Historical Trend in Ice Thickness on the Piscataquis River, near Dover-Foxcroft, Central Maine

Changes in water resources over time may affect public and private water supplies and the health of aquatic ecosystems. The U.S. Geological Survey is studying the relation between climate and water-resource variables in Maine and New England to provide resource managers, the scientific community, and the public with better information about the sensitivity of water resources to climate change and variability. The long-term collection and availability of high-quality water-resources data are crucial to these efforts.

Introduction

Systematic changes in water-resource variables can provide evidence for hydrologic response to climate change. Coherence among indicators within a region may be the most compelling evidence for change. Recent studies have shown that average dates of river ice-out (Dudley and Hodgkins, 2002) and high spring river discharge (Hodgkins and others, 2003) became earlier in New England during the 20th century. The growing season has lengthened in New England (Cooter and LeDuc, 1995) and numerous plant and animal indicators also are consistent with trends towards earlier spring warming (Walther and others, 2002) throughout the Northern Hemisphere during the 20th century.

The U.S. Geological Survey has historical records of river-discharge measurements, including measurements made during the winter, when rivers are typically ice-covered in Maine. Ice thickness can be estimated from the relation between the distance from the water surface to the bottom of the ice (which was systematically recorded) and ice thickness (which was recorded for a subset of the data). The purpose of this study was to assess the suitability of river-ice thickness as a sensitive hydrologic indicator for detecting climate change and to test for trends in this indicator over time. The Piscataquis River near Dover-Foxcroft in central Maine was studied because it is free from any significant human influences that could affect flow and a long-term record (1912 to 2001) was available. Methods and data sources are described in Huntington and others (2003).

Key Findings

Ice thickness was found to be a sensitive indicator of climate variability during the 1912 to 2001 measurement period. A distinct, overall trend towards thinning of river ice was found (fig. 1). Average ice thickness decreased by about 23 cm (about 9 inches) during this period (fig. 1) (Huntington and others, 2003). This change in ice thickness was equivalent to a decrease of about 46 percent. Ice thickness was significantly correlated with winter air temperature, the date of river ice-out, and the timing of high spring flow on the Piscataquis River.

Average winter air temperature increased during the 20th century, but there was a distinct period of cooling from about 1950 through 1975 (fig. 2). This trend reversal during the 3rd quarter of the 20th century, and the corresponding pause in the ice-thickness trend, are consistent with regional cooling during the 3rd quarter of the 20th century (Intergovernmental Panel on Climate Change, 2001). The increasing winter temperature trend of about 1.7°C during the 20th century is significant, and these warming trends are similar to those reported for the larger regional area (Intergovernmental Panel on Climate Change, 2001).

The increase in air temperature over time, including the trend reversals in the 3rd quarter of the 20th century and the corresponding decrease in ice thickness suggests a strong sensitivity of ice thickness to regional climate change. Decreases in ice thickness, advances in the timing of river and lake ice-out, and advances in timing of spring discharge are likely to have consequences for aquatic biota that are sensitive to changes in ice dynamics (Beltaos and Prowse, 2001). Collection of long-term water-resource data is essential for understanding the response of natural systems to climate change. Improving our understanding of the sensitivity of water-resource variables to climate change provides a

U.S. Geological Survey gaging station on the Piscataquis River near Dover-Foxcroft

