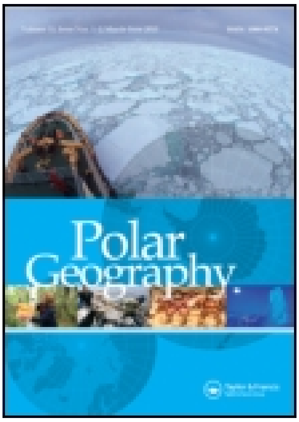

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Arctic Observing Network Social Indicators Project: overview

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Arctic Observing Network Social Indicators Project: overview

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The Arctic Observing Network Social Indicators Project (NSF OPP0638408) is intended to contribute to the development of the Arctic Observation Network and to the science goals of SEARCH in two ways: (1) develop and make available to the science community relevant datasets and (2) identify gaps in the existing observation system and recommend appropriate actions to fill those gaps. The SEARCH Implementation Plan identified the following arenas of human activity likely to involve climate–human interactions: (1) subsistence hunting; (2) tourism; (3) resource development and marine transportation; and (4) commercial fishing. This project seeks to develop and assess datasets in these four areas. Again drawing from the SEARCH Implementation Plan priorities, the project also seeks to develop and assess datasets measuring social outcomes. This special issue of Polar Geography contains articles on each of the four arenas of human activity likely to involve climate–human interactions, an article on demographic indicators of social outcomes, an overview article, and a synthesis of recommendations for researchers and statistical agencies. The articles also introduce datasets now available to the research community.

Origin of project

In 1997, Jamie Morrison of the Applied Physics Laboratory at the University of Washington came to a meeting of arctic scientists to share evidence of remarkable changes in the Arctic Ocean. In response, 40 scientists representing 25 different institutions joined in signing an open letter highlighting the importance of research to monitor and understand these changes (SEARCH SSC 2001, p. 2). Thus began a grass-roots effort of the US scientific community to understand arctic change.

As the science community and arctic residents developed science plans, the working definition of arctic change broadened from observed changes in the ocean, ice, and atmosphere to the following:

> The overall goal of the Study of Environmental Arctic Change (SEARCH) is to understand the nature, extent, and future development of the system-scale changes presently observed in the Arctic. These changes include, for example, increasing average annual surface air temperatures, decreasing summer sea ice extent and sea ice mass, changing ocean circulation, northward movement

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> of tree lines and vegetation zones, thawing glacial ice masses and permafrost, and changing socioeconomic dynamics (SEARCH 2005, p. vii).

A common theme raised by both scientists and arctic residents during the science planning process was the importance of long-term observations to understanding arctic change. Long-term observations are normally under the purview of government program agencies rather than government research agencies. It was therefore remarkable when the National Science Foundation, the National Oceanic and Atmospheric Administration (NOAA), the National Aeronautics and Space Administration (NASA), and later, other program agencies joined together to support an integrated science implementation plan that highlighted long-term observations (SEARCH 2005, p. viii). Among the highest priority activities in the implementation plan was to 'Develop an integrated observation network for identification and long-term monitoring of social and economic indicators of human subsystem changes that drive and/or feed back to arctic physical and biological system changes' (SEARCH 2005, p. x).

Reflecting the importance of observations to understanding arctic change, in 2006 the National Science Foundation issued an announcement of opportunity under the title of 'Arctic Observing Network,' known as AON (NSF 2007). AON has been a major research theme of NSF's International Polar Year initiatives. The Arctic Observing Network Social Indicators Project (AON-SIP) discussed in this volume is an NSF AON collaborative project led by two institutions, the University of Alaska Anchorage Institute of Social and Economic Research (UAA/ISER, NSF grant number OPP 0638408) and the University of New Hampshire (UNH, NSF grant number OPP 0638413).

Conceptual approach

The science driving AON is that of SEARCH and its international complement, the International Study of Arctic Change (ISAC 2010). In both SEARCH and ISAC, human dimensions of arctic change are seen as part of the arctic system. SEARCH science questions include (SEARCH 2005, p. viii)

(1) Is the arctic system moving to a new state?
(2) To what extent is the arctic system predictable (i.e. what are the potential accuracies and/or uncertainties in predictions of relevant arctic variables over different timescales)?
(3) To what extent can recent and ongoing climate changes in the Arctic be attributed to anthropogenic forcing, rather than to natural modes of variability?
(4) What is the direction and relative importance of system feedbacks?
(5) How are terrestrial and marine ecosystems and ecosystem services (i.e. processes by which the environment produces resources that support human life) affected by environmental change and its interaction with human activities?
(6) How do cultural and socioeconomic systems interact with arctic environmental change?
(7) What are the most consequential links between the arctic and the earth systems?

