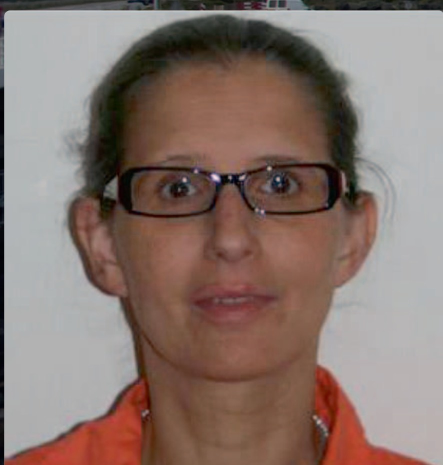
Going with the flow

Dr Leen Bastiaens gives a deeper insight into the methods, achievements and future plans of the AQUAREHAB consortium as they strive to develop methods to manage the implementation of innovative water rehabilitation methods into European water management strategies



Could you begin by outlining the aims and objectives of your project?

Within this project, different innovative rehabilitation technologies for soil, groundwater and surface water are being developed to cope with a number of priority contaminants (nitrates, pesticides, chlorinated compounds, aromatic compounds, mixed pollution) within heavily degraded water systems. Methods are being developed to determine the long-term impact of the innovative rehabilitation technologies on the reduction of these priority pollutants in receptors like drinking water wells and surface water. A connection between the innovative technologies and river basin management will be developed, with focus on groundwater as well as surface water.

The project focuses attention on three river basins: the Scheldt in Belgium, the Odense in Denmark and the Hovav in Israel. Why were these locations chosen?

In the first stage of the project (years 1-3) the technologies and integration of their impact in river basin management will be developed in three different river basins (Denmark, Israel, Belgium), representing different large-scale complex problems and different climatic zones. In a second stage (years 3-5), generic approaches will be extrapolated to one or two more river basins.

The Odense river basin is situated at the island of Funen, Denmark. The catchment drains a land area of approximately 1,100 km^2 and includes 1,100 km streams and 2,600 lakes and larger ponds. Agriculture dominates land use (1/3 of the catchment), but grasslands and forests are also represented (1/4 of the catchment). Another 6 per cent is covered by mires, freshwater and coastal meadows. The Odense River is the final receptor in the basin and heavily impacted by agriculture, receiving nitrate and pesticides from adjacent groundwater bodies and the atmosphere. The Odense river basin has several re-established wetlands and a comprehensive amount of data related to wetland restoration is available. This makes the Odense River an ideal site for detailed studies of wetland's capacities to reduce diffuse pollution from agriculture. Furthermore, the Odense River Basin is part of the EU-pilot river basin network, which includes 15 European river basins (Funen County 2003).

In the Hovav Basin in Israel, the groundwater within the chalk aquitard is heavily contaminated with industrial pollutants, including halogenated contaminants, pesticides and hydrocarbon residues, which are relatively stable in the sub-surface environment. This groundwater section is located in the upper part of the Hovav basin, endangering the down-river streams along with local and regional groundwater resources of the southern coastal aquifer of Israel and of the Palestine Authority. Of particular concern is the potential of contaminants seeping from the shallow elevated groundwater through the riparian zone to the Secher wash that accumulates hazardous dissolvable salts along the stream beds, which are later rapidly transported downstream in the event of floods.

The trans-boundary Scheldt river basin in Belgium extends from northern France, across Belgium to the southern Netherlands. It is one of the most pressured water systems in Europe, due to a high population density and intensive industrial and agricultural activities. Crucial final receptors that are threatened include surface waters, groundwater drinking reserves and aquatic ecosystems. Within the Scheldt river basin, notably the Zenne river is considered, which up until three years ago served as an open sewage system for the domestic wastewater of Brussels. It is also under pressure from industrial point sources and groundwater pollution and the Antwerp region where groundwater is degraded due to industrial and urban activities, threatening surface water and drinking water reserves in the subsurface. The Scheldt River Basin is also part of the EU-pilot river basin network. It is being intensively investigated within various EU projects in which numerous partners of AQUAREHAB are participating. The case studies ensure the involvement of local stakeholders faced with pollution problems.

What are the next steps for the team?

Phase one of the project is now in its last year, including the production of generic guidelines and tools related to studied remediation technologies and river basin management. Phase two of the project is being prepared and focuses on the extrapolation of a number of these generic protocols, tools, approaches to other river basin areas.

