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Modelling sediment input in large river basins

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Erosion and sediment redistribution play a pivotal role in the terrestrial ecosystem as they directly influence soil functions and water quality. In particular surface waters are threatened by emissions of nutrients and contaminants via erosion. The sustainable management of sediments is thus a key challenge in river basin management. Beside the planning and implementation of mitigation measures typically focusing on small and mesoscale catchments, the knowledge of sediment emissions and associated substances in large drainage basins is of utmost importance for water quality protection of large rivers and the seas. The objective of this study was thus to quantify the sediment input into the large drainage basins of Germany (Rhine, Elbe, Odra, Weser, Ems, Danube) as a basis for nutrient and contaminant emissions via erosion.
The sediment input was quantified for all watersheds of Germany and added up along the flow paths of the river systems. Due to the large scale, sediment production within the watersheds was estimated based on the USLE for cultivated land and naturally covered areas and on specific erosion rates for mountainous areas without vegetation cover. To quantify the sediment delivery ratio a model approach was developed using data on calculated sediment production rates and long term sediment loads observed at monitoring stations of 13 watersheds located in different landscape regions of Germany. A variety of morphological parameters and catchment properties such as slope, drainage density, share of morphological sinks, hypsometric integral, flow distance between sediment source areas and the next stream as well as soil and land use properties were tested to explain the variation in the sediment delivery ratios for the 13 watersheds. The sediment input into streams is mainly controlled by the location of sediment source areas and the morphology along the flow pathways to surface waters. Thus, this complex interaction of spatially distributed catchment properties cannot be characterized using only spatially lumped parameters for watersheds located in very different landscape regions. From all parameters tested, the mean slope of the watersheds and the share of arable land located in a distance of 500 m revealed a significant relation to the sediment delivery ratio. Using both parameters the sediment input was quantified for all other watersheds of Germany showing a good agreement with observed long term sediment loads at monitoring stations.