2010-2011 Annual Report - NFS Arctic Social Sciences
Dangerous Ice: Human perspectives on changing winter conditions in Alaska
Award Number: 0909517

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Alaskan rivers are integral to subsistence activities for many rural Alaskans throughout the year, but river conditions have changed during the last century in interior Alaska and are projected to become more variable in the future. As a result, changing river conditions (e.g., timing of break-up and freeze-up, flood magnitude and frequency, and ice conditions) may adversely impact residents and communities in rural Alaska.

In Alaska, the period referred to as the "shoulder season" relates to ice formation in early winter or spring break-up at the end of winter. These periods are challenging to Alaskan communities as they represent a transition period during which lakes and rivers are unsafe for travel or to support subsistence activities. Observational information has indicated that ice conditions during the shoulder periods have changed during the last seventy-five years. Recently, ice has been reported as degrading in place as break-up approaches, while historical observations note that ice degradation associated with break-up was typically a more sudden, episodic event.

Over the last year since our last report we have continued our collaboration with local experts in rural communities in mapping areas with dangerous river ice and collecting field data. We have continued to conduct interviews to foster knowledge exchanges with residents of rural communities.

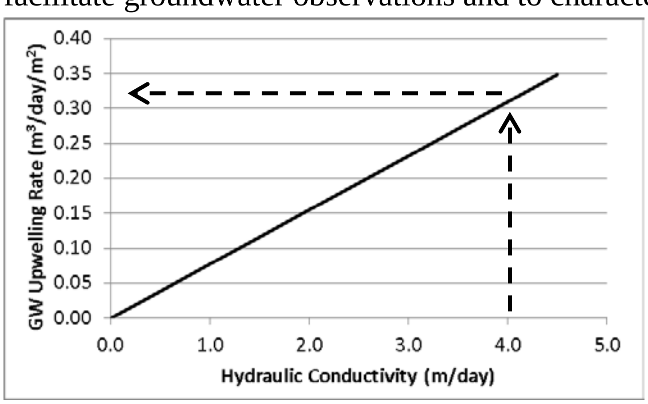
The Dangerous Ice Project Jukebox website is in transition from an HTML based format to a Drupal-based system, so work has been done over the last couple of years to re-design the site and re-organize the data for inputting into the new system. Originally, planned to be in Drupal 6, work on the site was stopped in the fall of 2011 when Jukebox initiated transition to using Drupal 7 for all future website creation. There was no point in continuing development work in Drupal 6 if Drupal 7 was going to be operational come July 2012. Creation of a new Dangerous Ice website is underway. It will include the gps, video and photographic data from all the river trips over all the years of the project (Fairbanks, Manley and Tanana), scientific data collected from the remote monitoring stations, map information, and summary analysis of the local and scientific observations collected during our site visits.

In March, 2012, project team members (Knut Kielland, Bill Schneider, Sam Demientieff, Neil Scannell, Chas Jones, Dave Norton, and Leslie McCartney) traveled from Fairbanks by snowmachine downriver on the Tanana River to assess previously documented dangerous ice locations and identify new sites. They videotaped discussions about the changing ice conditions, environmental causes for the open water locations, and features to look for when traveling to identify possible upcoming dangerous situations. They also collected data from the scientific monitoring stations that were established at key points along the river. There were two team meetings during the year to discuss the project plan for the final project year, and keep team members updated on each other's progress and priorities. In addition to updating of the Project Jukebox website with recent year's river trip data and the newly acquired scientific information, Sam Demientieff requested production of a small educational booklet that summarizes the highlights of our results and makes them understandable and useful to a general audience; i.e., something that would be useful for his cultural teaching of adults and school children out on the river ice. The team agreed to review the project's material and compile such a document.

During the last year we intensified our efforts to collect hydrological data to examine the mechanisms controlling ice cover associated with hazardous areas. Time-lapse photography allowed us to explore anomalous data such as an unexpected increase in water stage on November 1, 2011 (Fig. 1, below).

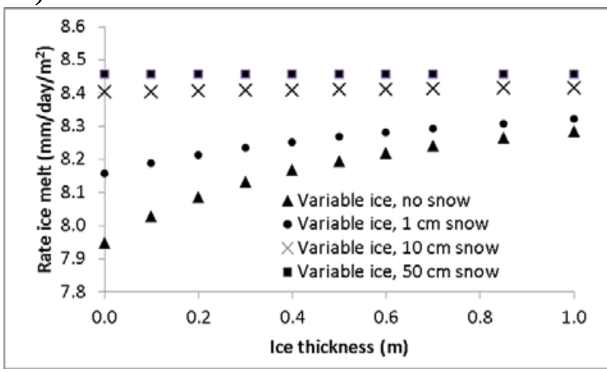
These images were used to explore hydrological anomalies at some field sites and to monitor changes in river stage and snow depth.

