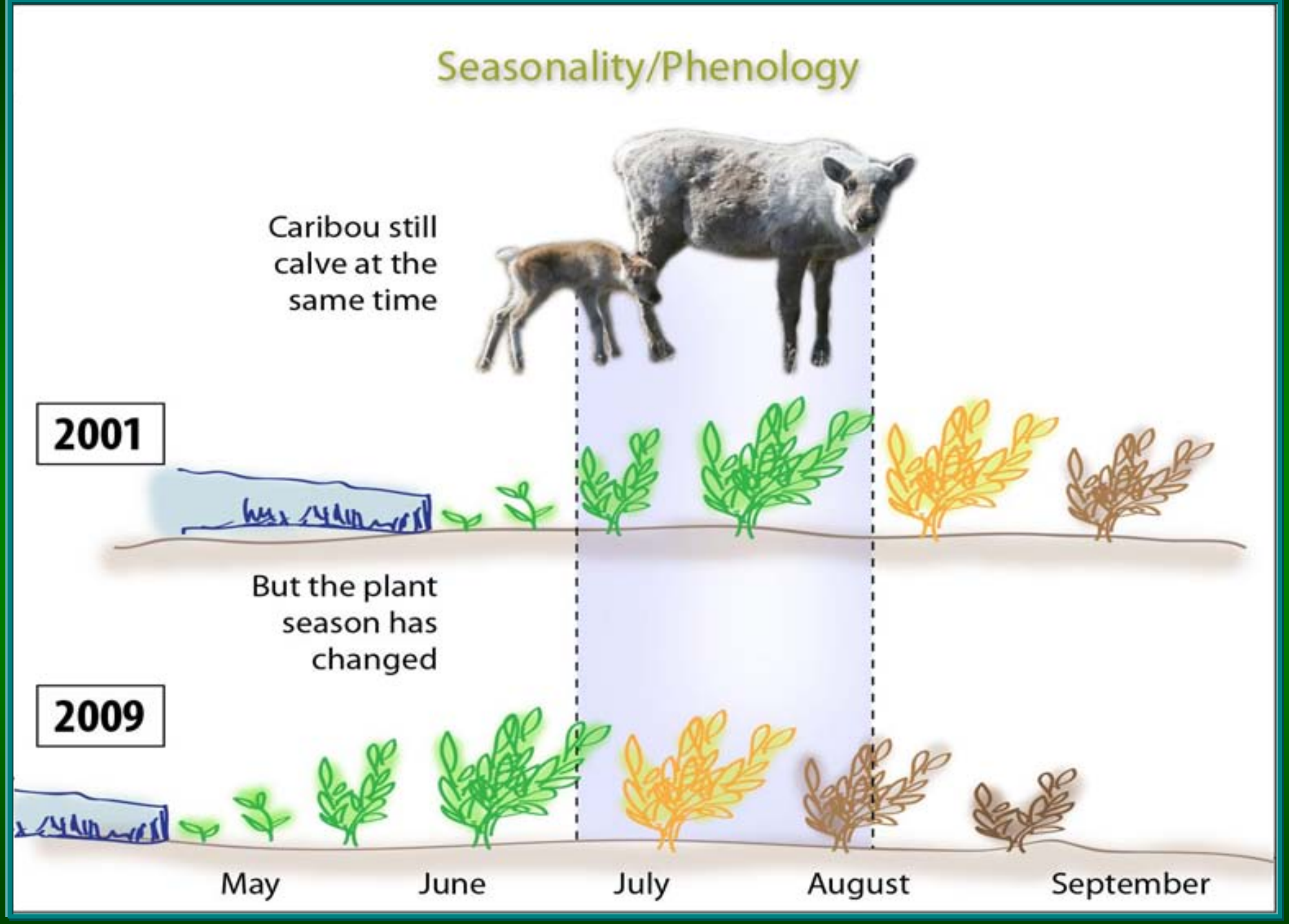


Muir Glacier, SE Alaska

August, 1941 (photo by William Field)



