BRAIN-be
Belgian Research Action through Interdisciplinary Networks

RESPONSE

Reactive transport modelling of point source contamination in soils and groundwater

DURATION
15/12/206 – 15/03/2021

BUDGET
961 690 €

PROJECT DESCRIPTION

The RESPONSE project deals with the transport of point-source contaminants in soils and groundwater. There exist numerous types of pollution point sources, including landfills, industrial facilities, storage tanks, disposal of hazardous waste, etc. Point source contaminations in Belgium from historical or current activities are numerous and display a great variety in forms, areas and contaminants involved. In the context of the EU Groundwater Directive (2006/118/CE), plumes resulting from point sources have received particular attention. However, the huge number of confirmed or potential point source sites constitutes a challenge. New methods to assess the migration potential of contaminants are needed.

Groundwater quality monitoring around contaminated sites is typically done by sampling piezometers, allowing detecting and following the evolution of a contamination plume. However, for management purposes a modelling analysis can help to anticipate the spatial and temporal evolution of the plume, to design remediation strategies and to assess the risks towards human health and the environment. If models explicitly account for chemical reactions during the transport of contaminants, they are called reactive (transport) models. Their main advantage is a more accurate representation of the physico-chemical reactions occurring in the underground and thus a potentially better prediction of contaminant routes and fate.

Although major advances have been made in the development of such computer codes, real-world applications of reactive transport models remain scarce because they usually require a tremendous number of site-specific parameters characterizing the soil and hydrogeological settings. RESPONSE aims at improving the use of reactive transport models to simulate the fate of inorganic and organic contaminants in soils and groundwater. More specifically, we want to (1) identify the minimally required available parameter set needed to predict current reactive transport of inorganic pollutants (e.g. heavy metals) and (2) improve/simplify modelling of the transport of xenobiotic (or artificial) organic pollutants (XOCs).

The methodology involves both experimental and modelling aspects. Three case studies, in shallow groundwater environments (to examine how the seasonally fluctuating soil-groundwater interface influences inorganic contaminant transport), will be selected for testing the methodology developed in the project. More generally for inorganic contaminants (heavy metals), RESPONSE will test whether reactive models can be used to predict transport in a satisfactory way, with only generic data such as groundwater level data, soil and geochemical maps, topography, etc. Concerning organic contaminants, RESPONSE aims to develop a simplified approach to infer the redox zonation and plume fringe in polluted aquifers.

Among the variety of point-source pollution types, RESPONSE will focus on typical groundwater pollution problems encountered in old municipal landfills sites and cemeteries. Even if they have been covered by a fresh ground layer since abandonment, old municipal landfills can still release hazardous pollutants such as heavy metals and XOCs to the environment. Cemeteries, as a special case of landfill, involve the release of various compounds to the underground such as arsenic and mercury, bacteria and viruses, etc. Besides, cemeteries have been identified as potential point sources for herbicide leaching to groundwater.

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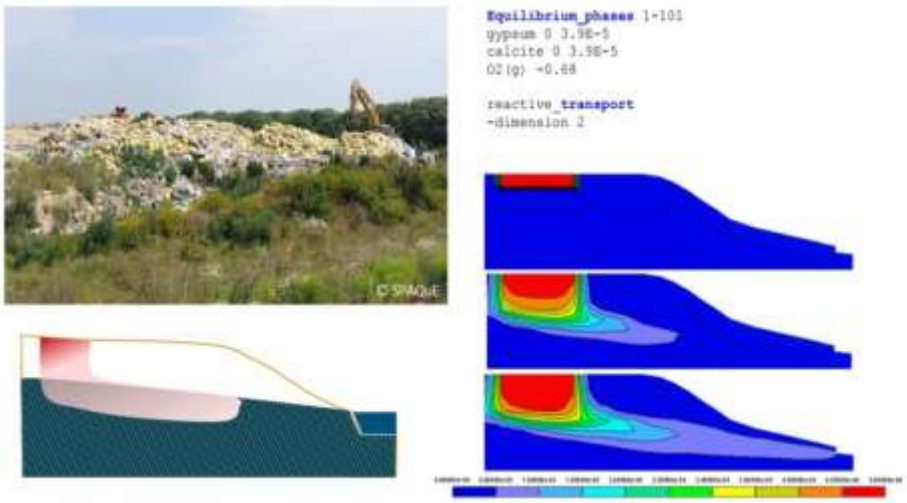
If RESPONSE confirms the applicability of reactive transport modelling for certain inorganic contaminants with just historical information on the source term and readily available data, this opens perspectives for more systematic environmental risk assessments without prohibitive costs of site-specific data acquisition. The outcome of the research is transposable to many kinds of point source pollutions (e.g. small-scale historical workshops and industries, railway tracks…), thereby enhancing the societal impact of the project. For organic contaminants, the efficiency of monitored natural attenuation activities for site restoration could be improved if a simplified approach for redox zonation can be developed.

Currently, cemeteries do not receive much attention concerning the potential pollution of groundwater However, many cemeteries are older than any legislation on cemeteries (burial depth, depth above groundwater) and it cannot be excluded that cemeteries represent a pollution risk in certain circumstances. In this respect, the research might also have some impact on the soil and groundwater policy.

Project outputs will consist of annual reports and scientific publications. The reactive transport models developed for the project will be available for use by stakeholders. Also, in the last semester of the project, a workshop will be organized to present the main project outcomes. Targeted audience will include environmental consulting companies, regional authorities of soil and water management, universities.

RESPONSE represents an interdisciplinary consortium of experts in hydrological and reactive transport modelling, geochemistry, geography, geology and microbiology.



Upper left: old municipal landfills are an example of a point source pollution.
Lower left: conceptual model of groundwater contamination due to the leaching of hazardous chemicals.
Right: snapshots of a reactive transport model simulation.

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LINKS

https://www.researchgate.net/project/RESPONSE-Reactive-transport-modelling-of-point-source-contamination-in-soils-and-groundwater

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