AQUAREHAB

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

NEWSLETTER OCTOBER 2013

Topics

Announcements:

Final AQUAREHAB Symposium, 20th-21st November, 2013, Leuven, Belgium.

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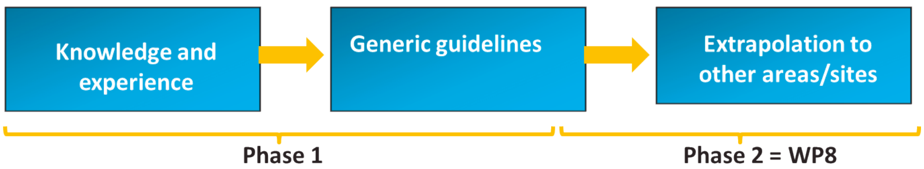
Introduction

AQUAREHAB has now been running for over four years, and aims to finish by the end of 2013. The principle work in the second half of 2013 has been the finalisation of the extrapolation of the AQUAREHAB developments to other areas (Work Package 8) and the preparation of the Final AQUAREHAB Symposium, which will be held in Leuven, Belgium in November 2013.

In this Newsletter we focus primarily on how we have approached Work Package 8 and report on the work that has been carried out in the field to date, with some initial results.

The extrapolation of the AQUAREHAB developments to other areas and sites (Work Package 8)

Within AQUAREHAB different innovative rehabilitation technologies for soil, groundwater and surface water were studied and developed to cope with a number of priority contaminants (nitrates, pesticides, chlorinated compounds, aromatic compounds, mixed pollutions…) within heavily degraded water systems (WP1-5). Methods have been developed to determine the long-term impact of the innovative rehabilitation technologies on the reduction of the influx of these priority pollutants towards receptors such as drinking water wells and surface water (WP7). A connection between the innovative technologies and river basin management is being finalised, with focus on groundwater as well as surface water, on the basis of different of modelling schemes (WP6-7). WP8 represents opportunities to extrapolate AQUAREHAB developments to other areas, in order to test the robustness of the innovative rehabilitation technologies and the modelling tools developed during the project.



Since the end of 2010 we started the process of selecting the extrapolation cases for WP 8 with a number of proposals being submitted by project partners. On the basis of selection criteria the following 4 cases were chosen to be implemented with the view that these would be used to update generic guidelines for rehabilitation technologies and modelling tools developed in Phase 1 of the AQUAREHAB project:

- » Wetlands extrapolation case (partners involved: KUL, GEUS, UCPH, CTM and EI) (WP1+);
- » ZVI-barrier extrapolation case (partners involved: VITO, TUD, Sapion, MU, POLITO, CTM) (WP4+);
- » Injectable ZVI extrapolation case (partners involved: VITO, SAPION, HB, POLITO, USTUTT) (WP5+); and,
- » REACHER local extrapolation case (partners involved: VITO, INERIS, USFD) (WP6+).

This selection meant that 15 out the 19 AQUAREHAB partners are involved in Phase 2 of the AQUAREHAB project.

Case 1: Wetlands extrapolation (WP1+)

During the Phase of the AQUAREHAB project WP1 developed models to predict the overall effectiveness of wetlands in removing pollutants taking into account possible effects of seasonal disturbances and guidelines for wetlands restoration aimed at optimal pollutant removal. The aims of the WP1+ extrapolation case are to (1) further validate and improve the developed subsurface nitrates transport models and to compare/acquire more information on subsurface denitrification rates across wetlands, and (2) validate and improve the developed subsurface pesticide transport models and collect/validate in situ information about seasonal differences in pesticide degrading wetland activity.

