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Groundwater and surface water contamination from diffusively contaminated soils. A case study: The Keersop catchment in the Kempen area.

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In many areas in the world, soils are diffusively contaminated with heavy metals or organic contaminants. These contaminants not only pose risks for humans, agriculture or soil ecosystems, but they also can form a source of secondary contamination, due to contaminant leaching to groundwater systems and surface waters. Modelling contaminant leaching to groundwater and surface waters is generally very difficult, as most contaminants are located in the top soil where soil properties will vary strongly with depth and there is often a strong gradient in contaminant concentrations. When also groundwater periodically penetrates the contaminated layers, stationary models (like most 3D models) will not be able to adequately describe contaminant transport. For a case study, we have used an instationary hydrological model to calculate current leaching rates and to predict future leaching rates of heavy metals. With this model we showed the importance to include instationary hydrology for

In the Kempen region located in the south of the Netherlands and the north of Belgium, zinc production has been performed since the 19th century. The zinc smelters in this area have led to high atmospheric emissions of Zn, Cd and also Pb. Consequently, this has led to elevated levels of these metals in soil. At current, atmospheric emissions from the zinc smelters in the Kempen region have stopped, but the heavy metals present in soil still pose a risk with regard to secondary contamination of groundwater systems and surface waters. For this study, the Keersop catchment in the Kempen region has been selected.

To calculate leaching of Zn and Cd, we used a combination of a 1D-hydrological model and an advanced geochemical model. We calculated leaching for the period of 1880 to 2060. The processes included in our calculations were atmospheric deposition, application of Zn and Cd in animal manure and fertilizer, plant uptake, emissions from Zn-ash roads, reactive transport, and discharge to surface waters.

The modeling results showed that leaching of Zn and Cd is a slow process, even for the acidic sandy soils in the Keersop catchment. Most of the emitted heavy metals are still present in the first 30 cm of the soil. Nevertheless, surface water concentrations have increased significantly during that period. The dynamics in surface water concentrations as found in measurements could be very well described by the model and were found to be related to changes in the groundwater level. Leaching estimates using stationary hydrology underestimated measured leaching systematically.