Understanding the Effects of Climate Change in the Yukon River Basin through a Synergistic Research Approach

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Abstract

Climatic warming in northern latitudes is resulting in a longer growing season, permafrost warming, thermokarst formation, enhanced glacier melting, and earlier ice breakup of lakes and rivers. The Yukon River Basin located in northwestern Canada and central Alaska has extensive permafrost of varying distribution and thickness that is degrading. The basin drains 854,700 km^2 and supports a population of approximately 126,000 people, 10 percent of which rely heavily on the basin's fish and game resources for their subsistence or livelihood (Brabets et al. 2000). The 3,300-km-long Yukon River and its major tributaries also supply drinking water for towns and villages in the interior of Alaska and provide routes for travel by local residents and for migration by spawning salmon. Therefore, streamflow timing is important from both water resource management and ecologic sustainability perspectives. Recent findings indicate a shift in streamflow behavior toward increased flow during the winter months when the large streams are fed by groundwater, an earlier spring peak, and decreased flow during summer months when streams are fed predominately by surface water runoff. These shifts in streamflow timing may be attributed, in large part, to permafrost thawing and a deepened groundwater flow system. A trend analysis shows the proportion of groundwater to total annual discharge from the Yukon River Basin increasing by 0.9 percent per year over the past several decades (Walvoord and Striegl 2007). Groundwater is depleted in organic constituents and enriched in inorganic constituents relative to surface water due to increased organic matter mineralization and inorganic weathering. Thus, a change in source water is expected to be accompanied by a shift in surface water chemical composition. The observed shift in streamflow timing and source water supports water chemistry data collected from the Yukon River and its major tributaries during a recent U.S. Geological Survey (USGS) water quality study (2001–2005) that indicate a historical decrease in summer–autumn dissolved organic carbon export and an increase in dissolved inorganic carbon export relative to water yield (Striegl et al. 2005). One of the main focuses of the 5-yr water quality study was to establish a baseline that would provide an important frame of reference to assess future changes in the basin that may result from a warming climate and permafrost thawing.

As the 5-yr water quality study neared its conclusion, the USGS began to foster a relationship with the Yukon River Inter-Tribal Watershed Council (YRITWC), a local grassroots organization representing more than 60 tribal councils and First Nations throughout the Yukon River Basin. The YRITWC was in the process of building a steward-based water-quality program. Through a collaborative effort, USGS and YRITWC developed and implemented a basin-wide water-quality program modified from the 2001–2005 study. The YRITWC program began in March 2006, utilizing USGS protocols and techniques. The USGS continues to provide annual training, technical support, in-kind sample analyses, and data interpretation. For three consecutive years (2006–2008), over 350 samplings and field measurements at more than 25 locations throughout the basin have been completed. Basic field measurements include pH, specific conductance, dissolved oxygen, and water temperature. Samples collected for laboratory analyses include major ions, dissolved organic carbon, greenhouse gases, selected trace elements, nutrients, and stable isotopes of hydrogen and oxygen. Field replicates and blanks were introduced into

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the program in 2007 for quality assurance. The USGS-YRITWC partnership continues to play an important supportive role in the ongoing USGS Yukon River Basin research by providing cost-effective, high-quality water chemistry data from remote basin-wide locations and by building toward a long-term database vital to climate change research.

References

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