Sediment-associated pollutants: Transport mechanisms and factors governing river sediment vulnerability

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Transport of hydrophobic pollutants in rivers is usually facilitated by suspended sediment particles, which are typically mobilized during high discharge events. Suspended sediments thus represent a means of transport for particle related pollutants within river reaches and may represent a suitable proxy for average pollutant concentrations estimation. Based on mean annual suspended sediment concentrations and distribution coefficients of pollutants in addition the fraction of particle facilitated transport versus dissolved fluxes might be calculated. Multiple high discharge events were sampled at high temporal resolution in the Globaqua River Basins Sava (Slovenia, Serbia), Adige (Italy), and Evrotas (Greece) and analysed for the presence of persistent organic pollutants such as PAHs (polycyclic aromatic hydrocarbons) or PCBs (polychlorinated biphenyls) and heavy metals. Overall results show that loadings of suspended sediments with pollutants are catchment-specific and relatively stable over time at a given location. This is further corroborated by additional long term measurements from contrasting catchments in Germany and Iran. Metal concentrations mainly display a geogenic origin and only vary moderately across all tested basins. In contrast, PAH are much more variable and more sensitive indicators of anthropogenic influence. We demonstrate that the contamination of suspended sediments with PAH can be explained by the ratio of inhabitants residing within the watershed and the watershed's sediment yield. Formerly developed in meso-scale catchments in Germany ranging in size from 1.4 to 3000 km², this conceptual approach is applied to the large catchments of Adige and Sava. It allows for reasonable predictions of the PAH loading of suspended sediments especially at larger scales. Furthermore, it can be concluded that, despite the existence of urban pressure within a catchment, sediment yield may exhibit a diluting effect and, consequently, be a crucial parameter governing the vulnerability of river sediments. River systems that are particularly sensitive to inputs of hydrophobic pollutants can be expected either in landscapes with inherently low sediment production, e.g. karstic areas, or where sediment transport is interrupted by artificial structures, e.g. by large dams. In principle this also holds for metals, however, due to the inherent metal concentrations of background sediments a delineation of additional urban/industrial metal inputs is more difficult. Our findings may, thus, easily be used to estimate the vulnerability of river systems to particle-associated urban pollutants with similar input pathways as the PAH or to indicate if contaminant point sources such as industrial activities or sites of legacy pollution exist in a river basin. To this end, catchments' sediment yields are required which may, if no measured data are available, be modeled based on the Revised Universal Soil Loss Equation (RUSLE2015, Panagos et al., 2015) and the sediment delivery ratio (SDR).

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References

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