Water without borders

Ensuring water resources remain at a high quality is a key aim for the EU. AQUAREHAB is an ambitious project integrating management of polluted water bodies under the EU Water Framework Directive

THE PROBLEM OF degraded water is extensive in Europe and in the year 2000, the EU adopted the Water Framework Directive (WFD) with the twin aims of achieving a community-wide restoration of good ecological and chemical status for all water bodies, and integrating water management activities at river basin level by 2015. It is now clear that more time is required to accomplish this. It is also apparent that due to the effects of climate change, some parts of the world will have less water available to them, so quality will be of increasing importance.

Thanks to a range of EU environmental directives, the quality of river water, lakes and groundwater across Europe has, in general, improved since the 1970s, but there remain significant 'hot spots' of degraded water, from both point and diffuse sources. There are also approximately 250,000 soil contamination sites across EEA member countries, with potentially polluting activities estimated to have occurred at nearly 3 million sites in total, and investigation is needed to establish whether remediation is required. If current investigation trends continue, the number of sites needing remediation will increase by 50 per cent by 2025.

AQUAREHAB will contribute to bridging the gap between surface water and groundwater management and research

AQUAREHAB is an EU-financed, large-scale research project which started in May 2009, comprising 19 partners collaborating for 56 months. It aims to provide information and tools to help planners and decision makers achieve WFD objectives, creating a multidisciplinary, holistic approach to the rehabilitation of degraded water systems, and developing within its first three years a variety of innovative technologies to tackle pollution and compounds of concern in degraded water bodies.

INTEGRATED PLANNING

The project will provide guidance to help decision makers assess the immediate and long-term effectiveness of restoration actions, designing appropriate environmental planning and optimal investment strategies at regional level. It will also create a series of tools, guidelines and standards to assess, design and plan restoration actions within water-related EU policies. One of these will be a generic river basin management tool that integrates multiple ecological and economic impact assessments of the entire water system, and a series of new, eg. OpenMI-compliant modelling techniques, will also demonstrate the impact of remedial actions on the ecological status of water bodies. The technological solutions will be reliable, ecologically-engineered and cost-effective, and take into account the impacts of climate change on water bodies, mitigation and adaptation policies.

Dr Leen Bastiaens coordinates AQUAREHAB and believes it will contribute to an integrated approach to bridging the current gap between surface water and groundwater management and research: "We are developing innovative rehabilitation technologies for soil, groundwater and surface water to deal with a number of priority contaminants – for example nitrates, pesticides, chlorinated or aromatic compounds, or mixed pollution – within heavily-degraded systems," she outlines. "We are also creating methods of determining the impact of these rehabilitation technologies on reducing the influx of these pollutants towards receptors like drinking water wells and surface water."

The project will demonstrate reliable, ecologically-engineered and cost-effective solutions, using a multidisciplinary approach which involves experts in remedial technology to develop its ideas, taking into account economic elements of the WFD such as 'the polluter pays', full cost recovery, and assessment of disproportional costs in achieving WFD objectives. This will mean being strategic about how knowledge is used and where remediation efforts are focused for maximum gain: "The new approach of the project is to test and evaluate the combined effects of different technologies, each conventionally used for a given source area, for a whole river basin," explains Bastiaens.

The impact of different technologies will be combined in a river basin model which, in conjunction with economical tools will yield the most cost-effective approach to cleaning up a system. If only limited financial resources are available, the approach will show where to spend the money to generate maximum effects for the whole system.

The project will also provide decision makers and planners with appropriate tools to assess, design and plan restoration actions, undertaking gap analysis and subsequent identification of

AQUAREHAB

DEVELOPMENT OF REHABILITATION TECHNOLOGIES AND APPROACHES FOR MULTI-PRESSURED DEGRADED WATERS AND THE INTEGRATION OF THEIR IMPACT ON RIVER BASIN MANAGEMENT

OBJECTIVES

To develop innovative rehabilitation technologies for soil, groundwater and surface water to cope with a number of different priority contaminants (nitrates, pesticides, chlorinated compounds, aromatic compounds and mixed pollution) within heavily degraded water systems.

