Geophysical Research Abstracts
Vol. 20, EGU2018-15217, 2018
EGU General Assembly 2018

The RESPONSE project: Reactive transport modelling of point source contamination in soils and groundwater

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Point source contaminations origin from historic or current activities and occur in a variety of forms, extents and contaminants involved (e.g. landfills, industrial facilities, storage tanks, disposal of hazardous waste). Point source contaminations may pose risks to human health and the environment; it is therefore important to develop/improve current methodologies to assess the migration potential of contaminants in groundwater.

Groundwater quality monitoring around contaminated sites is typically done by sampling piezometers. Modelling approaches can help to predict the spatial and temporal evolution of contamination plumes, design remediation strategies and assess health and environmental risks. Reactive transport models can potentially improve the prediction of contaminant routes, as they explicitly account for changing geochemical environments and chemical reactions during transport. In spite of recent advances, real-world applications remain scarce as these require large numbers of site-specific parameters.

The aim of the RESPONSE project is to improve the use of reactive transport models that simulate the fate of inorganic and organic contaminants in soils and groundwater. More specifically, this project aims to (1) identify the minimum amount of site-specific parameters needed to predict reactive transport of inorganic pollutants (e.g. heavy metals) and (2) improve/simplify the modelling of transport of xenobiotic organic contaminants (XOC, e.g. hydrocarbons and pesticides). The transport of XOCs is particularly complex to model due to the effects and zonation of microbial activity at the plume fringe in polluted aquifers.

The RESPONSE project focusses on typical groundwater pollution problems encountered around old municipal landfill sites and cemeteries. Municipal landfills can still release hazardous pollutants such as heavy metals and XOCs, even if they are covered by fresh ground layers after abandonment. Cemeteries can be considered a special case of landfill, releasing various compounds to the environment such as arsenic, mercury, bacteria, viruses and herbicides. Both location types are potential point sources for mixed groundwater pollution, typically including high concentrations of dissolved organic carbon (DOC), heavy metals and XOCs.

The methodology in this project involves both experimental and modelling aspects. During the first screening stage, groundwater samples have been collected from shallow piezometers at fifteen contaminated sites (municipal landfills and cemeteries) across Belgium. Also, an improved reactive transport model is built based on HYDRUS1D-MODFLOW-PHREEQC to explicitly account for the dynamic behaviour of chemical conditions at the soil-ground water interface. Next, based on laboratory analyses, three case-study sites will be selected for further modelling and testing.