Hydroclimate Observations in Arctic Alaska: Analysis of Past Networks and Recommendations for the Future

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The report cover photo is an airborne image of snow on tussocks, by J. Cherry, 2010.

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Executive Summary

The Arctic Landscape Conservation Cooperative (LCC) and the North Slope Science Initiative have both identified the importance of synthesizing and disseminating existing climate and hydrology data as well as improving the design of climate and hydrologic monitoring networks to meet management and research needs. We have partnered with the Arctic LCC to address this issue. During this project we designed a geodatabase called *Imiq*, inventoried hydrologic, climate, and related datasets, and populated the *Imiq* database with both data and metadata. Finally, we analyzed some of the spatial characteristics of the existing hydroclimate data and the observational network structure, in an effort to inform the development of an improved climate and hydrologic monitoring network. After analyzing the assembled data, several watersheds, communities, and other locations emerge as obvious candidates for enhanced monitoring infrastructure.

Site selection was further refined by discussions with several expert working groups organized by the Arctic LCC, including those on the related topics of climate, hydrology, permafrost, and coastal processes. Because most of the existing sites that were inventoried lack consistent support for long-term physical measurements, site recommendations that emerged from our analysis were based on the following factors:

1. The sites or areas have existing long-term or historical measurements of hydrologic and climate (referred to here as hydroclimatic) variables.
2. The sites or areas have some kind of existing physical infrastructure nearby (transportation, communication, a source of electrical power, or shelter).
3. The sites have intrinsic value because of their physical properties or relevance to socio-economic needs. For example, they are either highly representative of a particular physiographic region or their physical properties are distinctive enough that they challenge the existing knowledge of the arctic region. Other sites are logical because they are near a community or resource and the information would be valuable for decision-making. This 'intrinsic value' category is generally derived from expert opinion rather than emerging from the statistical analyses performed as part of this project.

In this report, we describe some of the anticipated physical changes in arctic Alaska as a motivation for enhanced monitoring, we inventory the current and historical network of observations, we discuss the impacts of the historical network on our state of knowledge about arctic Alaska's hydroclimate--including the role of observations in numerical modeling--and we present recommendations regarding the station network design and future management of data from the network.

The recommendations detailed in this report suggest cooperative, interagency support for the following:

A. The designation of research watersheds or concept areas (areas representing a hydro-physiographic region) with either new instrumentation or support for existing instrumentation. Some of these could be joint ventures with other LCCs.

B. Enhanced observing programs in communities, including both villages and work camps. Logical partners include agencies already operating community-

based observational programs such as the National Weather Service, the Federal Aviation Administration, the Alaska Department of Transportation and Public Facilities, and the Alaska Native Tribal Health Consortium.

C. Special attention to preservation and expansion of hydrologic gauging. Many of the past recommendations for enhanced gauging in the Arctic have never been realized, because of funding constraints. Existing gauges are threatened to be shut down for the same reason. Long-term river discharge measurements are a critical component to a hydroclimate observational network, particularly because they integrate many of the changes occurring upstream in the watersheds.

D. Expanded observation of the most sparsely measured variables, including evapotranspiration (ET), soil temperature and moisture, lake water levels, solar and long-wave radiation, relative humidity, snow depth, and snow water equivalent. Where the few existing measurements of these variables are made now, they are typically supported by a single research group and sites are vulnerable to the annual funding decisions of a small number of program managers.

E. Implementation of new instruments and techniques for hydroclimate observations, particularly for variables for which conventional measurements work poorly (i.e. snow) or are very costly (i.e. river gauging, ET fluxes). Arctic LCC support for instrumentation research and development may be most appropriate for technologies with relatively advanced readiness levels, according to the Technology Readiness Level (TRL) system used by the U.S. Government.

F. Ongoing improvements to data management practices such that various types of hydroclimate observations made by many different investigators can be integrated, analyzed, ingested into models, and used to improve our overall understanding of the arctic system.

The *Imiq* database that resulted from the project described in this report makes a unique contribution to the ongoing data integration efforts in the geosciences. It is the only database containing all of the historical data from major hydroclimate networks in northern Alaska. The goal of the authors is to continue to update *Imiq* and to make it a valuable community resource.

FULL REPORT AVAILABLE ON PROJECT WEBSITE:
http://ine.uaf.edu/werc/projects/lccdatalibrary/index.html