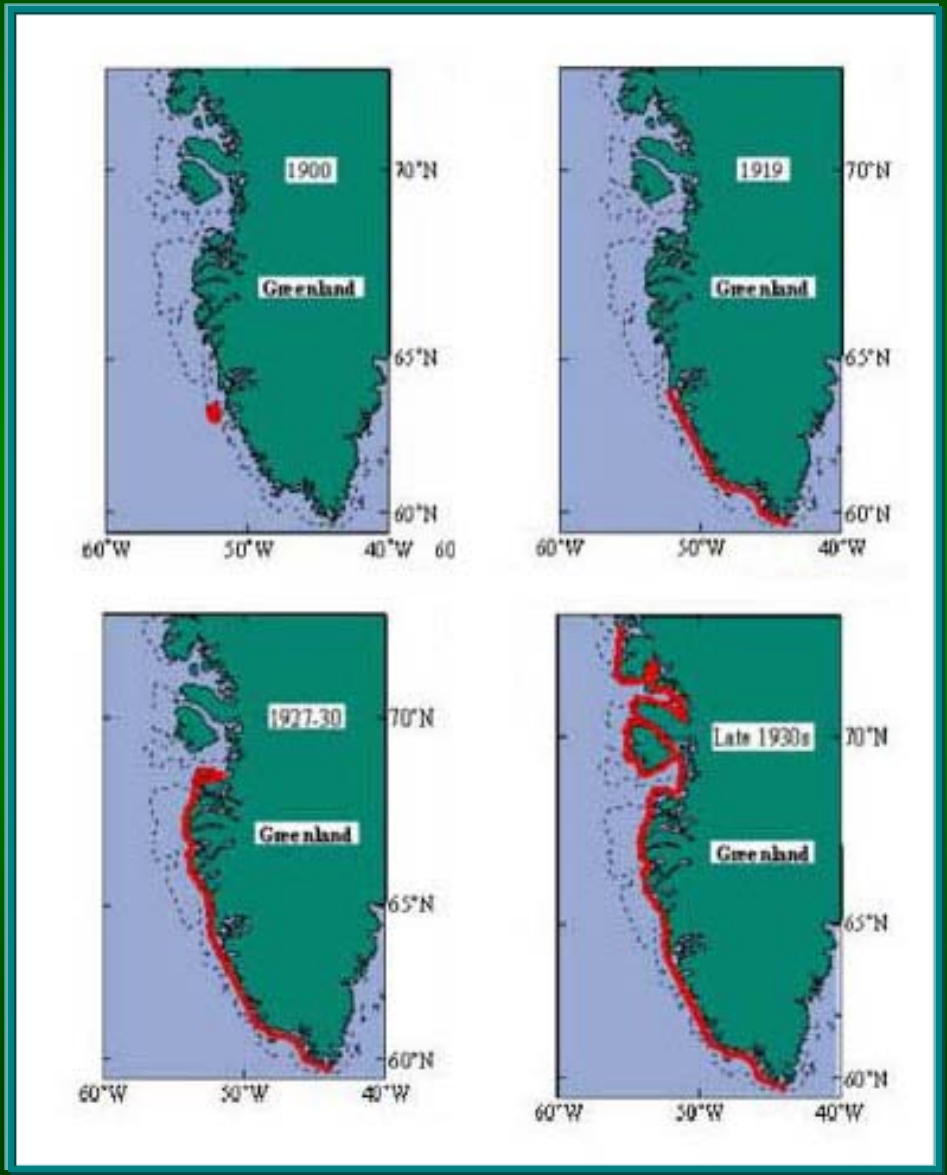
August, 2004 (photo by Bruce Molnia)