The AON-SIP team responded to the NSF 2007 AON announcement of opportunity by focusing on the first science question in SEARCH, 'Is the arctic system moving to a new state?' The team further focused on three areas of human activity identified in the SEARCH Implementation Plan as likely to involve climate change–human interactions within the Arctic: (1) arctic and subarctic fisheries; (2) marine transportation and associated resource development; and (3) subsistence harvests (SEARCH 2005, p. 44). The team later divided the second area of human activity into two parts: (2a) mining, petroleum development, marine transportation; and (2b) tourism. In addition, the team incorporated the SEARCH Implementation Plan priority of developing a pan-Arctic database of key social indicators of well-being (SEARCH 2005, p. xiii).

Climate-driven environmental changes are widespread and diverse, and may interact with other important drivers of change in Arctic societies, notably development and government policies (figure 1). Figure 1 applies to each of the areas of climate change–human interactions in the Arctic. Household decisions to harvest subsistence resources, for example, are affected by management actions (e.g. harvest quotas), ecosystem services (e.g. resource abundance), and development (e.g. access through oil fields). Subsistence harvests in turn have social outcomes, which can be measured by social indicators (e.g. kilograms of subsistence harvest per capita).

Climate-linked environmental changes will directly affect ecosystems that provide services to people, including processes that support human life. Social drivers of change in the Arctic, such as development and government policies, affect individual and collective decisions about resource use and harvests, creating feedbacks that may change the ecosystems. Development – mainly resource development and tourism – provides flows of jobs and money, while government policies affect services, infrastructure, money, and rules. These factors all influence resource use

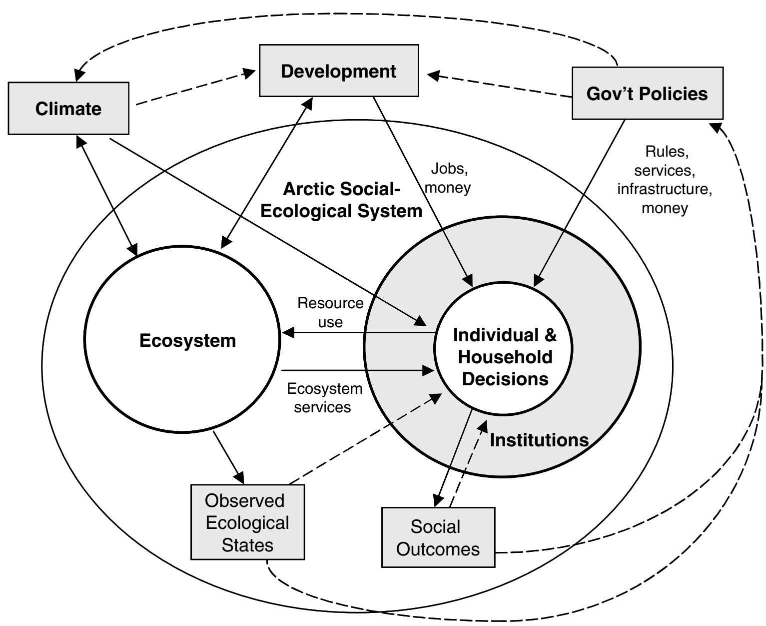

Figure 1. AON-SIP conceptual framework.

decisions (Berman *et al.* 2004; Kruse *et al.* 2004). Climate change also impacts development activities in the Arctic, along with infrastructure, transportation, and provision of government services. Studying the interactions within these arenas of change, and evaluating the coping capacity of communities, will advance the systematic assessment of Arctic societies' vulnerability to climate change (Ford and Smit 2004; Polsky *et al.* 2003).

AON-SIP represents a first step toward applying the above conceptual approach. While ultimately the goal of SEARCH is to understand and foster adaptive responses to arctic change, the immediate goal of AON-SIP is the compilation and assessment of existing data in the four focus areas of climate–human interactions (fisheries, subsistence, resource development, and tourism) and social indicators of well-being.

Project team

Jack Kruse (University of Alaska Anchorage) and Larry Hamilton (University of New Hampshire) are the project principal investigators. The project team is organized as shown in Table 1.

Project objectives

AON-SIP has two project objectives: (1) compile existing data relevant to the project focus areas into a database; and (2) recommend how the database could be improved to support analyses to understand arctic change. To support research

Table 1. AON-SIP investigators.