The validation and improvement of the developed subsurface nitrates transport models has been carried out at one of the three other wetlands sites in Denmark, studied by UCPH, that have been well-characterised regarding geohydrology but characterised less well regarding groundwater chemistry, including nitrates and pesticide content. All three sites are located in the head water catchment of the Skjern River Basin in Mid-West Jutland, Denmark. They all belong to the Holtum sub-catchment, an approximately 126 km^2 large catchment. The river is here called the Holtum stream and is about 14 km long from the headwater to the outlet of the catchment. Discharge at the outlet reaches an annual mean of around 1.0 m^3/s. The stream traverses agricultural and forest lands. Two field investigations were carried out; a survey in February 2013 to map nitrate concentrations at four field sites and the installation of two new wells with multi-level sampling. Based on these results the Hygild site was selected for a detailed survey. In May 2013, a new field campaign was carried out with the aim to acquire information on the distribution of nitrates, nitrite and dissolved oxygen content in the subsurface at the Hygild site, and to take soil cores in order to obtain detailed information about on-site denitrification rates for the modelling set-up. A 32m transect spanning the riparian zone was characterized at a high resolution. Water was sampled from 8 existing wells and from 31 new hand-driven wells. Two intact soil cores (0-2 m) were collected from the nitrates reduction zone. The cores were cut into 10-cm thick slices in the lab, and subsamples were handled under anaerobic conditions for the determination of nitrates reduction potential and for the measurement of soil organic matter (SOM) content.

Figure 1. Wetlands area close to the Odense River

The validation and improvement of the developed subsurface pesticide transport models has been carried out at a site in Moldova and one site in Belgium. In Moldova two sites were considered. Site 1 is related to an on-going modelling project in the Prut River Basin, which forms the western border of Moldova with Romania. This area suffers from regular floods, causing damage to cities and roads along the river. Moldova site 2 is a natural wetland area in the neighbourhood of pesticide polluted areas in the south-eastern part of Moldova (Dniester Basin, towards Ukraine). The Bernissem field site, in Belgium, is a restored riparian wetland that is constantly flooded by the Melsterbeek that drains a catchment dominated by fruit orchards and arable fields. All three wetlands function as a buffer against diffuse pollutants from the upstream catchment reaching downstream water bodies. Three field sampling campaigns in 2013 were performed on 11th February, 25th March and 24th June. During the weeks prior to the sampling in March, temperatures were well below zero and the soil and water were frozen. The microbial communities in the soil may have been affected by this freezing period, which may be reflected in altered kinetics of mineralization of MCPA or IPU. First results seem to support this hypothesis.

Case 2: (WP4+) ZVI-barriers – column study

During the first phase of the AQUAREHAB project WP4 has focused on the multibardem technology for treatment of mixed contamination plumes, in particular the zerovalent iron (ZVI) barrier technology. Multibarrier technology is an innovative in-situ remediation technology for groundwater, consisting of a combination of permeable reactive barriers and reactive zones, in which different pollutant removal processes are combined. WP4 developed optimised test procedures for lab scale feasibility tests to generate adequate data for prediction (via modelling) of the short and long term performance and impact of ZVI-barrier technology. The aims of the WP4+ extrapolation case are to extrapolate and if necessary refine, these optimised test procedures for lab scale feasibility tests at a new site. Three sites were considered in Belgium, Spain and Italy. As the CAH concentrations were low at the examined sites in Spain and Italy, the extrapolation case has been developed for the new site in Belgium.

