Societal working group – Question 1

DRAFT 2 (8/27/13)

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Question 1. How are environmental changes affecting subsistence & cultural resources, human health, and infrastructure – and their interactions – in the ABR and how are human societies responding?

1A Statement of the question

Feel free also to adjust the wording of your question(s) as needed.

Proposed: How are environmental changes in the ABR affecting natural and cultural resources, human health, and infrastructure and how are human societies responding? (SC) (EKL)

1B Description and rationale

Ecosystem services. The ABR (as defined by ABoVE) is home to thousands of people who depend directly on ecosystem services provided by the land they live on and the sea that surrounds them. People have been an integral part of ABR ecosystem -a highly dynamic environment- for thousands of years (since end of Pleistocene). Humans derive direct and indirect benefits/contributions from ecosystems via ecosystem services (e.g., clean water, clean air, etc.) that support individual well-being and societies. Thus the ABR is comprised of complex, linked social-ecological systems spanning a range of human activities and natural biomes, e.g., fisheries, subsistence, tourism, recreation, energy development, infrastructure, etc. Current and future environmental change will affect the ABR ecosystems, people, and their interdependencies, particularly in the following realms:

- Distribution, abundance and access to natural resources for provisioning and subsistence ecosystem services

- Direct and indirect effects on human health (disease vectors, food availability, mental health from fate control and intact culture). It is important to note that ecosystem services are a foundation of indigenous cultural identity; they are not just aesthetic amenities.
- Rapid direct and indirect effects on hydrology, permafrost, and sea ice which impact infrastructure and cultural landscapes (buildings, roads, airports, frozen rivers, historic/archeological sites)

Additionally, environmental changes in the ABR will have significant impacts at scales beyond the local and regional. The abundance of natural resources creates opportunities for the use and distribution of additional ecosystem services both locally and beyond, but the potential substantial losses from carbon sinks in vegetation and soil will result in a loss of the globally realized ecosystem service of climate regulation.

Interactions. It is important to maintain a "humans-in-nature" and systems perspective: Environmental changes have consequences for society, and human activity causes environmental change. Local changes are the result of both large-scale exogenous processes (e.g., global climate change, global market forces) and small-scale processes (e.g., land use decisions, community-level ecological dynamics, etc.). Feedbacks among both social and ecological subsystems can be positive (self-reinforcing) or negative (self-attenuating). Responses in one sub-ecosystem can have effects on adjacent sub-ecosystems and the larger-scale ecosystem. Therefore, it is important to consider both interactions between systems and across scales. The effects are often nonlinear, and hence are abrupt and/or not easily anticipated. Given these complexities and the rate of current environmental change in the ABR, there is high potential for large impacts on livelihoods and regional economic activity throughout the ABR and beyond.

Responses to change. ABR societies are (at least historically) highly resilient – there is a long history of people in the region successfully adapting to change. However, recent changes include historically unprecedented rates of climate change, as well as rapid economic development and increased connectivity with outside regions. In developing responses to these changes, people face great uncertainty about future conditions/ecosystem services. Different people and communities may respond in different ways to a common environmental change, both because they place different values on particular ecosystem services and because they have differing options for adaptation. Responses are often mediated through formal and informal institutions (e.g., governments, kinship ties, social networks, shared cultural norms, etc.). Responses are also mediated by economic factors (cost of living, cost of moving, availability of jobs for cash) and by public policy.

