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Modelling of phosphorus transport during spring flood in northern Sweden.

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Peaks in phosphorus concentrations are observed in connection to the spring flood in some, mainly unregulated, rivers in northern Sweden draining to the Baltic Sea. The elevated concentrations are only seen during a few days prior and following peak discharge in the rivers. This rapid event is often missed by the water quality monitoring programme with a standard monthly sampling frequency. As a consequence, calculated transport of phosphorus, both from interpolation of measurements and from simulations by models calibrated using observed time series may therefore be significantly lower than the actual transport. Possible explanations of this phenomenon were investigated using two numerical water quality models, the HYPE and HBV-NP models. The hypothesis was that the observed peaks in phosphorus concentrations were due to either river bank erosion, flash-out of previously settled phosphorus-laden particles in rivers and/or elevated loading from land in connection to snowmelt in the lowland areas of the catchment. The modelling exercise was supported by high frequency (daily) measurements of phosphorus concentration during the spring flood of 2008 and 2009 in River Kalixälven and in River Umeälven.

Results from the study indicate that different processes may be important in the studied catchments. The dynamics of the simulated phosphorus concentrations from the HBV-NP model, used for the Swedish reporting to HELCOM, greatly improved when a model function controlling sedimentation and resuspension processes in watercourses was activated. Regulated rivers in contrast to unregulated ones have relatively high sustained discharge throughout the winter period which hinders the sedimentation of particles. This could explain why mainly unregulated rivers experience elevated phosphorous concentrations during spring flood. Including bank erosion in the HBV-NP simulations increased simulated phosphorus transport to the right magnitude. Observations showed that the phenomenon of elevated phosphorus concentrations during spring flood was concentrated to regions close to the coast and mainly in areas below the highest sea level (before land rise due to isostatic rebound). Sediments deposited in the Baltic Sea since the last ice age and lifted by the isostatic rebound could be resuspended during the spring flood. Bank erosion from ice breakup may also be an explaining factor. The more HYPE model managed to simulate the concentration patterns well by adjusting model parameters connected to soil leaching and erosion. The model also enabled some of the investigated processes to be mapped in space and time. According to the model, the loading of phosphorus from land to watercourses increases rapidly during snowmelt as a result of groundwater reaching more phosphorus rich soil layers and due to increased surface runoff (causing soil erosion). The HYPE model also showed that resuspension of particles in streams and rivers was very quick at the onset of snowmelt and peaked locally well before peak discharge.