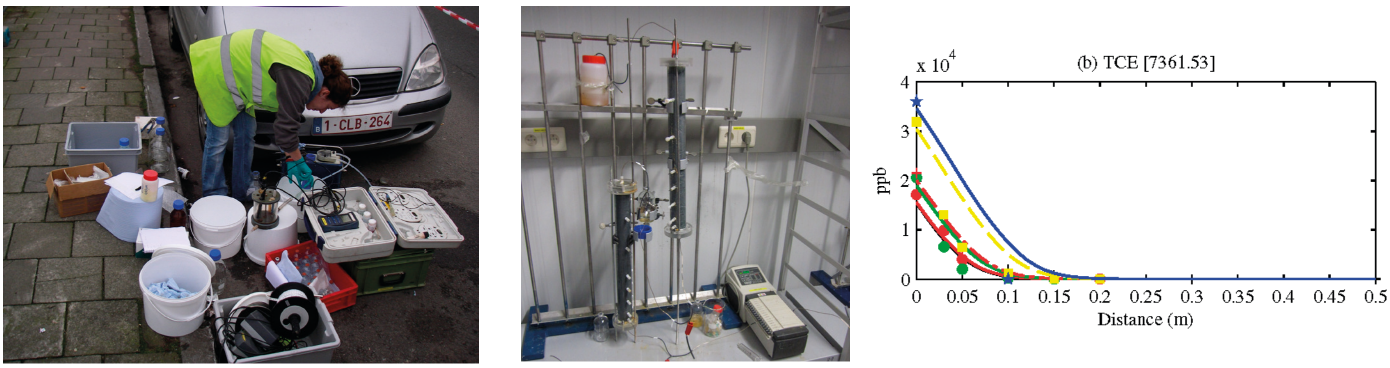


Figure 2. Sampling of large volumes of groundwater at Belgian site (left); Column feasibility test (middle); and measured and simulatedTCE concentration profiles along the column (right)

After examining available site information, a well was selected to sample a large volume (120L) of representative groundwater for the lab scale feasibility test. In January 2013 a column test was started using this groundwater and a ZVI-type from Höganäs that was newly developed within AQUAREHAB. Using the optimised procedure, the required parameters for predicting the reactivity and longevity of the ZVI-barrier are being determined. Further, a simplified model for predicting the reactivity and longevity of the ZVI-barrier will be evaluated and compared with results from a more complex numerical model. Up until now more than 400 pore volume of water have been pumped through the columns and the ZVI is still reactive. It is uncertain when a decrease in reactivity of the new ZVI type can be observed to derive inactivation parameters. One of the objectives is also to evaluate how easy non-modellers can work with the numerical tools. The work will allow further optimising the test procedure taking into account, the results, the required time and budget.

Case 3: (WP5+): Injectable ZVI – field injections

During the first phase of the AQUAREHAB project WP5 developed tools for detecting and predicting the migration of ZVI in the subsurface, as well as new reactive particles. Further efforts were made to distinguish injections via permeation from injections via preferential flow paths. The aims of the WP5+ case are (1) to use the developed tools at another site, following a number of steps described in the generic guidelines and (2) to test injection methods aiming at permeation and preferential flow paths in parallel.

Based on samplings and chemical analyses it was decided to perform the pilot tests for the site in Belgium on the parking lot near the source zone where suitable amounts of pollution (2->10 mg/l range) are present and space is available. At the start, lab tests were carried out to verify the reactivity of the selected Höganäs iron particles for the preferential flow-path injection test. In addition, a dose test with groundwater and aquifer material from the site was started and the required dose of guar gum for BASF and Höganäs iron was determined. Based on the calculation and experience from previous tests, the pilot tests were designed and technically worked out (Figure 3).

The field work comprised different aspects. Firstly, the injection well was installed with a multilevel monitoring system (comprising iron-sensors, T-sensors and sampling points). As hydraulic tests revealed that the injection well was not suitable for the envisioned injection, it was decided to install a new well with an adapted design. Slug test results and water injections tests indicated that the second injection well was good. Secondly, two types of injections were performed: the injection of 50 kg of BASF iron (2µm) in 0.2% guar gum via the injection well, targeting permeation; and, the injection of 250 kg of Höganäs iron H26 (50 µm) in 0.45% guar gum via direct push technology (Figure 4), creating preferential flow paths and a radius of influence of 0.5 m.

