Geophysical Research Abstracts
Vol. 13, EGU2011-3956-1, 2011
EGU General Assembly 2011

Isotopic apportionment of nitrate sources in the Bow River, Alberta, Canada

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The Bow River in Alberta is a major tributary to the South Saskatchewan River in western Canada. The river provides drinking water for many cities and municipalities as well as irrigation water for agriculture in the Bow River Basin. Urban development and agricultural activities including feedlot operations within the Bow River Basin can potentially impact the river water quality by elevating nitrate concentrations. In this project, we applied hydrological, chemical and isotopic techniques to identify sources of nitrate in the Bow River and quantify their respective contributions depending on season and flow. The study area stretches approximately 570 km along the Bow River from Lake Louise in the Rocky Mountain headwaters in the west to about 20 km upstream from its confluence with the Oldman River in the prairie region of southeastern Alberta. Between June 2007 and July 2008, monthly samples were taken from the Bow River for major ion chemistry and stable isotope compositions of nitrate. Flow data from Alberta Environment were used in combination with chemical data to estimate fluxes of nitrate and other ionic solutes along the river. Isotope data show that Bow River water near Lake Louise was characterized by δ15N-NO3 values between 0.1 and +3.5‰ and δ18O-NO3 values between +6.8 and +11.3‰ falling within the range typical for nitrate produced by nitrification in forest ecosystems. Between Canmore and Calgary, δ15N-NO3 increased to values between +3.4 and +8.1‰ and δ18O-NO3 ranged between -4.6 and +4.7‰Ṅitrate discharged from the Bonnybrook wastewater treatment plant in Calgary has elevated δ15N-NO3 values of 7.9$\pm$0.4‰ and low δ18O-NO3 values of -9.6$\pm$0.1‰Ṅitrate flux increased over an order of magnitude in the river as a result of wastewater effluent discharge at Calgary. In the agricultural irrigation districts downstream of Calgary, δ15N-NO3 values varied between +5.9 and +11.4‰ whereas δ18O-NO3 values ranged between -10.5 and +0.5‰Ṫhe elevated δ15N-NO3 and low δ18O-NO3 values indicate that wastewater derived nitrate from the wastewater treatment plant is the major cause for increased nitrate fluxes in the Bow River downstream of Calgary. Mass and isotope balances revealed that wastewater sources account for up to 50% of the riverine NO3 loads upstream of Calgary and for 84-92% downstream of Calgary. We conclude that isotopic techniques can enhance the understanding of the sources and the transport of nitrate in riverine systems, especially when isotope ratio data are interpreted in concert with hydrometric and chemical parameters.