Collaborators: E. Post, M. Forchhammer, S. Rysgaard

Zina Deretsky / National Science Foundation

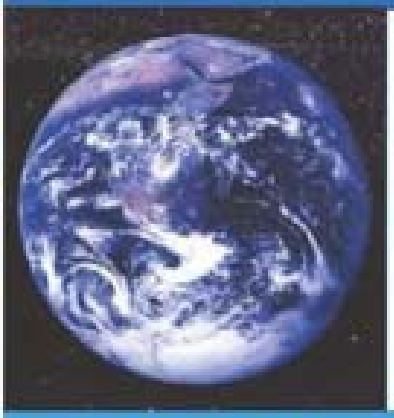
Cod Fisheries, 1900-1940

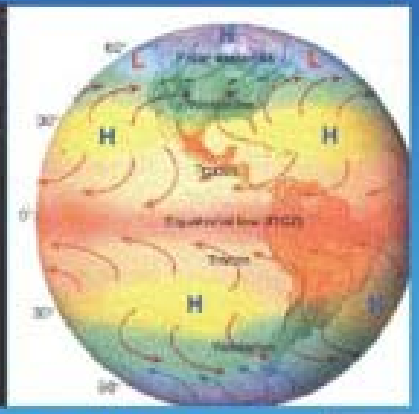


From Holland et. al., *Nature Geosciences,* Vol. 1, October 2008

