AQUAREHAB

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

NEWSLETTER FEBRUARY 2014

Topics

Introduction

The AQUAREHAB FP7 project has now finally finished with only a few reporting loose ends to be completed. The Project ran for four and a half years and ended with a concluding Final AQUAREHAB Symposium, which was held in Leuven, Belgium in November 2013.

In this Newsletter we focus primarily on summarising the final results and achievements of the AQUAREHAB project, with a reflection on how successful the project was and what could be carried out in the near and more distant future.

Final results of AQUAREHAB

The general objectives at the start of AQUAREHAB were to:

1. Develop a variety of innovative rehabilitation technologies for representative types of pollution (source zones, contamination plumes, diffuse pollution) and compounds that are of concern in degraded water bodies (e.g. pesticides, nitrates, Chlorinated Aliphatic Hydrocarbons, BTEX);
2. Develop methods (feasibility tests), tools (numerical models) and guidelines to design the innovative rehabilitation technologies and determine their (long-term) impact on local fluxes of pollutants;
3. Develop a collaborative management tool 'REACHER' that could be used by stakeholders, decision makers and water managers to evaluate the ecological and economic effects of different remedial actions on river basins;
4. Develop an approach to link the effects of the rehabilitation technologies with a river basin management tool; and,
5. Evaluate and disseminate, in the second part of the project, the generic rehabilitation guidelines, approaches and tools in collaboration with end-users, by applying them to other river basins facing other pollutant conditions and climates.

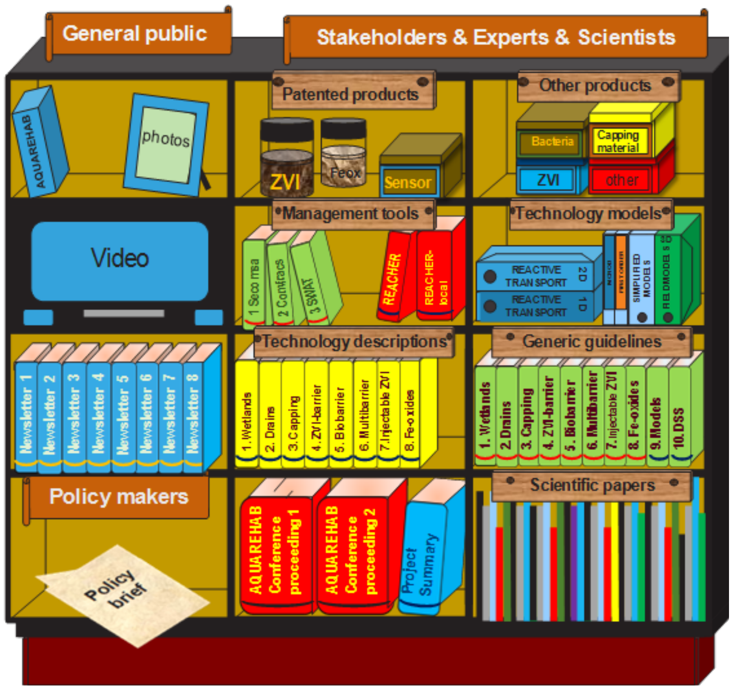

Figure 1: Schematic overview of outputs produced during the AQUAREHAB project

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During the first years the following 3 river basins were selected as study areas: The Scheldt River Basin (Belgium/France), the Odense River Basin (Denmark) and the Secher-Besor River Basin (Israel). In the second phase, results and findings collected during the first years were extrapolated to other River Basins and/or sites in Denmark, Moldavia, Italy, Spain and Belgium.

There has been a wide diversity of outcomes delivered by the AQUAREHAB project, including valuable information for: the general public, stakeholders, experts & scientists, and policy makers. An overview of these outputs is provided in Figure 1 (p1). In the sections below a short general overview of the range of outputs is given. All this information is now available via the AQUAREHAB website.

