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Assessment of diffuse trace metal inputs into surface waters – Combining empirical estimates with process based simulations

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As a result of mining activities since the 13th century, surface waters of the German Mulde catchment suffer from deleterious dissolved and sediment attached lead (Pb) and zinc (Zn) inputs.
The leaching rate of trace metals with drainage water is a significant criterion for assessing trace metal concentrations of soils and associated risks of ground water pollution. However, the vertical transport rates of trace metals in soils are difficult to quantify. Monitoring is restricted to small lysimeter plots, which limits the transferability of results. Additionally the solid-liquid-transfer conditions in soils are highly variable, primarily due to the fluctuating retention time of percolating soil water.
In contrast, lateral sediment attached trace metal inputs are mostly associated with soil erosion and resulting sediment inputs into surface waters. Since soil erosion by water is related to rare single events, monitoring and empirical estimates reveal visible shortcomings. This gap in knowledge can only be closed by process based model calculations. Concerning these calculations it has to be considered, that Pb and Zn are predominantly attached to the fine-grained soil particles (<0.063 mm). The selective nature of soil erosion causes a preferential transport of these fine particles, while less contaminated larger particles remain on site. Consequently trace metals are enriched in the eroded sediment compared to the origin soil.
This paper aims to introduce both, a new method that allows the assessment of trace metal leaching rates from contaminated top soils for standardised transfer conditions and a process based modelling approach for sediment attached trace metal inputs into surface waters.
Pb and Zn leaching rates amounts to 20 Mg ha-1 yr-1 resp. 114 Mg ha-1 yr-1. Deviations to observed dissolved trace metal yields at the Bad Düben gauging station are caused by plant uptake and subsoil retention.
Sediment attached Pb and Zn input rates amounts to 114 Mg ha-1 yr-1 and 173 Mg ha-1 yr-1 ,which increase measurements by 10 to 25 times. This can only be caused by an inappropriate sampling regime. Routine sampling seems to reflect base load of trace metals rather than total trace metal loads.