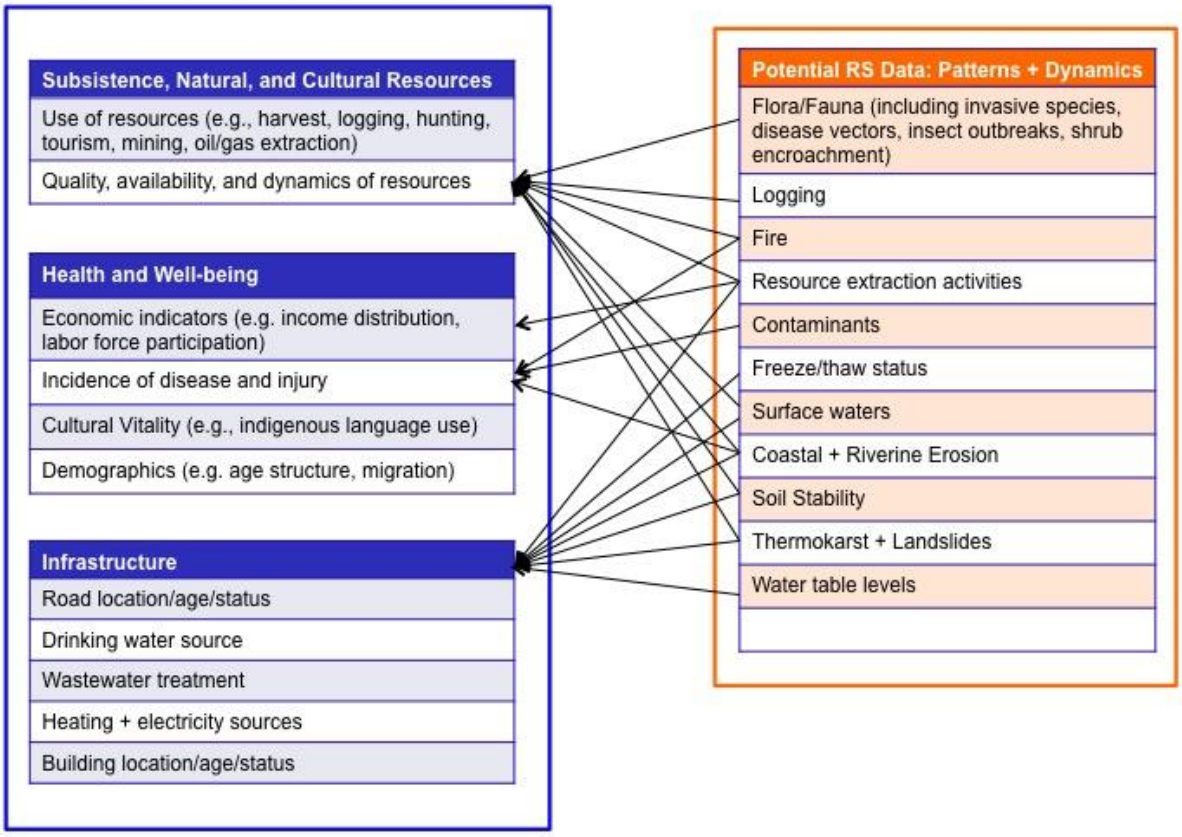
1C Top-level research approach

If funding were available for standard social science methods, we could draw a panel sample of ABR residents, conduct a baseline survey similar to the Survey of Living Conditions in the Arctic (SLiCA)(Kruse et al. 2007) and then follow the people in the sample over time as they respond to change. However, this approach is likely not feasible. Hence the approach will need to be some combination of existing

"conventional" social science research efforts and additional contributions of capabilities that are special to NASA.

1D Indicators and key variables needed

- Distribution and abundance of important (terrestrial) natural and subsistence resources
- Patterns of consumption and use of these resources
- Travel and mobility patterns utilizing ecosystem services (river corridors, frozen rivers, ice roads…)
- Incidence, locations and trends of disruptive events (flooding, erosion, fires)
- Health status of subpopulations (suicide, diabetes, accident rates)
- Movements of people between communities and into/out of the region, and reasons why they are moving
- Soil moisture, soil stability, changes in water table, changes in permafrost depth/ extent, ground-truthed surface geology and vegetation data will greatly benefit resource and land managers
- Coastal/ riverine erosion, permafrost degradation, thermokarst, etc.
- Land managers will benefit by having ability to make informed decisions regarding vulnerable areas/ regions to various feedbacks



2A "Strawman" study objectives

The questions that have been developed (Box 1) are very broad in nature, and developing specific objectives may be needed to identify the specific types of research that will be carried out during ABoVE. WGs should consider developing a "strawman" objective or two that attempts to capture what ABoVE expects to achieve to improve our understanding about, advance the science of, and/or reduce the uncertainty related to each science question. This can be considered a statement of our overall goal in asking each question.

- Obj 1. Correlate remote sensing data with *in situ* observations to validate the use of RS for monitoring changes in important ecosystem services. This task is not trivial because the analysis will necessitate several levels of interpretation and/or use of proxies. For example, the potential RS data in Figure 1 are all high-level products. Furthermore, the relationship between changing environmental characteristics and provisioning of ecosystem services is not direct. (SC)
- Obj 2. Identify ecosystem services individually—are some being impacted more than others? Are some more resilient that others? Rank in order of level of impact? Are there enough data to do this? (JK)

- Obj. 3. Evaluate tradeoffs between ecosystem services: the changing environment, coupled with altered human activity may result in the increase in availability of some ecosystem services, while others decrease. (LL)
- Obj 4. Develop and validate a regional-scale coupled model of ecosystem and social processes that can be used to assess future scenarios of change, to help inform response options, and to illustrate how different responses to change might play out over 10-30 years. (SC)

Research requirements

3A What improvements to models are needed?

