11-2009

Coastal Zone Climate Change: LTER Network Synthesis Prospectus

Long Term Ecological Research Network

COASTAL ZONE CLIMATE CHANGE: UNDERSTANDING AND ADAPTATION

There has been a clear awakening to the fact that climate change is underway. Lying at the interface of continental and oceanic realms, coastal systems can be expected to be especially impacted, experiencing the effects of climate change from both the land and the sea. With more than 50% of the U.S. population living in coastal counties, these changes will play out in coastal communities and economies. The LTER provides a network of coastal sites that differ in their biophysical vulnerability to various aspects of climate change, with some being more affected by sea level rise and storm surge (e.g. VCR, FCE); others by acidification (e.g. MCR, CCE); changes in temperature and loss of sea ice (e.g. PAL); or changes in freshwater inflow (e.g. PIE, GCE). These sites will also likely show gradients in human vulnerability, with differences attributable not only to their coastal population density and demographic composition (e.g. FCE vs. VCR) but also in the location and resilience of their built infrastructure (e.g. BES vs. SBC). This range of potential vulnerability positions the LTER network to be able to examine climate change and to better understand the factors controlling human and natural system vulnerability and response. The overarching question we seek to address is: **How do human and natural templates interact to affect vulnerability to climate change in coastal systems?**

Science to understand and anticipate the effects of climate change, to assess vulnerabilities of natural and human elements of coastal systems, and to adapt to or mitigate the effects of changes is prompting new efforts to integrate across academic disciplines and to create partnerships among academic, public and governmental constituents. Following the theoretical framework of the ISSE, we can ask the following types of questions of these coupled socio-ecological systems: How do the presses and pulses associated with climate change (temperature, pH, sea level precipitation, runoff, solar radiation, wind and wave climates, and salinity) affect the structure and function of coastal ecosystems and what attributes affect their vulnerability?; How do climate-induced changes in coastal systems affect critical ecosystem services, such as carbon sequestration, wildlife habitat, food web support and coastal fisheries, and storm protection?; What attributes of human systems (e.g. built infrastructure, working waterfronts, land use, demographics) influence vulnerability to climatic presses and pulses, and how do these interact with changes in ecosystem services to prompt responses of adaptation and mitigation? How would mitigation and adaptation strategies (e.g., coastal engineering, reductions in greenhouse gases) feed back to affect climate drivers and vulnerability of coastal systems?

Approach

We propose to take advantage of the distribution of coastal LTER sites and their differing socio-ecological characteristics. We will use a multifaceted approach including monitoring to assess status and trends; observations across gradients to infer controls on vulnerability, resilience, response and adaptation of human and natural systems; manipulative experiments to test key control mechanisms; and scenario development and modeling to assess the consequences and interactions of climate change, continuing coastal development and potential adaptation strategies on ecosystem services.

Our specific objectives are to:

1. Evaluate the pulses and presses of climate change to determine the most important drivers at each site and how they interact to impact human and natural systems. This will include observations of temperature, pH, sea level, precipitation, runoff, solar radiation, wind and wave climates, and salinity evaluated to understand deterministic and stochastic trends and their interactions.
2. Characterize the vulnerability of the natural template of each site to climate change based on factors such as saturation state of calcium carbonate, topography / bathymetry, tide and wave climate, geomorphology, and habitat distribution. This will involve accessing high-resolution, spatial data (such as LIDAR and other imagery) to map elevation and

habitat distribution and characteristics, and assessments of factors such as sediment supply, calcification of shells, and the structure of marine food webs.