Output for the General Public

For the general public the AQUAREHAB newsletters, the AQUAREHAB website and the AQUAREHAB Video plus other visual materials have been used to communicate information to the layman or non-expert about the approach, output and significance of AQUAREHAB.

Newsletters: In the course of the project, 8 newsletters (including this one) have been prepared describing the progress made in different aspects of the project and communicating special events and output.

The **AQUAREHAB video** was prepared in 2011 in collaboration with the WATERDISS project and gives a short visual overview of the aim and diversity of activities performed within AQUAREHAB. All publically available information about AQUAREHAB has been promoted and communicated through the **AQUAREHAB website** (https://aquarehab.vito.be/).

Output for stakeholders, experts & scientists

Patented products: Three products developed within the AQUAREHAB project have been filed for patents. One patent was filed, by Höganäs and VITO, for a new type of zerovalent iron (ZVI) that was tested in numerous laboratory scale tests and two field applications for the degradation of chlorinated compounds. A second patent was filed, by Helmholz Zentrum Munich, for a nano-sized iron oxide that is also an injectable reactive particle. The iron oxide particles were tested at the laboratory scale to stimulate the biodegradation of BTEX-compounds. Finally, the University of Stuttgart submitted a patent for the design of in-situ sensors to detect magnetic particles such as ZVIs. The performance of the in-situ sensors was evaluated in large laboratory facilities. The sensors were then installed and evaluated in the subsurface of two AQUAREHAB field experiments where microscale zerovalent iron particles (mZVIs) were injected.

Other products: In multiple WPs within AQUAREHAB, bacteria were isolated from environmental samples and were studied for their capacity to degrade certain pollutants. Enrichment cultures for aerobic and anaerobic degradation of chlorinated compounds were isolated, as well as pesticides-degrading bacteria, comprising an aerobic atrazine degrading strain. Further, materials for capping riverbeds to prevent influx of pollutants from the groundwater into the river water, were identified via laboratory scale tests. The materials are good carrier materials for bacteria and release C-sources needed for bacteria to degrade, amongst others, chlorinated compounds. In addition, a large set of microscale ZVIs was screened from which the most reactive compounds were selected.

Technology descriptions: The AQUAREHAB project focussed on the demonstration of a number of rehabilitation technologies. The rehabilitation technologies addressed included: activated wetlands (WP1), activated drains (WP2), stimulation of the hyporheic zone (interface between groundwater & surface water) by capping (WP3), (multi)barrier technologies (WP4) and injectable reactive iron particles (WP5). For each of these technologies, a 5-7 page document was prepared describing the general background information and the application area and boundary conditions for the technology. The aim was to briefly inform the authorities, consultants and site owners about the development and implementation of the rehabilitation technology.

Technology models: To evaluate the impact of remediation technologies on water quality over time and space, technology models were developed by mathematical modellers with input from technology developers. The technology models worked out within AQUAREHAB are related to a specific technology and aim (1) to develop reactive transport codes and hydrological models for simulating pollutant removal in riparian zones, river beds and groundwater, (2) to help design experimental work related to the technologies, (3) to evaluate models on various cases and generalize the model results, and (4) to develop a common modelling framework for incorporating model results into catchment scale models. Typical users are water managers, consultants, land owners. Some examples of models developed are: Wetland-FeFlow; PRB – PHAST; GRI- HP1; Wetland reactor; PRB lifetime calculator; GRI- TIS model and a particle distribution model. The software that was used to construct the technology models has to be bought by the user on a license-fee basis. On the other hand, input files for the different case studies and case descriptions will be made available via the AQUAREHAB website. Information on where to obtain the software and the contact details of the partner who developed the model will be added.