The Earth is a system of systems

what happens in one part will affect another





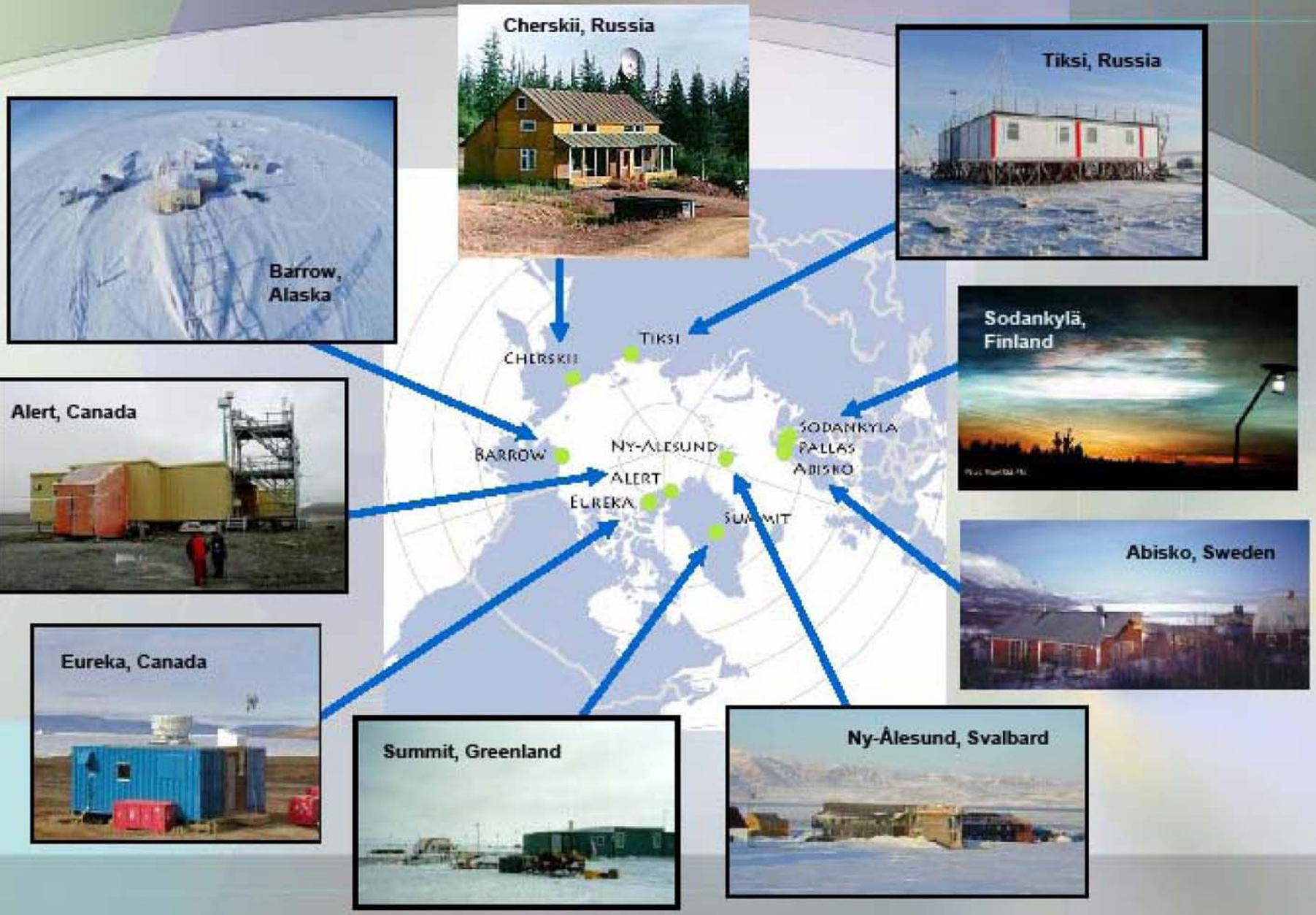
Atmospheric circulation

global ocean circulation

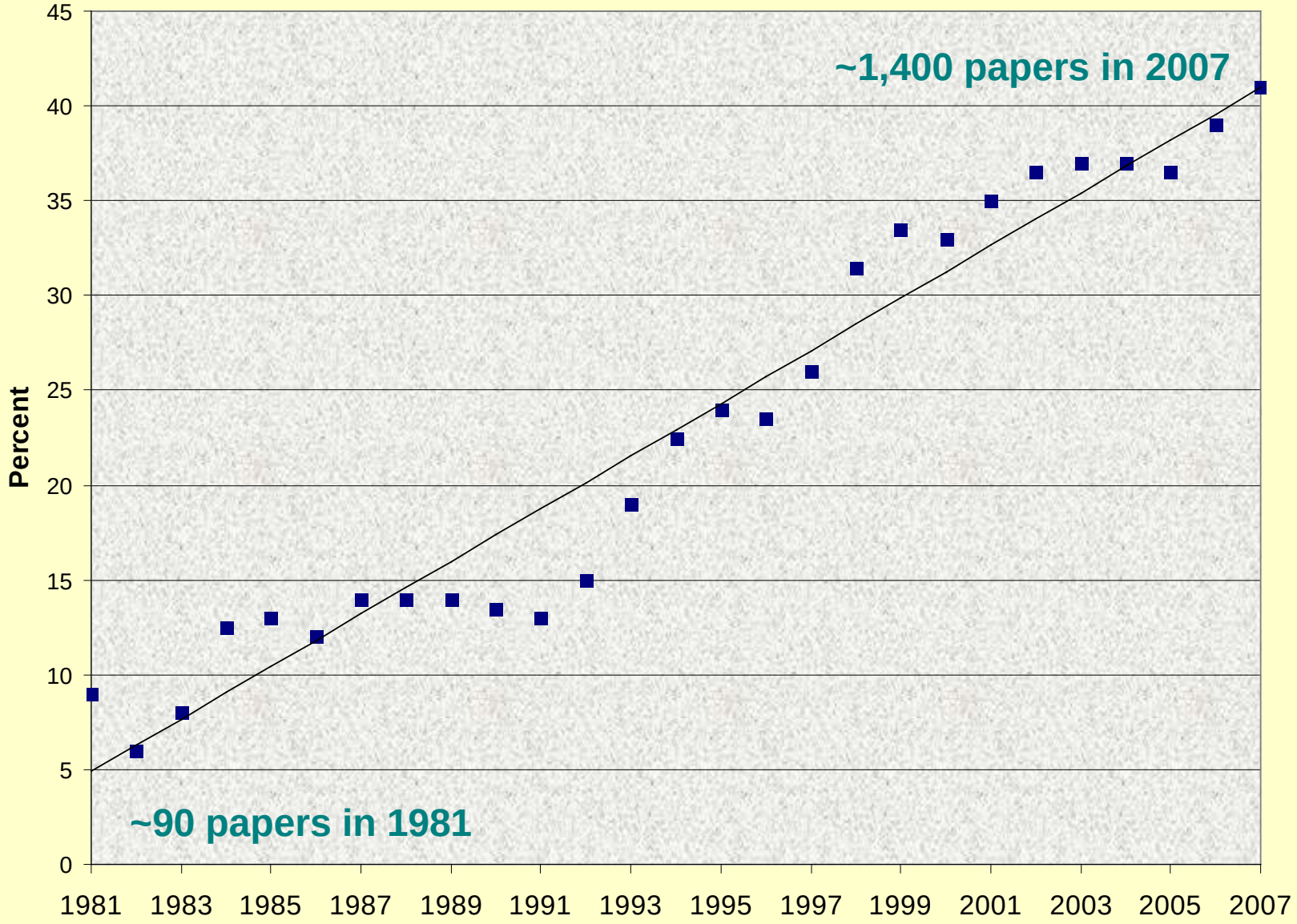
How Do We Respond?

