AQUAREHAB

Development of rehabilitation technologies and approaches for multipressured degraded waters and the integration of their impact on river basin management

Newsletter June 2010

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Conferences

AQUAREHAB results will be presented at

- PRB-RZ-2010 (Antwerp, being organised by VITO, 6-7 July 2010) www.vito.be/english/events
- CONSOIL-2010 (Salzburg, 22-24 September 2010) www.consoil.olanis.de

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Introduction

The AQUAREHAB project has now been operating for a year. It began with a Kick-Off Meeting at VITO (Mol, Belgium) in the first week of June 2009, and since then we have held the First End User Workshop at the Public Waste Agency of Flanders (OVAM) (Mechelen, Belgium) in November 2009, and the Second General Meeting with all partners at UNESCO (Delft, the Netherlands) in January 2010.

In this Newsletter we provide information about the outcome of the First End User Workshop and the Second General Meeting. In addition, we provide news on technology and modeling developments from Work Package 4 – Multibarrier technology for mixed groundwater pollution; as well as information concerning news from the field.

Technology and Modelling Developments - Multibarrier technology (WP4)

The multibarrier technology is an innovative in-situ technology to improve the quality of groundwater. A research topic within AQUAREHAB is a multibarrier consisting of 2 compartments to eliminate chlorinated aliphatic compounds (CAHs), such as trichloroethylene (TCE). The two compartments are: (1) a zerovalent iron barrier, and (2) a biological reactive zone stimulated with the injection of electrondonors. Earlier, the multibarrier concept was found suitable for an industrial site in Belgium, which has been selected as test site in AQUAREHAB. Currently, focus is on determining, based on lab scale experiments, CAH-degradation rates and corrosion rates of the zerovalent iron. New approaches to determine degradation rates with innovative molecular and analytical methods are being evaluated. The gathered data are required input for a model, which allows to evaluate the impact of the multibarrrier technology on the water quality in time and in space. The aim of the model is to realise a more accurate design of PRBs and RZ, including information on the longevity of the technology.

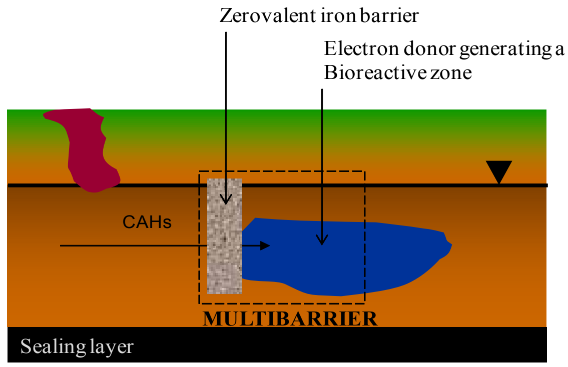

Figure 1: Multibarrier technology prevents the spread of a contaminated ground water system

Figure 2: Sampling of undisturbed aquifer and groundwater in the field (Antwerp, Belgium) (left) and laboratory CAH-degradation tests (right)

The general guidelines that will be produced for an optimal multibarrier design, will be applied to other multi-barrier systems later on in the AQUAREHAB project.

Modelling efforts focus on a quantitative description of the biogeochemical processes that drive contaminant degradation in multi-barrier systems. A thorough understanding of these processes is crucial for an effective and long-lasting implementation of the technology. For example, an important process in zero-valent iron barriers is precipitation of minerals: over time it leads to a reduction in degradation efficiency, eventually compromising the technology. If and when this happens, depends on many factors, including local groundwater conditions (flow velocity, geochemical concentrations) and design of the barrier itself (barrier thickness, reactivity of iron material). All these factors are integrated and accounted for by a numerical model developed as part of the AQUAREHAB project. Reliability of the model was assessed by comparing its predictions to measurements on a small-scale iron barrier in the lab.

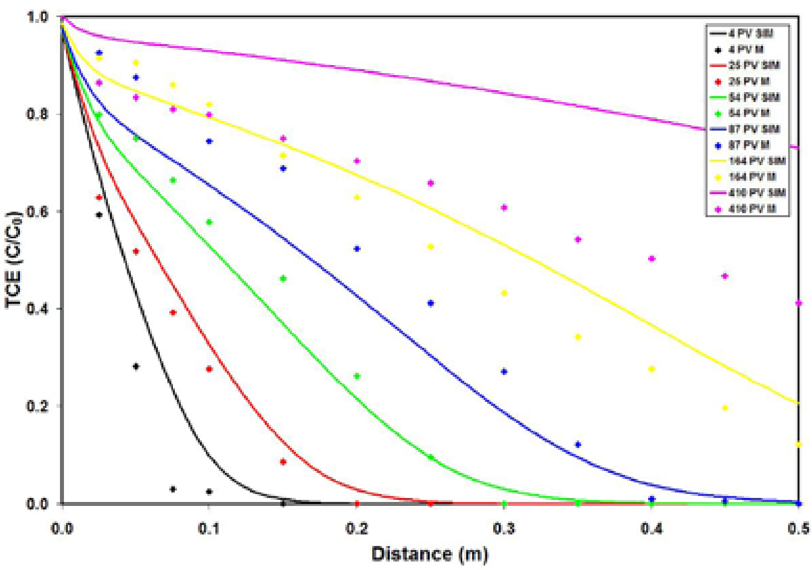

Figure 3: Comparison of measured (diamonds) and simulated (solid lines) CAH concentrations in a lab-scale iron barrier, showing reduction of degradation efficiency over time