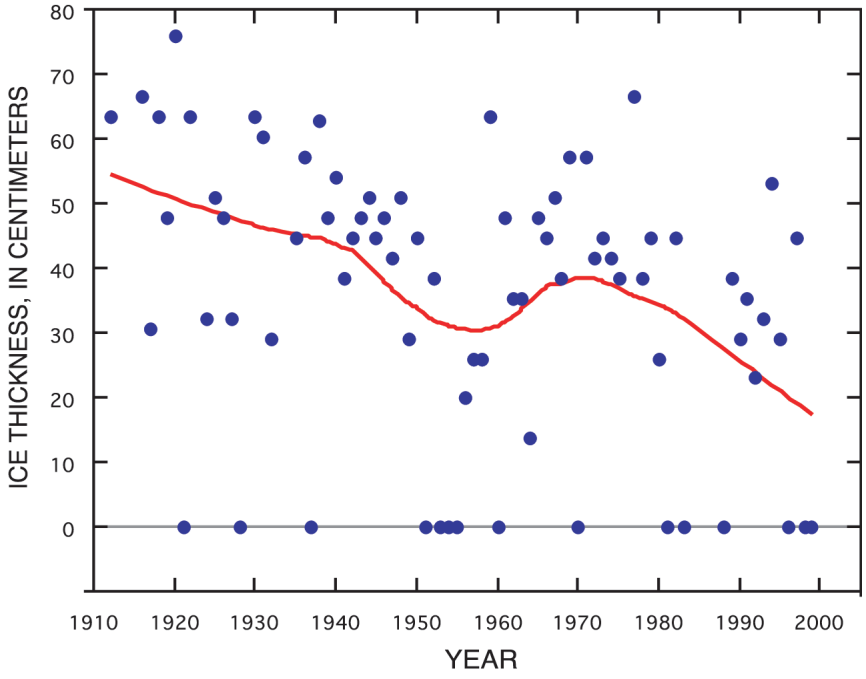

Figure 1. Historical trend in ice thickness and smoothed line measured on 28 February (+/-14 days) on the Piscataquis River near Dover Foxcroft.

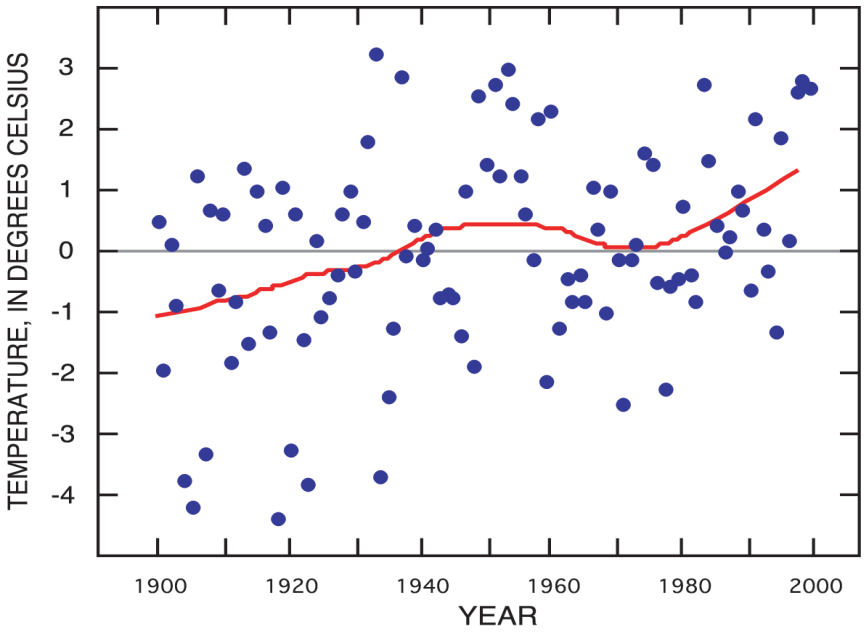

Figure 2. Historical trend in winter air temperature and smoothed line showing the average of seven U.S. Historical Climatology network stations in Maine.

foundation to develop predictive models that can be used by resource managers.

References

Cooter, E. J., and LeDuc, S., 1995, Recent frost date trends in the northeastern U.S.: International Journal of Climatology, v. 15, p. 65-75.

Beltaos, S., and Prowse, T. D., 2001, Climate impacts on extreme ice-jam events in Canadian Rivers: Hydrological Sciences, v. 46, p. 157-181.

Dudley, R.W., and Hodgkins, G. A., 2002, Trends in streamflow, river ice and snowpack for coastal rivers in Maine during the 20th century: U.S. Geological Survey Water-Resources Investigations Report 02-4245, 26 p.

Hodgkins, G.A., Dudley, R.W., and Huntington, T. G., 2003, Changes in the timing of high river flows in New England over the 20th century: Journal of Hydrology, v. 278, p. 244-252.

Huntington, T. G., Hodgkins, G. A., and Dudley, R. W., 2003, Historical trend in river ice thickness and coherence in hydroclimatological trends in Maine: Climatic Change, v. 61, p. 217-236.

Intergovernmental Panel on Climate Change, 2001, Climate Change 2001, The Scientific Basis: Cambridge University Press, Cambridge, 881 p.

Walther, G.-P., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T. J. C., Fromentin, J. -M., Hoegh-Guldberg, O., and Bairlein, F., 2002, Ecological responses to recent climate change: Nature, v. 416, p. 389-395.

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