An expanded network of groundwater wells and nested piezometers were installed to facilitate groundwater observations and to characterize the local groundwater system, including estimating upwelling rates. These field data provides the basis for modeling ice degradation rates (Fig. 2, left). Results from model runs show that the observed rates of groundwater upwelling can melt the river ice at a high rate (upwards of 1 cm/day), which is consistent with field observations of ice degradation happening over the span of 1-2 weeks even at very cold ambient temperatures.

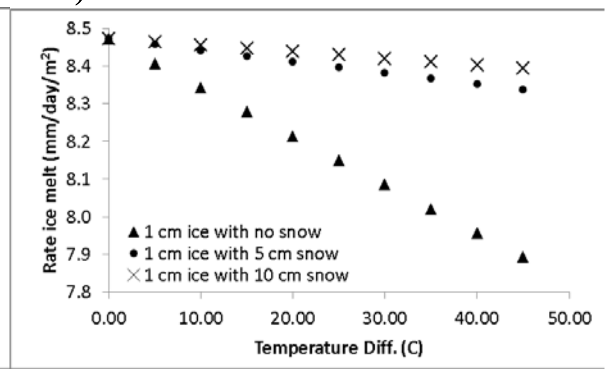


However, the rate of ice degradation is controlled by opposing physical forces. For example, lower air temperatures decrease the rate of melting, while greater snow depth (on the ice) accelerate melting rates as illustrated in Fig. 3, panels below). We are in the process of finalizing this physical (numerical) model of ice degradation as a function of groundwater upwelling rates, channel depth and velocity, air temperature, ice thickness and snow depth.

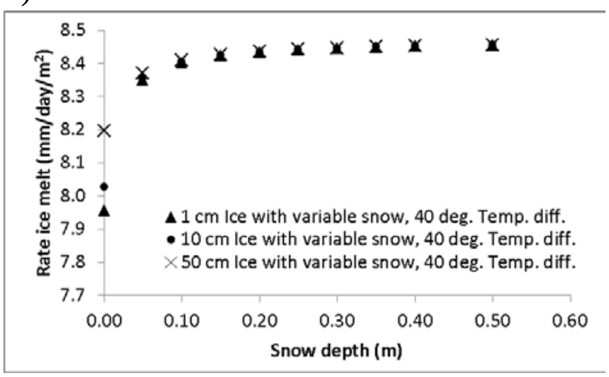
A)



B)



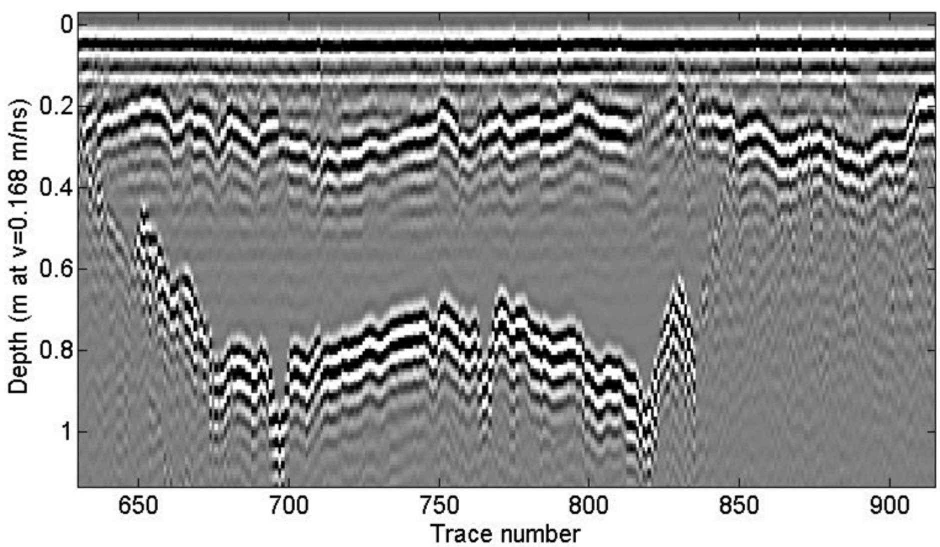
C)



As can be seen from the model results depicted in the panels, the factors controlling ice dynamics show complex non-linear interactions. Of particular interest for river travellers is the effect of snow depth, as it has a great positive influence on the rate of ice thinning. The practical message from this result would be to suggest increased vigilance when travelling on river ice after a recent snowfall. It is also important to note that even a moderate amount of snow (a few inches) can potentially have great effects on ice degradation even at very cold temperatures (panel B, C).

