INLAND CLIMATE CHANGE: SOCIAL AND ECOLOGICAL SENSITIVITIES AND RESPONSES

Climate change will profoundly affect socio-ecological systems, particularly those built around terrestrial ecosystems where climate is a major driver of ecological processes and ecosystem services. While socio-ecological systems will vary in their responses to climate change, the relative sensitivities of different systems, and the mechanistic basis and consequences of these differential sensitivities, are largely unknown. At present, *our ability to predict social and ecological consequences of potential climate changes in different systems is constrained by a lack of fundamental data derived from common conceptual frameworks and approaches*. The LTER network is uniquely positioned to meet this critical need with a coordinated network-level approach integrating site-based and cross-site research, manipulative and natural gradient experiments, ecological and sociological approaches, and explicitly incorporating graduate student training. Accordingly, **we propose a continental-scale research program to assess how the major socio-ecological systems of the U.S. differ in their sensitivities and responses to human-caused climate change.**

Our approach incorporates: (1) experimental manipulation of climate drivers at specific LTER sites, (2) comparative analyses of natural variations in responses of socio-ecological systems to climate *across time*, and (3) natural gradient experiments made possible by analyzing variation *across LTER sites and their broader regions*. Some key issues we will address are: How will socio-ecological systems of the U.S. respond to climate change, and in particular to changes in soil water availability? How will these responses vary across both space and time? How are ecosystem stresses mitigated or exacerbated -or both- by real-time human expectations and responses? Which ecosystems, or components of ecosystems, are more or less resilient, and what attributes can be used to forecast or mitigate this differential sensitivity? For social systems, which are most and least vulnerable to climate-driven changes in ecosystem services, and which show the greatest promise for mitigation or enhanced adaptive potential?

Approach

We will establish a coordinated, continental-scale climate change experiment at an array of LTER sites, coupled with social and economic studies to assess relative impacts of climate change on ecological and social systems across a wide range of climates and ecological and social system types. This approach will address the factors regulating the sensitivities of social and ecological systems to climate change, provide training for the next generation of scientists in conducting cross-site, synthetic, interdisciplinary research, and support for outreach and education activities that can inform the public and policy makers regarding critical climate change issues at local to national scales.

Two related overarching questions are: What determines the differential sensitivities of ecological systems to climate change; and what determines the sensitivities of social systems to the ecological impacts of climate change and how their responses feed back on ecosystems? More specific questions follow:

1. How do changes in soil water availability influence ecosystem processes and in particular water-use efficiencies and rainfall use efficiencies; species composition; connectivity among landscape elements; and ecosystem services (e.g., C sequestration, soil conservation)?
2. How are humans currently responding to these changes — and/or to anticipated changes in the future? What are the underlying reasons for these responses, and what are the emergent effects?
3. How do changes in key ecosystem services (e.g., yields from working lands, subsistence, recreation, and cultural services), mediated by changes in soil water availability, affect local and regional economies, land-use and policy decisions, and human migration patterns?
4. How do changes in ecosystem services, and human responses to these changes, feed back to affect ecosystem functioning and management decisions?

We propose core funding to support the deployment of a common experiment across LTER sites that span multiple ecosystem types, natural climatic gradients, and social systems. Core funding will also support social science teams, synthesis/modeling activities, and cyberinfrastructure / information management components. Funds will be allocated for bringing teams from all sites together for synthesis activities.

The responses of terrestrial ecosystems to climate variability are tightly linked to changes in dynamics of soil water availability, making this a key integrative variable for assessing responses to climate change and other global change drivers (e.g., elevated CO_2). For the common experiment, passive rain-out shelters and paired rain-on plots will be deployed in a gradient design to provide soil water availability at 5 levels (ambient, +/- 30% and +/- 60%) across a range of ecosystem types. In addition, funds will be allocated for additional treatments such as warming in shorter-statured ecosystems where this is logistically possible. A common set of response variables will be measured at all sites, including temporal and spatial dynamics of soil moisture by depth; soil temperature; soil nutrient availability and C flux; decomposition, soil biota; potential leaching; and changes in root biomass. Aboveground responses will include microclimate; plant community composition, productivity and phenology; plant ecophysiology and gas exchange; and herbivore damage.

Comparative social science research will focus on "natural experiments" made possible by variations in social systems around the experimental sites and in other comparative locations. These studies will be based on county-based yield data; per capita income in rural and urban counties; population densities/ migration; proportion of economic activity from different sectors; perceptions regarding impact of climate change; and land-use decisions based on perceptions of climate change. We focus on four kinds of data: (1) historical data, from aerial photographs and secondary records, to begin drawing "long-term" conclusions relatively quickly; (2) quantitative survey data and qualitative ethnographic data, collected from populations and communities around experimental sites and selected comparative locations; (3) systematic first-hand or observational data, collected using comparable research protocols across sites; and (4) publicly available or secondary data, ranging from sociodemographic or census-type data, to local and regional economic and land-use data, to information on water use policies and trends.

The project will provide site-specific to continental-scale information, models and publications on responses to climate change, a robust database on relative sensitivities of multiple socio-ecological systems that will inform predictive social and ecological modeling of climate change impacts at multiple scales, a cadre of new scientists trained in synthetic, interdisciplinary research, and informed policy and public perceptions/understanding of critical climate change issues.

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Initiating LTER Participants
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Potential Partners
NSF, DOE, EPA, NOAA, USDA, USFS, USGS, TNC

Cyberinfrastructure Needs
The project requires an information manager and cyberinfrastructure to support (1) collection, storage and dissemination of data from the common experiment, and (2) discovery, collection and dissemination of social, demographic and economic data for regional social systems around and across sites. Relational capabilities across datasets are required for project synthesis and modeling efforts.

Potential Budget
$1.6M/yr over 5 years to support 8-9 graduate students, undergraduate students, synthesis/modeling activities, an Information Manager, modest PI support, travel/meetings, experimental infrastructure, materials & supplies, and outreach and broader impact activities.