3. Characterize the vulnerability of the human template at each site to climate change based on parcel level analysis of property characteristics, population, demographics, fishing and mariculture industries, cultural attitudes, transportation and utility infrastructure, property value insurance maps, GDP and governance structure. Here we might expect differences in vulnerability to climate change across the LTER network because of prior adaptation in regions already experiencing severe aspects of climate change, e.g., hurricanes.
4. Assess the recent human response to climate change at each site. This would include information on adaptation and mitigation efforts in each community such as revised building codes, shoreline engineering, use of artificial reefs, flood management planning, as well as general awareness of climate change. What knowledge triggers an adaptation response?
5. Evaluate expected future changes in both the natural and human template. This will require downscaling national and regional predictions to make them appropriate for management units, as well as predictions of population growth and shifts in natural resource dependencies.
6. Develop scenarios to assess future vulnerability to climate change in relation to potential adaptive or mitigation responses. This will be accomplished by combining socio-economic and physical models to evaluate the effects of changes in permitting, zoning, natural area preservation, or other policy scenarios in the context of projected climate change. This will be important at local, national and global scales. We will draw on existing multi-site LTER efforts to produce such scenarios, to provide a basis for a suite of scenarios tailored to this particular application. In the process, we will contribute to an emerging multi-site LTER effort to advance knowledge on the general conditions under which a coastal coupled human-environment system may or may not become vulnerable to the effects of climate and other relevant changes.

Cyberinfrastructural Needs
We will have extensive needs for Embedded Cyber-Infrastructure and protocols for managing instrumentation and sensor arrays. Support will be needed to link the wide variety of models that will be employed and to assimilate remote sensing data and to develop effective visualizations for conveying long-term forecasts of climate change as well as displaying landscape change scenarios for interpretation by scientists, community leaders, educators, and the general public..

Lead Coordinators
Charles Hopkinson, Merryl Alber, Evelyn Gaiser, Colin Polsky

Initiating LTER Participants
BES, CCE, FCE, GCE, MCR, PAL, PIE, SBC and VCR.

Potential Partners
NOAA (including Sea Grant, NMFS, CSC, NOS, NEERS), USGS, NASA, ONR USACE, NPS and EPA. We expect that some of these partners will provide modeling data (e.g. USGS, NOAA) while others will help test model predictions (e.g. NEERS) or provide outreach to local communities (e.g. Sea Grant). We will also involve state and local governments and non-governmental agencies, in light of the importance of this research to policy decisions.

Potential Budget
$1.6M/yr for 5 years: Salary (support for students, post-docs, IT support, and PIs to collect data on climate drivers, map biophysical and human templates, develop scenarios, run models 65%); Travel (site and system-wide workshops, scientific meetings, 10%); and supplies (LIDAR, aerial photography, sample analysis, 25%).

TO: Executive Board and Phil Robertson

FROM: The Climate Vulnerability Working Group (Merryl Alber (GCE), Chuck Hopkinson (PIE), Evelyn Gaiser (FCE), Colin Polsky (PIE) and Kirstin Dow (BES))

RE: Working Group request

DATE: 30 November 2009

It is our understanding that the NSF will soon announce a cross-directorate Climate Research Initiative. The Climate Vulnerability working group requests support ($15,000) from the LTER Network to hold two workshops that will lead to the submission of an NSF proposal addressing the pertinent RFP within the Initiative.

Background: The Climate Vulnerability working group was assembled and first met at the Science Council meeting in San Diego in May 2009. At that meeting a group of mostly natural scientists representing 9 coastal or oceanic LTER sites met and discussed the development of a concept paper (or 2-pager) that describes how we can take advantage of the range of potential vulnerabilitise of our coastal network of sites to examine climate change and understand the factors controlling human and natural system vulnerabilities and response. While we met briefly with Morgan Grove, our concept paper (*Coastal Zone Climate Change: Understanding and Adaptation*) was developed without fully engaging the social scientists within our network.

At a follow-up meeting in Estes Park, the Climate Vulnerability working group had an opportunity to meet again. Although this meeting was attended by Tom Baerwald, we were again unable to engage a wide segment of the LTER social science community because of their pre-existing commitments and scheduling conflicts. Our discussions focused primarily on giving due weight to ocean acidification as an aspect of climate change that is important at some sites and in identifying the human communities potentially most impacted by the effects of acidification, as opposed to other aspects of climate change.

Bottom line: It is critical that we bring together a diverse group of social scientists to focus on the human aspects of climate change vulnerability prior to assembling an interdisciplinary proposal writing team. We therefore seek support for two workshops to meet the following goals:

Goals:

1. Develop integrated social-ecological questions and approaches to characterize and analyze adaptation and mitigation strategies for climate change, and how they interact with ecosystems.
2. Write an integrated proposal to NSF that addresses one of the soon-to-be released RFPs for the Climate Research Initiative.

