Quantifying phosphorus transport in spring flow in two rivers in northern Sweden – implications for annual load estimates

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A large quantity of different elements is transported in Swedish rivers as the water discharge reaches its maximum in connection to snow and ice melting in spring. In this study, water chemistry data from daily water sampling during spring flood 2008 and 2009 in the river mouths of Kalix and Ume River in northern Sweden has been evaluated. Both rivers are included in the national monitoring program for large rivers, where the main aim is to deliver data on element loads to the surrounding seas. As much as 30-60% of the total annual load of phosphorus in these rivers are transported during spring flow. This mean that there is a risk that the total riverine load of phosphorus to the Bothnian Bay, Bothnian Sea and Baltic Sea may be significantly underestimated if the spring peaks are missed in the regular monitoring program. The water discharge in both Kalix and Ume River is characterized by a distinct peak during the first half of May which will slowly decrease until middle of June when a second, considerably smaller peak will occur, the so-called mountain flood. The daily concentrations of the examined variables pH, total organic carbon (TOC), Tot-P, PO4-P, Tot-N, NO2+NO3-N, Fe, Cu and Zn have similar patterns in both rivers during spring flood. Significant relationships with discharge could be seen in pH, which decreases when discharge increases, while TOC, P-fractions, Fe and Cu increase. The loads calculated from daily samplings have been compared with loads calculated from ordinary monthly water sampling to examine how an increased sampling frequency will affect the quality of the load calculations. The results of the load calculations showed that the total flux of most of the elements calculated from daily samplings was higher compared with calculations from monthly samplings, indicating that the monthly sampling underestimates the loads to the sea. Generally, the proportion of total annual element flux during spring flood is higher in Kalix River than in Ume River for most of the variables. This is specifically pronounced for Tot-P and Fe. During spring flood in the regulated Ume River the loads of Tot-P and Fe are one third of the total annual load, while the loads of Fe and Tot-P in the unregulated Kalix River are almost two thirds of the total annual loads. One reason for the difference may be that the unregulated Kalix River has a more powerful spring flood and a quicker ice breakup that together cause river bank erosion and transport of suspended particles downstream. In the regulated Ume River the river bank erosion is probably not as pronounced as in Kalix River and sedimentation of suspended particles may be more effective. Using monthly sampling in an unregulated river like Kalix River will, hence, in most cases lead to underestimation of the total annual flux of many water quality variables, especially for phosphorus. Flow-weighted water sampling would improve the precision in element flux calculations for unregulated rivers in northern Sweden but may complicate trend estimates. An alternative approach could be to intensify the water samplings by, for example taking weekly or daily samples during spring flood. Since regulated rivers have a more constant discharge over the year and, thus a more or less constant element flux, monthly samples will produce reliable annual load estimates for these types of rivers.