Figure 3 shows us that focus is now shifting to applying the model at the AQUAREHAB test site in Belgium. As such, the model provides a unique opportunity to integrate all measurements and data that have been collected thus far at the test site within the AQUAREHAB project. It is expected that this will lead to improved understanding and prediction of multibarrier remediation systems.

Measured (diamonds) and simulated (solid lines) TCE concentration profiles in a lab-scale iron barrier, show reduction of degradation efficiency over time: initially, TCE degradation occurs rapidly (as indicated by black diamonds), but gradually degradation efficiency decreases over time, as shown by the shifting TCE concentration profiles (ending with the pink symbols at later times) (Figure 3). The gradual failure of the lab-scale iron barrier in Figure 3 was observed over a period of several months using accelerated flow conditions. Under much slower natural groundwater flow conditions, failure is expected to occur over a period of years to decades, depending on local site conditions.

News from the Field

In the **Scheldt case study** area (Belgium) a number of contaminated groundwater sites are being investigated for remediation technology.

A site is heavily contaminated by chlorinated aliphatic hydrocarbons (CAHs) as shown in figure 4. Within AQUAREHAB, there has been a chemical, ecological and hydromorphological survey at 3 locations along the Zenne river during the autumn of 2009. Further samples were collected for lab scale testings by different scientific partners.

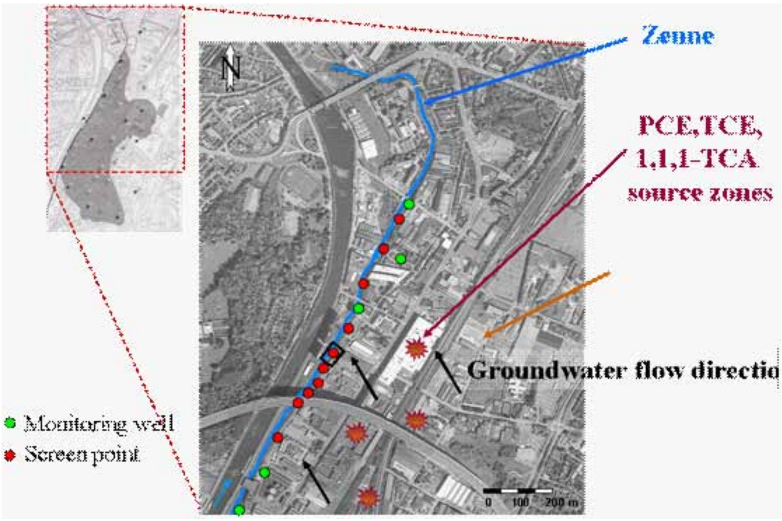

Figure 4: Aerial view of Industrial site (River Scheldt, Belgium), with monitoring sites

At an industrial site in Antwerp (Belgium), there is a multibarrier in operation for several years now, where abiotic reduction (zerovalent iron = ZVI) and biodegradation are combined (see Figure 1) to cope with a CAH-contamination plume. AQUAREHAB makes use of the full scale ZVI wall (200 m long) at the site to extrapolate results from the lab into the field and calibrate numerical models. Every 3 to 4 months, a monitoring campaign of the groundwater in and near the multibarrier is taking place (see Figure 2).

To investigate the performance of injectable reactive Fe-based material to remove CAHs and BTEX, a number of potential field sites in Flanders were screened. The most interesting site (near Antwerp) will be selected for further investigation.

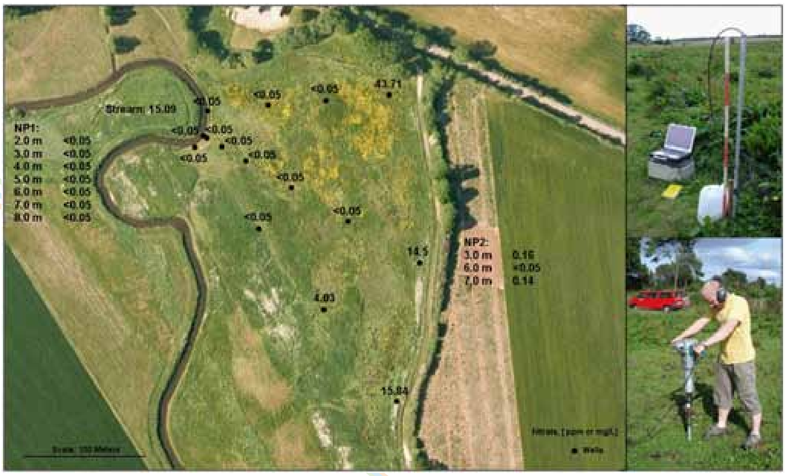

Figure 5: Aerial view of Brynemade (River Odense, Denmark), with geophysical sampling points

