Tracing Sources and Fluxes of Nitrate and Phosphate in Riverine Systems of Western Canada using Chemical and Multi-Isotope (N, O, B) Tracer Approaches

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Excess nitrogen (N) and phosphorus (P) entering surface waters often causes water quality degradation, eutrophication, and in some cases hypoxia of coastal oceans and inland lakes. Improving the understanding of sources of nitrate and phosphate, assessing their riverine fluxes, and understanding N and P biogeochemical cycling in riverine systems is therefore of critical importance. The combination of hydrological flow data, aqueous geochemistry results, and isotope tracer techniques constitutes a promising approach for determining the sources of nitrate and phosphate in surface water systems, and may reveal information on processes these nutrients may have undergone in aquatic systems. Therefore, the objective of this study was to test the effectiveness of combined flow, chemical and multi-isotope tracer approaches for revealing sources and sinks of riverine nitrate and phosphate in two watersheds in Western Canada with markedly different landuse.

In the Bow River Basin of Alberta, flux data indicated that urban wastewater with characteristic $\delta^{15}N$ and $\delta^{18}O$ values predominantly from the metropolitan area of Calgary was responsible for the most significant nutrient loading of this riverine system. Further downstream, nitrate removal proceesses were identified by flux data while additional nitrate inputs from agricultural return-flows containing manure-derived nitrate were identified using $\delta^{15}N$ and $\delta^{11}B$ values. In the Oldman River Basin of Alberta, dominated by agricultural landuse, the combination of $\delta^{15}N$ and $\delta^{11}B$ values also revealed nutrient inputs from agricultural return-flows containing manure-derived nitrate. The obtained results revealed that it can be challenging to differentiate nitrate from waste water and manure-derived sources based on nitrate isotope data alone, but that the use of boron isotope ratios can assist in distinguishing these sources. This project also revealed that phosphate from urban wastewater sources has remarkably low $\delta^{18}O$ values in Western Canada constituting a unique nutrient tracer.

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