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Changed transport of weathering products after river regulation; the Lule River, northern Sweden

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The Lule River in northern Sweden is strongly regulated with 15 power stations producing 15 TWH/year, representing one eighth of the total produced electricity in Sweden, and one fourth of the hydroelectricity. The drainage area covers 24 900 km^2. The geochemistry of the Lule River near the river mouth was studied during a one year cycle, and was, to understand the pre-regulation conditions, compared to the geochemistry of the pristine Kalix River. The Kalix River has a drainage area of 23 600 km^2, situated just north of the Lule River drainage basin. In addition, a mass balance study of the upstream reservoir Stora Lulevatten was performed, by sampling of inflows and the outlet during one year.

In the Kalix River, the spring flood is dominated by woodland water, the summer discharge by mountain water and rainwater, and the low base flow during winter by groundwater. In the Lule River, the spring flood and the main summer discharge are retained in the reservoirs, and released during winter for production of electricity. As a result, nutrients and other elements reach the Gulf of Bothnia in changed amounts and during different seasons than what would have been the case for the unregulated river.

The mass balance study indicates a significant retention of Fe, Si, Al, Mn, P, NO_3 and DOC in the reservoirs. The Si retention is probably an effect of increased diatom production after the construction of the reservoir. This has been confirmed by counting of diatom frustules in sediment profiles.

Due to the always-mixed water in the river channel of the Lule River downstream the reservoirs, the seasonal variations of the geochemistry have been smoothed out. During the low base flow in winter, the concentrations of most elements increase in the Kalix River due to the strong influence of local groundwater on river water composition. Such increases do not occur in the Lule River, clearly indicating that processes in the riparian zone have been changed. The spring peak of TOC, distinctly developed in the Kalix River, has disappeared in the Lule River, and the spring peak of Fe is truncated compared to that in the Kalix River. The total transport of Fe, in particular, but also of other elements including P and Si has decreased as a result of river regulation, but the transport of suspended detrital material has increased, possibly depending on increased erosion along the river channel.

4.5.83

Sources and contribution of atmospheric boron to rivers budget of French Guiana

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During the last decade, the use of boron isotope as a proxy of oceanic paleo-pH values and atmospheric partial pressures of CO_2 has raised considerable interest on its geochemical cycle at the surface of the Earth. With two stable isotopes, ^{10}B and ^{11}B, boron is highly soluble and presents a wide range of concentrations and isotopic compositions ($\delta^{11}B$) in Earth systems. The variability of boron isotopic compositions between surface reservoirs results from large isotopic fractionations induced by water/rock interactions and makes boron a reliable tracer of the water cycle, in particular continental erosion. A wide range of boron concentrations and isotopic compositions was recently measured in the dissolved load of rivers by Lemarchand et al. [1]. The large range of boron isotopic compositions, from –6 ‰ to 42.8 ‰, in the dissolved load of rivers probably results from a combination of isotopic fractionations occurring during chemical weathering reactions, sources effect (corresponding to the different lithologies) and to variable atmospheric inputs. Because the atmospheric boron cycle is poorly known and complex, the contribution of atmospheric boron to rivers is difficult to assess.

This present study tends to better constrain the boron atmospheric cycle and to estimate the contribution of atmospheric boron to the rivers. In order to have an average of wet boron fallout, we systematically analyzed rainwaters collected in French Guiana during one year. We analysed both boron concentrations and isotopic compositions in samples integrating one month of precipitations; they range from 3.5 ppb to 14 ppb and from 30.5 ‰ to 45 ‰ respectively. Data, combined with experimental results on boron evaporation from seawater, indicate that most of the boron in French Guiana rainfalls originates from a marine component. The comparison between the mean annual atmospheric input and the riverine output shows that dissolved boron in French Guiana rivers is essentially of atmospheric origin. Furthermore, the similarity of boron isotopic composition in rivers and rainwaters suggests that no or negligible isotopic fractionation is associated to evapo-transpiration and plant uptake processes.

Reference

[1] Lemarchand et al. (2000), *Nature* **408**, 951-954.