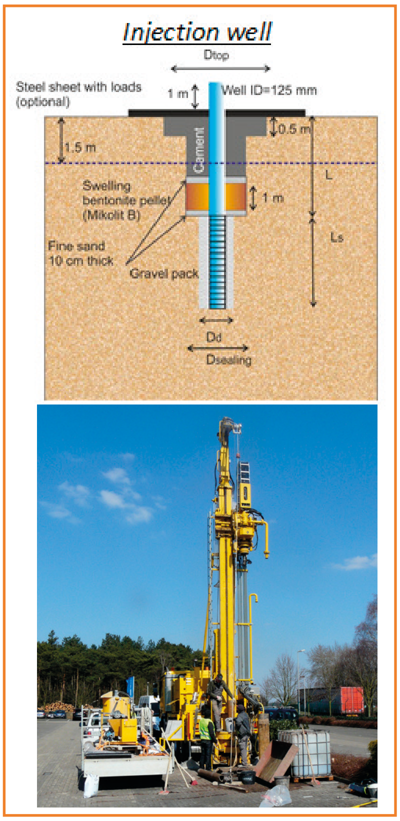


Figure 3. Design and installation of injection well

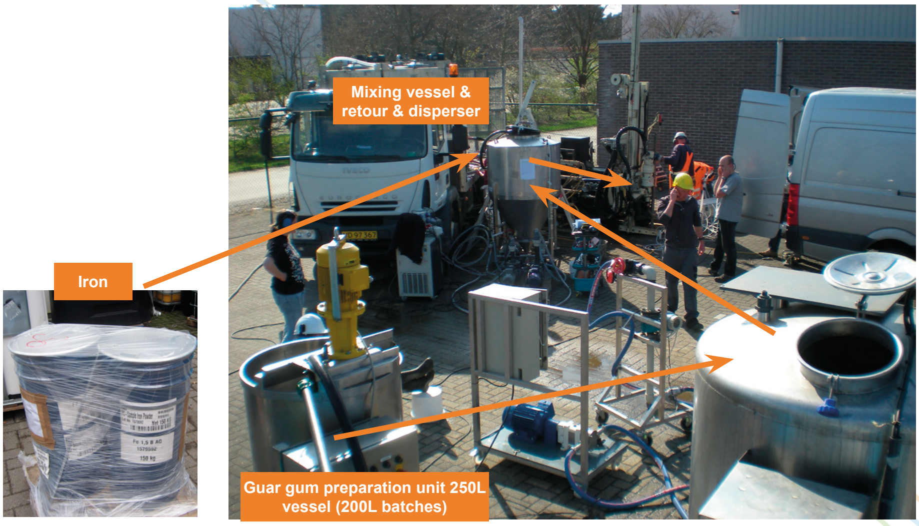


Figure 4. Injection of guar gum stabilised microscale ZVI via direct push

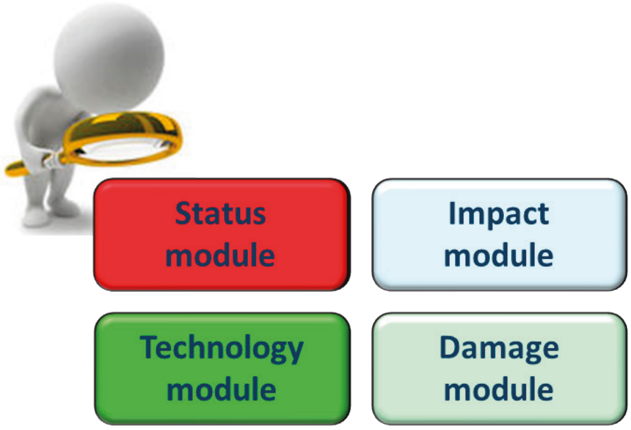
Immediately after the injection, soil cores were taken for iron determinations via susceptibility and via hydrogen measurement after acid treatment. For the injection via the well, the iron seems to have reached a distance about 0.8 m far from the injection point. Significant amounts of iron were detected within 0.5 m from the direct push injection points, but occasionally also at a few meters distance. The long term monitoring is still taking place, but first results clearly indicate a conversion of PCE to lower chlorinated compounds and to ethane.