PARTNERS

VITO, Belgium • **Isodetect GmbH**, Germany • **Sapion Hans Milieu-Advies**, Belgium • **CTM Centre Tecnologic**, Spain • **Environmental Institute S.R.O.**, Slovakia • **Höganäs AB**, Sweden • **The Geological Survey of Denmark and Greenland**, Denmark • **UNESCO-IHE Institute for Water Education**, The Netherlands • **Helmholtz Zentrum Muenchen**, Germany • **Masarykova Univerzita**, Czech Republic • **Ben-Gurion University of the Negev**, Israel • **Københavns Universitet**, Denmark • **Institut National de l'Environnement et des Risques Ineris**, France • **Universitaet Stuttgart**, Germany • **Technische Universiteit Delft**, The Netherlands • **Politecnico di Torino**, Italy • **Wageningen Universiteit**, The Netherlands • **Katholieke Universiteit Leuven**, Belgium • **The University of Sheffield**, UK

FUNDING

EU Seventh Framework Programme (FP7) – contract no. 226565

CONTACT

Dr Ir Leen Bastiaens
Project Coordinator

VITO Flemish Institute for Technological Research
Boeretang 200
BE-2400 Mol
Belgium

T +32 1433 5634
E leen.bastiaens@vito.be

http://aquarehab.vito.be

DR IR LEEN BASTIAENS completed her PhD in 1998 at VITO and at the Catholic University of Leuven on the isolation and characterisation of PAH-degrading organisms from soil and the evaluation of the use of the isolates in soil slurry bio-remediation. She currently works as a senior scientist and project leader in the fields of soil and groundwater remediation.

measures to close the gap. In order to ensure success, a number of river basin authorities have been included in the project.

LOW-COST SOLUTIONS

Bastiaens believes that the project will provide valuable information and guidelines on the capacity of re-established wetlands to remove pesticides and nitrates from diffuse agricultural sources: "The installation of wetlands in the riparian zone has been considered as a very promising approach for mitigating the diffuse pollution of agricultural pollutants," she reveals. "For example, the re-establishment of wetlands has been used in many countries as a restoration technology to reduce the nitrate load on rivers and lakes. Recent work indicates that wetlands might also be successful in lowering the transport of pesticide residues."

Key to the AQUAREHAB work programme is the investigation of passive, in situ rehabilitation technologies, and monitored natural attenuation, as such methods are highly cost-effective compared with remediation using energy-intensive 'pump and treat' systems. One of the more interesting technologies being investigated is the use of a tailored carrier and bacteria to rehabilitate severely degraded waters. In areas of shallow water with high industrial pollution, one approach is to drain the contaminated groundwater into covered trenches. These contain a porous material which supports biofilms of microorganisms which degrade the pesticides. The carrier material is designed to protect the microorganisms from toxic compounds or protozoa.

Alongside the trench approach, the team is researching the use of natural sediment interfaces and permeable reactive barriers (PRB). The operational costs of PRBs are estimated to be between two and five times smaller than traditional pump and treat systems: "Our results will reduce uncertainty in the application of multi-barrier technology and contribute to the effective design and application of such systems. We expect this to unleash the true potential of these technologies, leading to cost-effective rehabilitation as required under the WFD," Bastiaens points out.

Other low-cost, fast and simple solutions being examined include the possibility of injecting reactive, iron-based particles into degraded ground waters, like zerovalent iron (ZVI) and iron-oxides. ZVI particles degrade chlorinated compounds in an abiotic and relatively fast way, and have, in addition, a positive influence on soil bacteria that can biodegrade these compounds. Ferric iron colloids function as electron acceptors during the biodegradation of other contaminants and there are positive signs regarding the speed and ease with which these particles could be installed to act as bioreactive barriers in aquifers. The focus is on small-sized particles (lower micro to nanometre range). As compared to current pump and treat technologies which cost millions and have to last for decades, the iron injection is more passive and causes no above ground hindrance after injection. The process does not involve any operation or maintenance costs, the only major investment being the production and injection of the particles themselves.

LEVERAGING SUCCESS

AQUAREHAB is adopting a European, rather than a national approach to tackling the development of rehabilitation technologies; many of the major river basins are international, so monitoring the impact of a given solution requires a European approach to integrating information. Testing the efficacy of these technologies across Europe also requires case studies based on varying socioeconomic and climatic conditions, which provide vital information on the technologies' regional performance across Europe and whether any adaptations are required.

Bastiaens remains rightly confident in the project's collaborative value: "By working with an array of European partners with their own local contacts, we can exert greater leverage for successful technologies to be more rapidly adopted across Europe and beyond".