- Observations
- Models
- International Collaboration
- Interdisciplinary Collaboration

Atmospheric Arctic Observing Sites

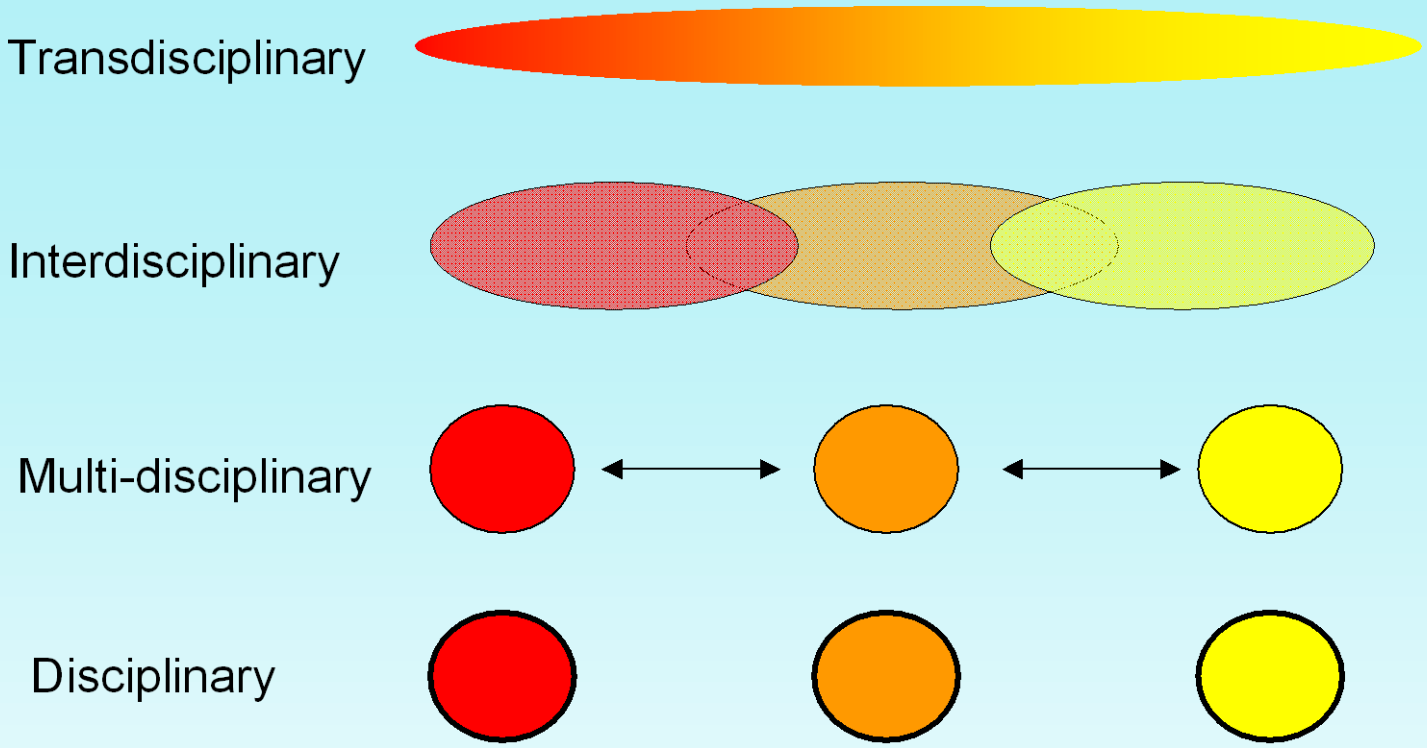


International coauthorship, polar research papers
(Aksnes and Hessen, 2009)



Why Beyond Disciplines?

- Problems lie at and beyond the margins of existing disciplines.
- Phenomena being studied may interact in complex wide-ranging ways.
- “Real world" problems don’t recognize disciplinary boundaries.
- Individual researchers who remain within their disciplines may be limited in the questions they ask or the approaches they use.



The Sciences In Transition

Different Kinds of Research

Erich Jansch distinguished as follows:

- **Multidisciplinary research** -- the coming together of scholars from different fields in ways that maintained the autonomy of different disciplines and that would not lead to changes in existing disciplinary and theoretical structures.
- **Interdisciplinary research** -- scholars working together to develop a uniform, disciplinary-transcending terminology or common methodology, cooperating within a common framework.

NSF and Interdisciplinary Environmental Research

- Traditional mechanisms include joint review of a proposal by multiple programs.
- Perspectives and cultures of programs and the communities they serve strongly influence interactions.

