Humans and Arctic Hydrology

Report of an online workshop organized by the
HARC Science Management Office
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Background

The Human Dimensions of the Arctic System (HARC) research initiative, a component of the National Science Foundation's (NSF) Arctic System Science (ARCSS) Program, began in 1997. Since then, HARC projects have examined several ways in which humans affect and are affected by the arctic system. In an effort to spur greater activity in the initiative, NSF has sponsored a Science Management Office (SMO) for the HARC initiative. The Humans and Arctic Hydrology workshop is the fourth in a series of online workshops designed to stimulate discussion about topics related to HARC and to inspire researchers to submit proposals to the initiative.

Introduction

The arctic hydrological cycle encompasses all aspects of the flow of water—as liquid, solid, or gas—through the arctic system. It affects people and society in many ways, from clothing choices to resource development strategies. Changes in that cycle may have drastic consequences in arctic regions. The ARCSS Program has recently launched an initiative focused on arctic hydrology, the pan-Arctic Community-wide Hydrological Analysis and Monitoring Program (Arctic-CHAMP), noting the relevance and importance of human dimensions research.[1] To involve natural scientists, social scientists, and arctic residents in a discussion of this topic, the HARC SMO organized an online workshop to discuss some of the issues related to humans and arctic hydrology. Transcripts of the discussions in PDF format, the participants list, and further information about HARC and the workshop can be found on the HARC website (www.arcus.org/harc).

This report is intended to highlight research ideas and opportunities that arose during the workshop. These ideas are neither exhaustive nor exclusive. There is considerable overlap, and potential projects may well include ideas from more than one section of this report. We hope readers and participants will use this report as a starting point for developing proposals to the HARC initiative. Some of the ideas described are worthy of further attention, but do not fit easily within the scope of HARC. Future workshops will also be held in an effort to help bring researchers together to collaborate on human dimensions research. The SMO welcomes ideas for additional workshops or other ways of promoting collaborative discussions about human dimensions of the arctic system. Those interested in proposing to HARC should visit the HARC website for further information, including contact information for the program director at the National Science Foundation.

General Themes

Assessing and studying the relationship of humans and the hydrological cycle in the Arctic is a complex undertaking. Several considerations apply to most types of research in this area:

- ***Spatial scale needs to be determined carefully.*** Most effects on society manifest themselves at local scales, though the causes may be local, regional, or global. Human impacts to hydrology are typically from local or regional sources, but the impacts themselves may be spread across larger scales.
- ***Time scale also requires careful thought.*** Some changes may take decades or centuries to complete, but the impacts of those changes may appear much earlier. Other changes may be rapid, but perhaps with transient effects. The magnitude of change and its relation to past variability also depend in part on the length of time being considered.
- ***The relationship of generalizations to place-specific findings is important***

in examining particular social and natural conditions. Some characteristics of human-hydrological interactions will remain constant across time and space, whereas others are likely to depend greatly on particular circumstances.

- ***Local communities can have a significant role in identifying research needs, carrying out research projects, and acting on the results, but achieving this is often difficult.*** More work must be done to encourage community participation in discussions of this kind and to make their concerns and priorities known to the research community at large. Additionally, research results must be published as technical articles in scientific journals, but it is also essential to make results known to local communities so they are able to make informed decisions.

Community Planning

How can climate change be incorporated into community and land-use planning? Many plans are developed with an assumption that environmental conditions are stable. If conditions change, plans for environmental restoration or community development may be in jeopardy. Furthermore, effective responses to changes such as erosion depend on a sound understanding of the relevant societal and natural processes. A key element of planning is the involvement of the community or communities in question, and the ways that environmental information can be conveyed effectively. In this regard, perception is an important variable in that it determines how people respond.

Water and Waste Disposal

Most arctic villages utilize shallow tundra ponds or rivers for their water supply leaving them very vulnerable to subtle changes in the hydrologic cycle. The disposal of waste, including garbage and sewage, is often complicated in areas of low topographic relief and occasional flooding. Contamination of water supply by wastewater is a risk, likely increased by certain hydrological changes. In some areas, rusting barrels of hazardous materials, previously frozen for decades, may escape as permafrost degrades or as beaches erode. Contaminants may spread much more rapidly and over larger areas when frozen ground prevents infiltration to deeper soils. Regulations and plans concerning water and waste may not be followed in remote villages, where social and environmental conditions may not correspond to the expectations of the planners or regulators. The vulnerability of arctic communities to this type of impact has not been well studied, nor have the options for prevention or response.

Infrastructure and Engineering

As with community planning, much of the infrastructure built in the Arctic was designed on the assumption that the environment is not changing. A good example is the use of permafrost as support for buildings, roads, and pipelines. Design specifications may have addressed the impacts of the development itself, or have included a safety factor sufficient to account for a certain degree of warming. Nonetheless, climate-induced changes may exceed design tolerances. Better links could be established between permafrost researchers and permafrost engineers, particularly in terms of developing a probabilistic assessment of potential future conditions. Other examples of infrastructure concerns include the strength and duration of ice roads and the containment of contaminated soils at DEW (Distant Early Warning) Line sites. An interesting aspect to this question is the impact of social and economic changes, such as those in Russia that reduced or thwarted efforts to maintain permafrost by ending snow removal or constructing smaller structures that changed local thermal regimes next to large buildings.

Characterizing the Human-Hydrological Relationship

Humans affect and are affected by hydrology in many ways, but the nature of that relationship has been explored in only a few cases. More work could be done to characterize the relationship across sectors of human activity and regions of the Arctic. Noting the uncertainties in scaling, it would be appropriate to conduct such characterizations at local and regional levels. The use of historical and pre-historical examples of significant change, for example fisheries impacts of changes in waterflow in the North Atlantic, could illuminate vulnerabilities and links. The characterization should include human influences, such as industrial use of freshwater in oil production or changes in river flow resulting from large dams such as those east of James Bay. Paleo-evidence indicates that drastic vegetation changes (tussock tundra to grasslands) have occurred within a century in arctic regions. How society could adapt to such rapid changes is worthy of consideration.

Mapping Social and Biophysical Parameters

A related undertaking is the mapping of social and biophysical parameters related to hydrology. Potential parameters include demography, land use, biological productivity, biological sensitivity, societal vulnerability, and a range of other factors that can be mapped at different scales. Here, too, scale is a critical consideration, as is the selection of parameters to be mapped and analyzed. One advantage of a well-conceived map is its effectiveness in communicating data and ideas, particularly if it can be used as a spatial model to show changes over time, including projected changes.

Conclusions

The relationship between humans and hydrology in the Arctic is complex and critical to arctic communities and human activities in the North. There are many productive ways to study this relationship, especially in relation to global environmental change. The workshop provided a starting point for researchers interested in developing proposals in this area, which we hope will develop into a substantive human dimensions component of the new hydrology initiative.

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NOTE

[1] For more information about the Arctic-CHAMP initiative, see *The Hydrologic Cycle and its Role in Arctic and Global Environmental Change* available at http://www.arcus.org/ARCSS/hydro/index.html.