Project Component	Senior Investigators	Affiliation
Fisheries	Marie Lowe	UAA/ISER
	Jahn Petter Johnsen	University of Tromso, Norwegian College of Fishery Science
Subsistence	Jack Kruse	UAA/ISER
	John Bengtson	National Oceanographic and Atmospheric Administration, National Marine Mammal Laboratory
Tourism	Ginny Fay	UAA/ISER
	Anna Karlsdöttir	University of Iceland
Resource Development	Sharman Haley	UAA/ISER
Social Indicators	Larry Hamilton	UNH
	Gerard Duhaime	Université Laval, Quebec
Modeling & GIS	Matt Berman	UAA/ISER
	Richard Lammers	UNH
Stakeholder Direction	Ed Ward	Maniilaq Inc., Kotzebue Alaska
	Larissa Abryutina	Russian Association of Indigenous Peoples of the North (RAIPON)
	Kristina Lasko	Sámicouncil, Sweden

to understand arctic change, a pan-Arctic human dimensions database must be capable of integrated arctic system analyses. Scientists may, for example, want to test for associations between changes in atmospheric pressure, ocean surface temperature, fishery biomass, and fishery employment. Such integrated arctic system analyses require datasets sharing a common spatial and temporal structure. The AON-SIP team includes Richard Lammers, who is part of another team funded by NSF and NASA to develop an integrated hydrological monitoring system for the Arctic known as the Arctic-Rapid Integrated Monitoring System (ArcticRIMS 2010). The first order goal of Arctic-RIMS is to create a harmonized suite of biogeophysical data to enable analysis of historical and contemporary change in water budgets across the pan-Arctic drainage region (figure 2). Arctic-RIMS is based on a Lambert Equal Area grid centered on the North Pole that is used by the National Snow and Ice Data Center called EASE-Grid (NSIDC 2010). The shaded area in Figure 2 shows the Arctic-RIMS definition of pan-Arctic and consists of a 721 by 721 matrix of 25×25 km grid cells, or 519,841 cells. As an example of the data housed in Artic-RIMS are daily precipitation by 25 km grid cells for the period 1980–2006. The data are currently housed in Arctic-RIMS at five different geographic levels (pan-Arctic, continental, sea basin, watershed, 25 km grid cell) and at three time periods (daily, monthly, and annual).

Richard Lammers and Larry Hamilton are part of an NSF project to extend the capabilities of Arctic-RIMS to incorporate social science data (NSF grant number OPP 0531354). To provide this capability, Hamilton, Lammers, and their colleagues have developed three new geographic hierarchical levels (Figure 3) at which data are to be stored in Arctic-RIMS: national, subnational (e.g. state, province), and region (e.g. borough, county).

Most human dimensions data are available only in aggregated form at the national, subnational, and regional levels, and in some cases at the place level. Arctic-RIMS is designed to allow researchers to disaggregate their data into 25 km

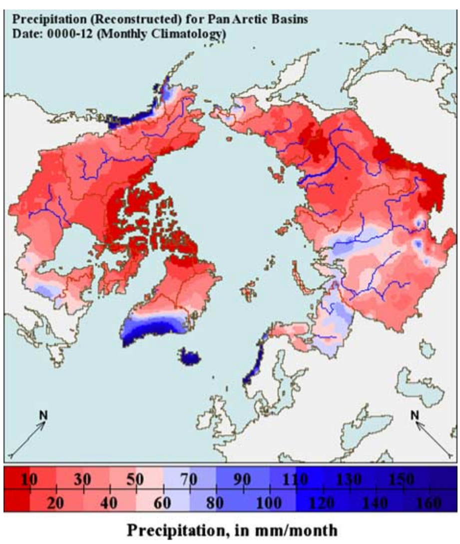

Figure 2. Arctic RIMS geographic area.

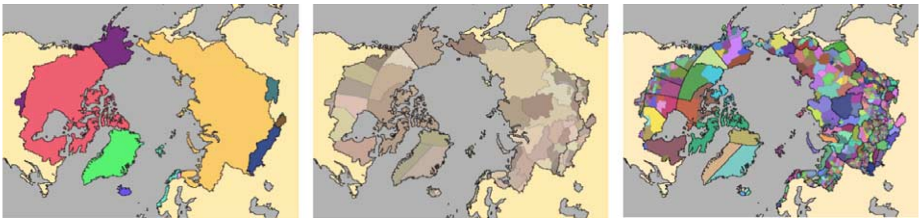

Figure 3. Arctic RIMS political geography.

grid cells and re-aggregate them to a common spatial structure (e.g. hydrologic basins). The challenge is to come up with a meaningful disaggregation algorithm for each indicator. The most common algorithm is to take a value for a region and divide it up among the grid cells that make up that region. Is it meaningful, for example, to take county-level data and assign each grid cell contained within the county the same value on a social indicator such as the number of persons who have completed a college degree? The AON-SIP team decided to defer the Arctic-RIMS disaggregation step and to focus on the prior step of compiling data in regions that are already recognized in the Arctic-RIMS framework.