- Programs that are good "mixers"
  - Ecosystems studies
  - Ecological biology
  - Climate dynamics
  - Hydrological sciences
  - Decision, risk, and management sciences
  - Geography and spatial sciences
- Even these programs worry about how to sustain "the core" while they explore ways to support work in "the periphery."

Early NSF Efforts

- Research Training Groups
  - Integrated Graduate Education and Research Training (IGERT) awards
- Conservation Biology competitions
- Global change programs and competitions
  - Arctic System Science
  - Ecological Rates of Change
  - Human Dimensions of Global Change
  - Methods and Models for Integrated Assessment

- NSF-EPA Environmental Partnership
  - Water and Watersheds
  - Technology for a Sustainable Environment
- Intellectual expansion of the LTER effort
  - Urban LTERs
    - Baltimore
    - Phoenix
  - Adoption of socioecological research as a major emphasis

Biocomplexity in the Environment

- Biocomplexity "megacompetition" in 2000 led to establishment of a panel bringing together ecologists, social and behavioral scientists, and kindred spirits.
- "Dynamics of Coupled Natural and Human Systems" emerged in 2001 as one of the BE special competitions.
  - Early flagging of land-use/land-cover change, ecosystem services, and resilience/vulnerability/sustainability

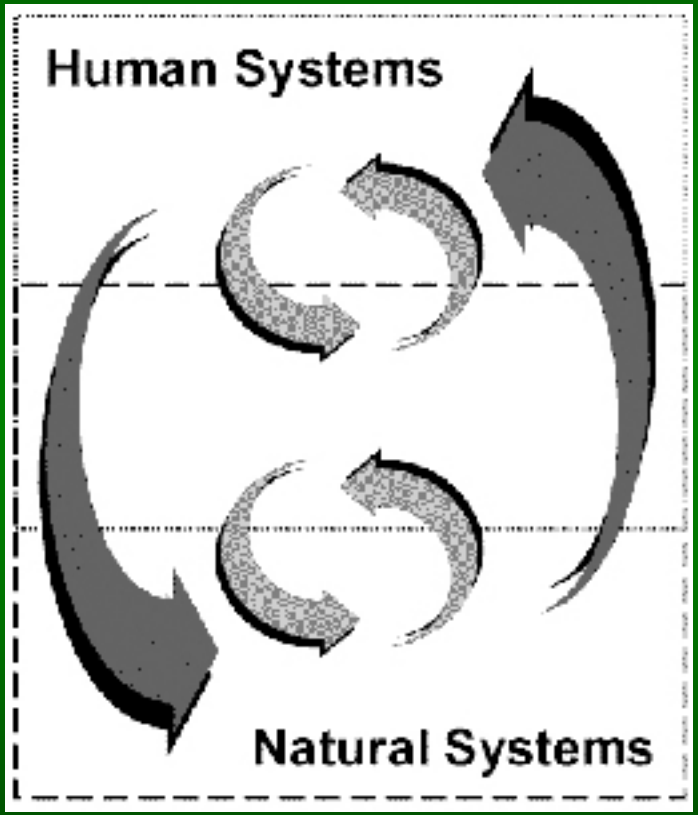
CNH Core from 2001 to the Present

Take key words in the competition title very seriously:

Dynamics of

Coupled

Natural <u>and</u> Human Systems



The Transition of CNH

- End of the BE special competitions in 2005
- BIO, GEO, and SBE established a new standing, multidirectorate program in 2006.
- Transitional competition in 2007
- Formal standing program with fixed deadlines and a "permanent" solicitation operated in 2008 and 2009.

Future Possibilities for CNH

- Possible modifications for the near future
  - Formal call for Research Coordination Network proposals
  - Potential for some funding of "developmental awards" for prospective teams
- Longer-term possibilities
  - CNH becomes more like a "normal" program with supplements, joint review, etc.
  - Conversion of CNH to be an "umbrella program" that overseas the current competition and a number of more focused competitions.

