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Improved water resource management using three dimensional groundwater modelling for a highly complex environmental

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Proper allocation and management of groundwater is an important and critical challenge under rising water demands of various environmental sectors but good groundwater quality is often limited because of urbanization and contamination of aquifers. Given the predictive capability of groundwater models, they are often the only viable means of providing input to water management decisions. However, modelling flow and transport processes can be difficult due to their unknown subsurface heterogeneity and typically unknown distribution of contaminants. As a result water resource management tasks are based on uncertain assumption on contaminants patterns and this uncertainty is typically not incorporated into the assessment of risks associated with different proposed management scenarios.
A three-dimensional groundwater model was used to improve water resource management for a study area, where drinking water production is close to different former landfills and industrial areas. To avoid drinking water contamination, artificial groundwater recharge with surface water into the gravel aquifer is used to create a hydraulic barrier between contaminated sites and drinking water extraction wells. The model was used for simulating existing and proposed water management strategies as a tool to ensure the utmost security for drinking water. A systematic evaluation of the flow direction and magnitude between existing observation points using a newly developed three point estimation method for a large amount of scenarios was carried out. Due to the numerous observation points 32 triangles (three-points) were created which cover the entire area around the Hardwald. We demonstrated that systematically applying our developed methodology helps to identify important locations which are sensitive to changing boundary conditions and where additional protection is required without highly computational demanding transport modelling. The presented integrated approach using the flow direction between observation points can be easily transferred to a variety of hydrological settings to evaluate systematically groundwater modelling scenarios.