Once each component of the AON-SIP team embarked on its own data acquisition phase it soon became apparent that the fit between a hydrology-based definition of the arctic and a human dimensions-based definition is not perfect. Large areas of Ontario, Manitoba, Saskatchewan, and Alberta drain northward into arctic waters, for example. Most of Norway and all of Sweden and Finland do not drain into arctic waters. The team ultimately decided to adopt the definition of the Arctic used in the Arctic Human Development Report (AHDR 2004). Applied to the Arctic-RIMS framework, the AHDR definition yields 75 regions distributed as follows: Canada (8), Greenland (18), Faroe Islands (1), Finland (1), Iceland (8), Norway (4), Russia (7), Sweden (1), and United States (Alaska, 27). The time dimension of choice for AON-SIP is straightforward: annual. The AON-SIP databases and related materials can be downloaded from the AON-SIP website (WWW.SEARCH-HD.NET).

Relationship of AON-SIP to Arctic Social Indicators

Concurrent with the start of AON-SIP, the Arctic Council initiated the *Arctic Social Indicators* project (ASI) as a follow-up to the Arctic Human Development Report (AHDR 2004). The intent of ASI is to devise a limited set of indicators that reflect key aspects of human development in the Arctic, that are tractable in terms of measurement, and that can be monitored over time at a reasonable cost in terms of labor and material resources (ASI 2010). Four members of our project team were invited to be ASI participants: Kruse, Hamilton, Duhaime, and Rasmussen. Over the past two years, we have collaborated with over 50 other scientists and indigenous people in ASI. Building on the recommendations of the AHDR, ASI identified six dimensions to describe human development: material well-being, education, demography and health, cultural integrity, contact with nature, and fate control. Within each of these dimensions, scientists and indigenous people involved in ASI identified an indicator, or index composed of several indicators. ASI leadership, including

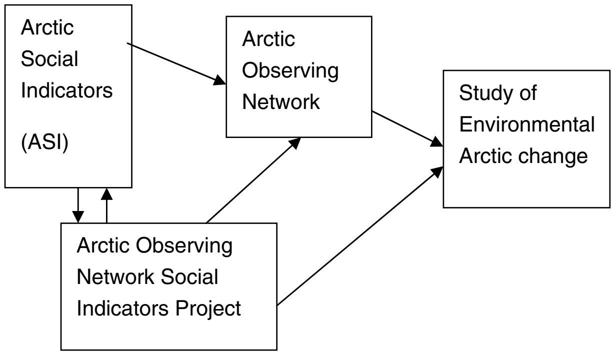

Figure 4. Relationship of AON-SIP to ASI, AON, and SEARCH.

Hamilton, Rasmussen, and Kruse, presented ASI results to the membership of the International Society of Quality of Life Studies in San Diego in 2007 and to the membership of the International Arctic Social Science Association in Nuuk in 2008.

The work of the Arctic Observing Network Social Indicators Project and ASI has, by design, converged. We are both using the same six dimensions to describe social outcomes (or in ASI terminology, human development). It has become clear to both groups that there are critical gaps in the existing Arctic Observation Network. The most critical gap is the lack of current and ongoing observing of subsistence resource harvests. It is equally clear that the gap in resource harvests can only be filled through primary data collection. Less clear is how best to measure the dimensions of fate control and cultural integrity. Testing of alternative measures, including those requiring primary data collection, is required. Even education and language measures appear to require special tabulations by government statistical agencies. ASI published its initial findings in 2010 (ASI 2010). A second phase of ASI is now focusing on the compilation and testing of indicators.

Figure 4 shows the relationship between this project and three major science initiatives: the Study of Arctic Environmental Change (SEARCH), the Arctic Observing Network (AON), and the Arctic Social Indicators initiative (ASI). ASI provided to AON-SIP the intellectual grounding for the definition of social outcome domains. AON-SIP is providing ASI with data. ASI is a major contributor in the human dimensions to the development of AON. AON-SIP is an AON project, coordinating with 35 AON projects. AON-SIP is also directly based on the SEARCH Implementation and Science plans, as are many other AON projects.

Acknowledgments

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