THE DISAPPEARING CRYOSPHERE: SOCIOECOLOGICAL CONSEQUENCES FOR ECOSYSTEM SERVICES

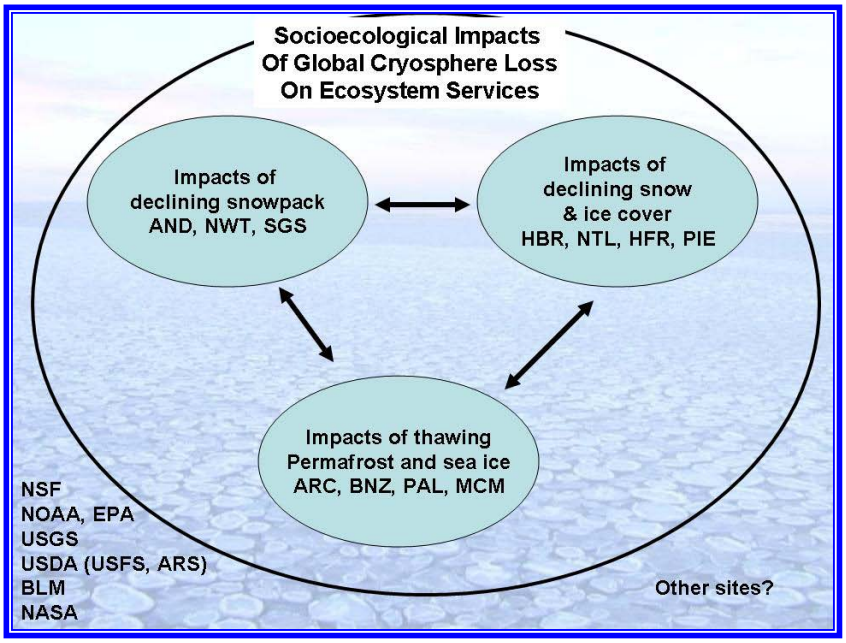
The Earth's Cryosphere, which includes glaciers; sea, lake and river ice; seasonal snow; and ice-rich permafrost, harbors over 80% of the freshwater on the planet. The Cryosphere cools the planet, regulates global sea level, stores substantial stocks of carbon, insulates soil from subfreezing air temperatures, and, most importantly, serves as a seasonally-rectified water supply for human consumption, irrigation, nutrient transport and cycling, and waste disposal. Cryosphere loss imposes enormous threats to these ecosystem services, with potential costs to the world economy in the trillions of dollars. A one meter sea level rise, projected over the 21st century, alone represents an estimated economic impact of $1 trillion (Anthoff 2006).

The extent and rates of cryosphere loss are increasingly well-monitored, and our ability to project future rates of geophysical decline is improving. However, the ecological consequences and especially the nature, extent and economic impacts on human society and institutions are still poorly understood. Building on the LTER ISSE framework, **we propose an LTER Network-wide effort to investigate the socioecological consequences of cryosphere loss, with a focus on a socioeconomic assessment of the alteration of ecosystem services.**

Approach

We propose to initiate and conduct coordinated research on three related topics, each associated with ongoing work at several LTER sites (see figure): 1) Declining snowpack in the western US (e.g. NWT, AND, SGS); 2) disappearing snow and ice cover in the northeastern US (e.g. NTL, HBR, HFR, PIE) and 3) thawing permafrost and sea ice at both poles (e.g. ARC, BNZ, PAL, MCM). The socioecological impacts and consequences of pulse and press forcing of declining cryospheric elements will be the focus of this initiative. Research will be pursued in two phases: first, identifying critical gaps in observations and data, and building improved ecosystem-level understanding of the processes linking the natural and human systems. In the second phase, data syntheses and understanding gained in Phase 1 will be used to create new process-based models of the relationships and connections between climate forcing, ecosystem responses, and consequences for society. These new models will be used to create regional scenarios and projections of climate-driven socioecological change, and to quantify the economic and social costs.

We will build on the rich data legacies and interpretive capabilities at individual LTER sites, but the proposed research will be pursued mainly at the Network level. The principal mechanism for this approach will be formation of three research teams that will work across sites and site clusters, with each team investigating one of the three central research topics. Each team will be composed of an ecologist, a resource economist, and a sociologist. These Cryosphere research teams will meet regularly to share results, coordinate their research, and strive to scale up from site-based research at LTER and other sites to develop regional and continental-scale understanding of the socioecological impacts of



cryosphere loss. Other expertise (e.g., data discovery, modeling, scenario-building) will be drawn from outside the LTER community as required.

Key research questions, drawn from the LTER Decadal Plan, each address a specific ecosystem service threatened by cryosphere loss.

1. How is climate regulation affected by feedbacks from thawing permafrost and sea ice, especially because of the release of vast stores of carbon and loss of albedo? What are the implications for regional and global economies and policies, including sovereignty?
2. What are the economic implications of snow and ice loss? What is the future of winter recreation and other related cultural activities?
3. How will changing snowpack (amount and timing of water storage and delivery) in the western US influence ecosystem services and thus the economies of this region? Will impacts be disproportionately imposed on disadvantaged groups?
4. What are the cultural mechanisms by which cryosphere loss influences public opinion? What policies and legal instruments are most effective for environmental protection, impact mitigation, and adaptation in the face of climate change?

Cyberinfrastructural Needs
This project will require a network-level cyberinfrastructure to enable search, discovery and harvesting of data across and beyond sites, focusing on ecological, socioecological, economic and demographic changes. This may include spatially-explicit remote sensing and GIS data. Relational capabilities across these datasets are required for data synthesis as well as efficient condensation, analysis and presentation of 3D model results.

Lead Coordinators
Mark Williams, Hugh Ducklow, David McGuire, Charles Driscoll, Catherine Keske.

Initiating LTER Participants
NWT, AND, SGS, NTL, HBR, HFR, PIE, ARC, BNZ, PAL, MCM.

Potential Partners
NOAA, NASA, EPA, USDA (USFS, ARS), BLM, USGS.

Potential Budget
$1.6M/yr for 5 years; with costs primarily for salary support for 9 PhD level scientists ($765k), with the remainder for technical support, travel, and supplies.

Reference:
David Anthoff, Robert Nicholls and Richard S.J. Tol. 2007. Sea level rise and equity weighting. FNU-136, Working Papers from Research unit Sustainability and Global Change, Hamburg University.
http://www.fnu.zmaw.de/fileadmin/fnu-files/publica ... quityWeightingWP.pdf