In the **Odense case study** area (Denmark), which is an important agricultural area, two wetland case study areas have been selected for further work: Brynemade and Skallebank. Most work has been done at Brynemade, where geophysical characterisation and conceptual modelling is well advanced. In addition, there has been chemical, ecological and hydromorphological survey at 7 locations along the Odense river. Further work includes identifying the main pathways of pesticide release to the river and explaining the peaks of pesticide concentration in river water in spring time run-off.

Figure 6: Drainage system installed along the local groundwater stream paths for the removal of hazardous pollutants from the Sechor-Besor aquifer

In the **Sechor-Besor case study area** (Israel), which is close to a large chemical plant, work is ongoing to assess the use of tailored carrier/bacteria technology to remove pesticides from ground water. An initial characterisation has taken place – the site water is brackish with the following main organic compounds detected: BTEX, phenyl urea based compounds and some brominated pollutants.

Papers

- J. Bosch, K. Heister, T. Hofmann, and R. U. Meckenstock (2010). Nanosized Iron Oxide Colloids Strongly Enhance Microbial Iron Reduction. Applied and Environmental Microbiology, p. 184–189.
- J. Bosch, A. Fritzsche, K. U. Totsche, R. U. Meckenstock (2010). Nanosized Ferrihydrite Colloids Facilitate Microbial Iron Reduction under Flow Conditions, GEOMICROBIOLOGY JOURNAL, vol.27 (Issue: 2), p. 123-129.
- Maphosa, F., De Vos, W.M., and Smidt, H. (2010). Exploiting the ecogenomics toolbox for environmental diagnostics of organohalide respiring bacteria. TIBTECH 28: 308-316.

Presentations

The AQUAREHAB team has recently made presentations and shown posters at the following conferences:

- European Geosciences Union (EGU) General Assembly 2010 (Vienna, Austria, 02-07 May 2010)
- Meuse Symposium (Liège, Belgium, 23-24 April 2010)

Announcements

- AQUAREHAB's Second Open End-User Meeting will take place 18 January 2010 in Copenhagen (Denmark).

AQUAREHAB meetings

AQUAREHAB's Open First End User Meeting.

The First AQUAREHAB End User Meeting was held on 18 November 2009 at the Public Waste Agency of Flanders (OVAM) (Mechelen, Belgium). The meeting was attended by 32 people, principally stakeholders from Belgium. VITO presented the technologies being addressed in the AQUAREHAB project and the likely functionality of the Decision Support Tool. In addition, there was a presentation by Jiska Verhulst (OVAM) concerning soil remediation policy in the Flanders Region and by Anja Van Geyt (VMM) concerning the programme to reduce the occurrence of priority substances in the Scheldt River Basin.

AQUAREHAB's Second General Meeting

The AQUAREHAB project had its Second General Meeting at the UNESCO-IHE Institute for Water Education (Delft, the Netherlands) on 14 to 15 January, 2010. The meeting was attended by representatives of 18 out of AQUAREHAB's 19 partners – in total 37 scientists were present. The participants were welcomed by Prof. Joop de Schutter (the Vice-Rector). The Second General Meeting was an opportunity to discuss the progress of the Project in its first year, present the results achieved in 2009, and have detailed WP meetings to define the tasks and deliverables for the next 6 to 12 months. Other issues such as how the work of the project is being disseminated and the involvement of end users were also discussed. The next AQUAREHAB General Meeting will be held in Copenhagen (Denmark) in January 2011.

AQUAREHAB in a nutshell

AQUAREHAB is an EU financed large scale research project (FP7) that started 1st May 2009 with 19 project partners. The AQUAREHAB consortium will work together on the project for 56 months (until 2013). Within this project, different innovative rehabilitation technologies for soil, groundwater and surface water will be developed to cope with a number of priority contaminants (nitrates, pesticides, chlorinated compounds, aromatic compounds, mixed pollutions…) within heavily degraded water systems. The expected outcome of the project is new or improved remediation technologies; guidelines to describe feasibility tests, applications and monitoring; technology specific numerical tools to improve designs and predict the long term effects of technologies; and, a generic river basin management tool that predicts the impacts of measures on surface and ground water bodies. AQUAREHAB therefore aims to be the basis for improving future river basin management tasks and site specific remediation management.