Recent Complementary Efforts

- Human and Social Dynamics (HSD) priority area
  - Functioned from 2004 to 2008
  - Based in SBE but involving all units
  - Large share of awards were environmental
  - Some legacy funding continues to promote interdisciplinary research
- Decision Making Under Uncertainty (DMUU) related to climate vulnerability and change
  - 5 centers/teams funded from 2004 to 2008
  - Follow-up competition now in final stages

Emerging Opportunities

- Matching funds to make jointly funded proposals more attractive
  - Environment, Society, and Economics (ESE) "Dear Colleague Letter" from GEO and SBE
- Urban Long-Term Research Area Exploratory Awards (ULTRA-Ex)
  - Joint effort by US Forest Service and NSF (BIO, SBE)
  - May foreshadow a major ULTRA competition in future
- Communicating Hurricane Information
  - Joint with NOAA
- Disaster Resilience in Rural Communities
  - Joint with USDA

The Broader Challenges for Funding Interdisciplinary Research

- Identifying the motivation for conducting interdisciplinary research
  - Broader impacts (especially societal significance and practical utility)
  - Intellectual merit (fundamental research that will enhance theory and develop new tools with many uses possible in the future; potentially transformative)

- Organizing research programs
  - "Bottom-up" vs. "top-down" approaches

    Let 1,000 flowers bloom or impose strict, predetermined research agendas
  - Hybrid approaches often are used.
  - A special challenge is to engage the broader community in the goal-shaping process.
  - "Campaigns" have been successful in some realms, but they require individuals to operate within a broader structure.

Sustaining Opportunity

- Challenges of sustaining support when programs do not match up well with the organizational structure of the funder(s)
  - Sustained, consistent support is required to avoid the problem of "moving or vanishing targets."
  - "Champions" play a crucial role, but efforts need to be able to outlast changes in personnel.
  - Funders and researchers both need a collective sense of "ownership."

Next Steps for NSF

- Climate Research Investment (FY10 Budget Request)
  - Integrated regional spatial and decadal models of climate, energy, ecosystems
  - Ocean acidification and changing carbon fluxes
  - Impacts on natural and engineered hydrological systems
  - Innovative adaptation and mitigation methods
  - Long-term studies of ecosystem resilience in areas of change or testing mitigation methods
  - Roles and responses of social systems

Sustaining Collaborations: Balancing Costs and Benefits

- Costs of collaboration
  - Need to find common theoretical foundations
  - Need to find common language
  - Need to come to agreement regarding what constitutes production of knowledge
  - Requires added time up front
- Benefits of collaboration
  - Ability to deal effectively with practical problems
  - Enhanced interactions with practitioners and stakeholders
  - Enhanced interactions with scholars from other fields

Special Issues Related to Interdisciplinary Collaborations with Social Scientists

- Be aware of multiple approaches to conducting research.
  - Qualitative vs. quantitative methods

    Mixed methods may also be used.
  - Validity of a "scientific approach" can be questioned.

    Critical question may be "What is the perspective and the possible influence of the researcher on the research?"

- Modeling approaches will vary.
  - "Stochastic" approaches generally are favored over "deterministic" approaches.
  - Modeling seeks to enhance understanding.
  - Improving predictions is viewed with suspicion.
- Theoretical motivations are critical.
  - Don't assume the social science is the study of "policy impacts" or "educational outreach.
  - Understanding why people (or organizations) act as they do is as critical as understanding the dynamics of the natural systems you focus on.

- Protection of human subjects poses special challenges.
  - IRBs must approve research protocols so that people are protected.
  - Protection is not only against physical harm but also protection from possible reactions by other people.
  - Preservation of privacy and confidentiality often are paramount.

    Integrating geospatial data can be problematic.
  - IRBs often require full specification of protocols before research is undertaken.

Despite the Challenges....

- The need for research that integrates insights regarding people, natural systems, and their interactions is great.
- The opportunities are enormous.
- Examples of successful projects abound.

Some Examples

- Mosquito governance under climate change
- Geographic analysis finds higher flood levels associated with levees
- Adoption of renewable energy technologies
- A green competitive advantage
- Forest cover influences real estate prices in metropolitan areas
- Size and local management of community forests enhances carbon storage and promotion of local residents' livelihoods

Sustainable Competitive Research Environments

- “Ecology of innovation”
  - Analogy with complex natural ecosystems
  - Complex social system with numerous parts
- For EPSCoR, components include
  - State
  - Academic institutions
    - Faculty
    - Students
    - Institutional profiles
  - K-12 schools
  - Private sector
- Connections, interactions are critical