Management tools: Prototypes for two management tools were developed within AQUAREHAB. The generic collaborative management tool 'REACHER' was developed to be used by stakeholders, citizens or water managers to evaluate the ecological and economic effects of different remedial actions on water bodies. The tool consists of four major parts: (1) fate models to integrate the fluxes of chemicals at the river basin scale; (2) an assessment of the ecological effects of chemicals in river basins; (3) an economic analysis of the rehabilitation technologies (costs and benefits); and (4) the integration of fate, effects assessment and economic analysis tools into a collaborative management tool or DSS REACH-ER with a users' interface. The tool covers a river basin scale with the Scheldt River Basin and the Odense River Basin as examples, focussing mainly on surface water. The second prototype tool is called REACHER-local and focuses on groundwater at a regional scale. Users are able to explore (1) the status of polluted sites across a region; and (2) how the sta¬tus evolves in time with/without remediation. In addition, it can identify which: (1) potential impacts can be expected for differ¬ent sites; (2) societal costs we would be expected to bear due to environmental damage; (3) societal benefits that can be achieved by reducing pollution levels; and, (4) technologies can be implemented for different sites and score best in terms of costs and effectiveness (speed).

The REACHER and REACHER–local software are open and will be made available through the AQUAREHAB website. Georeferenced data on specific contamination sites are protected and fall under confidentiality agreements with the data providers. Public data, however, can be obtained by a specific data request to the public authorities. The developed fate models, SWAT, SECOMSA, COMFRACS and MCA are freely available and input files will be made available on the AQUAREHAB website.

Generic guideline documents are prepared for most technologies and describe the technology in more detail. Further, they provide generic guidelines to evaluate the feasibility of the technology, and to design, implement and/or monitor the technology. This information is especially useful for scientists and consultants who are considering the application of the technology for a site, and may also support authorities charged with following up the impact of the technology. Generic guideline documents are also being composed for technology models and decision support systems. The aim of the guidelines is to group knowledge and experiences from the AQUAREHAB project and make them available for the outside world.

Scientific publications: To date, more than 30 scientific peer reviewed papers related to AQUAREHAB work have been published. In addition, other reviewed papers have been accepted recently, or were submitted or are being prepared.

Other publications: AQUAREHAB organised 2 external conferences (Barcelona 2012 & Leuven 2013) where different aspects were presented. A significant number of proceeding papers were prepared and are available to the public via the AQUAREHAB websites.

Output for authorities

Policy briefs: Water and environmental agencies and technology providers share a common interest in applying the best technologies to remediate water degraded areas. In September 2012, AQUAREHAB and the WaterDiss2.0 project organised a Policy (implementation) Session that aimed to match the needs of policy makers and practitioners to the new solutions provided by research projects, in order to meet the objectives set out in the Water Framework Directive and related Directives. One central issue for the groundwater management discussion was that currently the integration of groundwater management and remediation in 'water management' does not seem to be fully addressed nor accomplished by EU policy. It was observed that Water Framework Directive (WFD) is mainly focused on the long term and large scale management of surface water within water bodies – so that activities related to groundwater as part of remediation of contaminated sites are probably at a too local scale for the WFD and are mainly addressed by regional environmental authorities. This might be so but we view it essential to put more efforts into harmonising standards and legislation concerning risk assessment and the management of contaminated sites and pollution incidents. Since local groundwater contamination can often affect large groundwater bodies, it is still important to consider the effects of the parcel scale on the larger scale. Furthermore, groundwater is an important reserve for clean water in the future, and should be considered as a receptor and not just a path of pollutants to reach surface waters. Besides scale, the pollutant types listed in the WFD are mainly based on the needs of maintaining good surface water status, while other compounds are of more concern to groundwater quality status. In addition, the limited dynamics of groundwater complicates the use of tools and legislation developed for highly dynamic surface waters. At the moment it seems that more public information is needed concerning the status of the groundwater to increase the awareness and understanding of its impacts and the best remediation approach. Furthermore, it is important to establish relations between the use of the groundwater and the quality in order to assess whether all groundwater reserves are adequate for all uses or whether there should be restrictions on use depending on the quality. AQUAREHAB decided to release a policy brief summarising its experiences in relation to the 'integration of groundwater management in water management' and propose recommendations for policy makers.