Landscape processes in the ABR are experiencing accelerated rates of anthropogenic impacts. Landscape evolution in many parts of this region where people live is complex and the result of integrated biological, physical, and cultural processes- or landscape taphonomy. Observations of landscape evolution at multiple scales are necessary to investigate the severity and rate of ground surface disturbances that are adversely affecting human societies including the resources and infrastructure people depend on. Understanding the rate and extent of landscape processes (geomorphology) such as increased coastal and riverine erosion, thawing permafrost, ablation, thermokarst, etc. is crucial to informing mitigation options, land use decisions, and adaptive management plans. Remotely sensed datasets (e.g., aerial photos, Landsat and MODIS satellite imagery) are currently one of the most cost effective means of investigating these processes in the ABR. High resolution datasets, however, are currently lacking in the ABR. LiDAR Digital Elevation Models (DEMs) in particular have proven useful in providing baseline datasets on current ground surface conditions, modeling landscape complexity, monitoring landscape change, and investigating human-environmental interactions- all having implications for ecosystem services. (JMK)

For models of the area, a major improvement would simply be increasing the extent and quality of input data – particularly hi-resolution aerial and satellite imagery. Existing observational data are very sparse. For example, currently only 30-meter DEMs are available, and this is problematic for local-scale modeling of edaphic and hydrologic properties and dynamics. Increased LiDAR coverage (including bare earth in vegetated areas) would be very helpful…

3B What research is needed for these model improvements?

- Gather better data on current use of natural resources for subsistence (harvest data) (SC)
- Examples of models linking socio-economic and ecological systems are still relatively novel, especially ones utilizing remotely sensed data.

3B(1) What research is ongoing or planned by other efforts?

- The interagency Study of Environmental Arctic Change (SEARCH) aims to address some of the same general questions about society and environmental change, but its focus is on the Arctic and on marine and nearshore systems and resources (sea ice, marine mammals, fish). SEARCH

has not been embraced by agencies other than NSF and much of the research is investigator-driven.

- NSF Arctic SEES (Science Engineering and Education for Sustainability) and NSF Arctic Social Sciences programs entertain proposals that could address aspects of this question.
- Stockholm Environmental Institute- Arctic Resilience Report- International interdisciplinary collaboration to examine the resilience of Arctic social and ecological systems amid rapid change. Focus on shifts in ecosystem services that affect human well-being.

3B(3) What research specifically will be carried out by ABoVE?

Develop and test methods for linking remotely sensed data with ground-truthed data (see Obj 1 above). (SC)

Pilot studies that involve interdisciplinary/transdisciplinary approaches that integrate natural and social science research, recognizing role social sciences have in climate change research.

Collection of basic data sufficient for monitoring landscape change and long-term human responses, as discussed in section 1D. Develop new methods for carrying out this data collection more efficiently and inexpensively by using RS methods.

Conceptual: Integrate human dimensions with other aspects of ABoVE research by identifying the most relevant drivers and feedbacks that affect ecosystem services. Address interactions between social and biophysical processes.

ABoVE could provide an example of how to bridge the social science, natural science divide by exploring/documenting concepts/examples of landscape change coupled with cultural changes and by demonstrating the relevance of research to decision-makers

3C What data sets are needed to carry out this research?

For Obj 1: (1) The RS data on the natural resources in question or the hypothesized proxies, and (2) The ground-sourced data on actual resource abundance or use

Resource managers rely heavily on an array of RS data in ABR due to remoteness, cost of transportation, high level of risk involved in travel. Any improvement in quality/ resolution of current data sets will be useful

3C(2) What datasets are available or will become available over the next 5 to 7 years?

Availability of subsistence harvest data seems to be getting WORSE and less available during next 5-7 years. Existing data from past years will depreciate as time passes.

LiDAR coverage, currently limited, is increasing rapidly.

3C(3) What dataset development specifically will be carried out during ABoVE?

- RS data that is (or might be shown to be) especially pertinent to the ecosystem services people value the most. This may already exist, or might be readily collectible with existing assets. (SC)
- Data that improves understanding of past and on-going changes/ impacts to ground surface/ short and long-term trends. (JK)
- Ground-sourced data on human use of resources and human responses to change that can be linked or correlated with the RS data (SC)

References (many more to add)

Kruse, J; Poppel, B; Abrytina, L; Duhaime, G; Martin, S; Poppel, K; Kruse, M; Ward, E; Cochran, P; Hanna, V. 2007. Survey of Living Conditions In The Arctic: What Did We Learn? Anchorage: Institute of Social and Economic Research. http://www.iser.uaa.alaska.edu/Publications/researchsumm/SLiCA_07.pdf