Approach for Goal 1 (Engaging the Social Scientists):

We would like to be broad-based in terms of climate change (e.g., sea-level rise, storms, climate as it affects watershed loading to the coastal zone, changes in pH and temperature) with the recognition that there are different spatial and temporal scales over which these changes play out in both their social and biophysical aspects. For example, the decision horizon and anticipated consequences for changes in pH would likely occur at a very different scale than responses to increased storminess or sea level rise (e.g., global vs local impacts).

With a workshop focusing on the social sciences, we envision inviting 8 social scientists and only 4 natural scientists. Social scientists will lead this meeting with Colin Polsky (PIE) and Kirstin Dow (BES) leading discussions. The natural scientists are to include investigators from along the east coast (Hopkinson - PIE, Alber - GCE, and Gaiser - FCE) and the Pacific (probably Holbrook or Schmitt). We will involve social scientists working on coastal issues who are already involved with LTER, but this is also an opportunity to bring in some new expertise.

Eight social scientists and alternates will be chosen to attend this meeting as soon as funding availability is known. (A list of potential invitees is attached.) Decisions on who to invite will be made during a conference call between Alber, Gaiser, Polsky, Dow, and Hopkinson.

We envision a 2-day workshop to be hosted by Hopkinson and Alber at UGA (to hold down costs) during the first week of February (after LTER renewal proposals are due).

Workshop Product: The product of this workshop will be an expanded version (3-5 pages) of our prospectus on *Coastal Zone Climate Change: Understanding and Adaption*, which will fully develop the social science aspect of our working group. The revised prospectus will serve as the initial outline for our 2nd workshop.

Approach for Goal 2 (Writing workshop):

Following workshop 1, a proposal writing team will be chosen by conference call between current working group leads (Hopkinson, Alber, Gaiser, Polsky, Dow). We expect to invite an equal number of social and natural scientists to this second workshop (probably 4 and 4). We also expect that the RFP will have been issued by this time, which will give us some further guidance on the appropriate membership of the writing team.

At the proposal writing workshop we will develop a draft proposal to be submitted to NSF. This will include standard proposal components including research questions and hypotheses, the work plan, management structure, information management, broader impacts, etc. We will also discuss how to distribute funds amongst the LTER sites and develop an implementation plan. (There are several funding models that we will have to evaluate in terms of their effectiveness of working at a network scale.)

We envision a 3-day workshop to be hosted by a site yet to be determined within 3-4 weeks of the proposal due date (e.g., 1st or 2nd week of March).

Workshop Product: The product of this meeting will be a proposal ready or nearly ready for submission to the NSF Coastal Climate Initiative. Writing responsibilities for completing the proposal will be assigned prior to leaving the workshop.

BUDGET:

$10,000 - Engaging the Social Scientists Workshop: All aspects of travel for 12 people to Athens, GA for a 2-day meeting (no cost to Hopkinson and Alber)

$5,000 - Writing Workshop: All aspects of travel for 8 people to a destination to be determined based on cost and logistics. At the network $1,000 per person rule of thumb, we will chose a site to minimize travel and lodging costs. Duration 3 days.

Potential Workshop Participants (Social Scientists)

Resource Economists:

Martin Smith (Duke)
Craig Landry (East Carolina Univ.)
Paul Bin (East Carolina Univ.)
Jamie Cruise (East Carolina Univ.)
Jim Boyd (Resources for the Future)
Elena Irwin (Ohio State, BES)
Austin Troy (Univ. of Vermont, BES)

Geographers:

Colin Polsky (Clark, PIE)
Jennifer Brewer (East Carolina Univ.)
Laura Schneider (Rutgers, HBR)

Environmental Policy

Rob Neff (University of Maryland, Baltimore County, BES)
Charles Lord (Boston College)
Dorinda Dallmeyer (Univ. of Georgia)

Anthropology

Laura Ogden (Florida International University, FCE)
Susan Stonich (UC Santa Barbara)
Bonnie McCay (Rutgers)