Case 4: (WP6+): REACHER-Local

During the first phase of the AQUAREHAB project WP6 developed the REACHER river basin management tool. This tool focuses on large scale areas and includes, in the main, highly dynamic processes that have a large effect on the goals set in the Water Framework Directive. Groundwater is considered within the REACHER, but in an abstract (inexplicit) way. Diffuse pollution resulting from agriculture can be considered within REACHER, and efforts are made to include the impact of wetlands on the water quality. However, it turned out to be almost impossible to link groundwater management to the existing REACHER tool, in particular local groundwater pollution is difficult to integrate and consequently most innovative technologies (besides wetlands) have had, to date, no links with the REACHER tool. As such, a more locally oriented tool is required that is specifically aimed to prioritize measures implemented at the local scale. Therefore, the aim of WP6+ is to develop a prototype management tool (REACHER-LOCAL) that can be used to as a tool to help the management of groundwater pollution of the phreatic layer (or water table) at the local, site specific scale.

This comprises:

- Mapping the groundwater quality, taking into account all regulated pollutants, so that there is a better simulation of the current groundwater quality in the phreatic layer and the identification of regions of major concern.
- Modelling the evolution of the pollutant concentration in the groundwater, with and without measures and visualisation. The aims are to: estimate the evolution of the pollution concentration with time; estimate the impact of source removal and plume containment on flux reduction; identify the most critical places, taking into account land and groundwater use. The movement of plumes will be taken into account using a very simplified approach.
- Technology selection module in order to propose suitable technologies required to accomplish the necessary flux reduction or mass removal
- Economic considerations in order to estimate the loss of economic value due to groundwater pollution (now and for future use) and to estimate remediation costs in order to propose a rough cost-benefit analysis.



On 15th October, 2013 AQUAREHAB WP-leaders and stakeholders were invited to a conference meeting where preliminary results were presented and discussed. The feed-back received is being used to finalise the REACHER-local prototype.

AQUAREHAB meetings

ANNOUNCEMENT: AQUAREHAB's Final Symposium in Leuven, Belgium

The AQUAREHAB's Final Symposium will take place in Leuven, Belgium 20th to 21st November, 2013 as part of the Second European Symposium on Water Technology & Management Symposium. This symposium aims at bringing together scientists, policy makers (local, country and European level), consultants, site owners, water managers and remediation companies who are working on or involved in water quality. The goal is to improve interaction between different disciplines as well as between people involved in different aspects of water management. It will be a platform for different thematic symposia and different projects to disseminate their results. The specific topics decided for the Symposium are: groundwater remediation & management; innovative wastewater treatment technologies; and drinking water. The outcomes of the AQUAREHAB project will be presented via diverse platform and poster presentations.

More information can be found at the AQUAREHAB website: https://aquarehab.vito.be/events/Pages/SecondEuropeanSymposium-WaterTechnolgiesManagement.aspx

Papers

New papers published:

- Atashgahi, S., Maphosa, F., De Vrieze, J., Haest, P. J., Boon, N., Smidt, H., Springael, D., Dejonghe, W.,2013. Evaluation of solid polymeric organic materials for use in bioreactive sediment capping to stimulate the degradation of chlorinated aliphatic hydrocarbons. Appl. Microb. Biotech., DOI 10.1007/s00253-013-5138-9.

- Jesenská, S., Némethová, S., Bláha, L., 2013. Validation of the species sensitivity distribution in retrospective risk assessment of herbicides at the river basin scale - the Scheldt river basin case study. Environmental Science and Pollution Research DOI 10.1007/s11356-013-1644-7.

- Velimirovic, M., Larsson, P.-O., Simons, Q., Bastiaens, L., 2013. Reactivity screening of microscale zerovalent irons and iron sulphides towards different CAHs under standardized experimental conditions. J .Hazardous material 252-253: 204-212.

- Velimirovic, M., Larsson, P.-O., Simons, Q., Bastiaens, L., 2013. Impact of carbon, oxygen and sulfur content of microscale zerovalent iron particles on its reactivity towards CAHs. Chemosphere 93, 2040-2045.

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.