Remote sensing is being used to monitor river conditions. Airborne infrared and optical images were collected over our study reach near Fairbanks on three dates (November 8, 2011, February 22, 2012, and April 22, 2012) to study spatial and temporal changes in seasonal river ice distribution. Flight elevation of 2500 ft AGL was used for each flight. We are planning a fourth and final data collection effort in October 2012 to compare low flow, ice-free conditions to winter conditions.

We have also experimented with using a ground penetrating radar (GPR) to examine at seasonal changes in snow and ice thickness. We used GPR in mid-March and mid-April along a longitudinal profile of Sam Charlie slough. During each effort, we followed parallel tracks very close to each other in attempt to capture the similarly packed snow conditions. The GPR surveys were a collaborative effort with International Arctic Research Center to use GPR to monitor snow and ice in a riverine system behind a snow machine. We also used GPR to look at snow and ice thickness in specific cross-sections across the slough. We plan to extend these measurements to several of the main sections of the Tanana River that exhibit mid-winter ice degradation.



PUBLICATIONS AND PRESENTATIONS

Schneider, W.S. and K. Kielland. 2011. Dangerous Ice: Human perspectives on changing winter conditions in Alaska. ELOKA Conference, Nov 2011 Boulder, CO

Jones, C., L.D. Hinzman, K. Kielland, W. Schneider. In prep. Using local knowledge, hydrology, and climate data to develop a driftwood harvest model in interior Alaska.

Jones, C., K. Kielland, A. Prakash, L.D. Hinzman. In prep. Using airborne remote sensing and integrated field studies to monitor seasonal dynamics of ground water input into the Tanana River, Alaska.

Jones, C., K. Kielland, L.D. Hinzman, D. Kane. In prep. Quantifying the heat dynamics of ground water flux into the Tanana River, Alaska.

Jones, C. L.D. Hinzman, K. Kielland. 2012. Using local knowledge, hydrologic, and climate data to develop a driftwood harvest model in interior Alaska. 2012 Alaska EPSCoR Annual Meeting, AK. May 24-25, 2012.

Jones, C. L.D. Hinzman, K. Kielland. 2012. Characterizing seasonal and spatial variability of groundwater in the Middle Tanana Valley. 2012 Alaska EPSCoR Annual Meeting, AK. May 24-25, 2012.

Jones, C. L.D. Hinzman, K. Kielland. 2012. Using local knowledge, hydrologic, and climate data to develop a driftwood harvest model in interior Alaska. 2012 AWRA Alaska Section Annual Conference, Juneau, AK. March 3-8, 2012.

Jones, C., L.D. Hinzman, K. Kielland. 2011. Using local knowledge, hydrology, and climate data to develop a driftwood harvest model in interior Alaska. 2011 American Geophysical Union Meeting, San Francisco, CA. December 5–9, 2011.

Jones, C., L.D. Hinzman, K. Kielland. 2011. Integrating remote sensing and traditional knowledge to assess hazardous river conditions. 2011 AWRA Alaska Section Annual Conference, Fairbanks, AK. April 4–6, 2011.

Jones, C., L.D. Hinzman, K. Kielland. 2011. Integrating remote sensing and traditional knowledge to assess hazardous river conditions. 2011 4-IGERT Workshop. "Understanding rapid environmental and social change in the Arctic: Bridging traditional knowledge and interdisciplinary science across IGERTs, Juneau, AK. March 22–24, 2011.

Jones, C., L.D. Hinzman, K. Kielland. 2010. Integrating remote sensing and traditional knowledge to assess hazardous river conditions. 2010 AGU Fall Meeting, San Francisco, CA. December 13–17, 2010.

Dangerous Ice project highlighted on Polar Field Services Newsletter December 2011
http://www.polarfield.com/blog/documenting-dangerous-ice/ .

COMPLEMENTARY FUNDING AWARDS (Jones/Kielland)

Alaska Climate Science Center Award; $13,250	2012
Alaska EPSCoR Fellowship; $13,000	2012
Alaska Climate Science Center Travel Award/WERC; $1,200	2012
National Institute of Water Resources Grant; $22,000	2011–2012
Resilience and Adaptation Program IGERT Fellowship; $94,000	2009–2011
Water & Environmental Research Center Travel Grant; $500	2011
Water & Environmental Research Center Travel Grant; $1,500	2011
Alaska EPSCoR Fellowship; $16,000	2011
Alaska EPSCoR Travel Award; $1,500	2010, 2011