Conclusions

During four and a half years the multidisciplinary AQUAREHAB consortium worked on the development of rehabilitation technologies for degraded waters and tried to integrate the impact of the technologies in water management. Good progress has been made on both aspects. The potential of the remediation technologies addressed was evaluated in detail and useful knowledge and new products were developed. The technology models enabled us to predict the impact and effectiveness of the technologies in both time and space. This required a close collaboration between the modellers and the technology developers. Prototypes of water management systems (Decision Support Systems) were elaborated at the river basin scale with the focus on surface water (REACHER) and at the regional scale with the focus on groundwater (REACHER-local). The full integration of local groundwater based models and river basin management models was not found possible due to the differences in the dynamics, the scale and the pollutant types considered.

AQUAREHAB meetings

Final AQUAREHAB Symposium in Leuven, Belgium

The AQUAREHAB's Final Symposium took place in Leuven, Belgium 20th to 21st November, 2013, as part of the Second European Symposium on Water Technology & Management Symposium. The symposium aimed 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 was to improve interaction between different disciplines as well as between people involved in different aspects of water management. The specific topics addressed at the Symposium were: groundwater remediation & management; innovative wastewater treatment technologies; and drinking water. The Symposium included a Plenary session and nine Thematic Sessions, as well as a Poster Session. In total there were 150 participants. The proceedings of the Symposium can be downloaded from the AQUAREHAB website:

https://aquarehab.vito.be/home/Pages/SecondEuropeanSymposiumRemediationAndWater.aspx

Some photos of the final AQUAREHAB conference:



Final Project Meeting in Leuven, Belgium

AQUAREHAB's Final Project Meeting took place on the premises of the KU Leuven on the 19th November 2013. During the meeting the final presentations for each Work Package were presented with the final loose ends and activities being addressed to ensure final completion of the project.

Final Meeting Group Photo:

Papers

New papers published:

1. Braunschweig J., Bosch J., Meckenstock R.U. 2013. Iron oxide nanoparticles in geomicrobiology: from biogeochemistry to bio-remediation. Journal of Microbiological Methods (89) 41-48 (WP5)
2. Hoang L., Griensven A. van, Keur P.van der, Refsgaard J.C., Troldborg L., Nilsson B., Mynett A., 2014. Comparison and evaluation of model structures for the simulation of pollution fluxes in a tile-drained river basin. Journal of Environmental Quality, 43, 86-99.
3. Schneidewind, U., Haest, P.J., Atashgahi, S., Maphosa, F., Hamonts, K., Maesen, M., Calderer, M., Seuntjens, P., Smidt, H., Springael, D., Dejonghe, W., 2014. Kinetics of dechlorination by Dehalococcoides mccartyi using different carbon sources. J. Cont. Hydrol., 157: 25-36. (WP3/WP7)
4. Velimirovic M., Simons Q., Bastiaens, L., 2014. Guar gum coupled mZVI for in-situ treatment of CAHs: continuous-flow column study. J. of Hazardous Materials, 265: 20-29. (WP5)
5. Velimirovic M., Carniato L., Simons Q., Schoups G., Seuntjens P., Bastiaens L., 2014. Corrosion rate estimations of microscale zerovalent iron particles via direct hydrogen production measurements. J. of Hazardous Materials, 270, 18–26 (WP5)
6. Smetanová S., Bláha L., Liess M., Schäfer R., Beketov M. 2014.- Do predictions from Species Sensitivity Distributions match with field data?. Environmental Pollution 189:126-133. (WP6)
7. Ribas D., Calderer M., Marti V., M. Rovira. 2014. Effect of different seasonal conditions on the potential of wetland soils for groundwater denitrification. Desalination and Water Treatment. (WP1)
8. Gastone F., Tosco T., Sethi R. 2014. Green stabilization of microscale iron particles using guar gum: Bulk rheology, sedimentation rate and enzymatic degradation, Journal of Colloid and Interface Science, 421, 33-43. (WP5)

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, groundwaterand 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.