OUR PRECIOUS GROUNDWATER GOES GREY… WHAT CAN WE DO?

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Groundwater is a precious natural resource. However, its vulnerability is often overlooked because in Western-Europe it is easy to use, cheap and abundant. But slowly our groundwater is turning grey: even when soil remediation and groundwater quality standards are formally met, groundwater is gradually impacted by decades of industrial and agricultural activities. Consequently, at numerous water production wells, quality has dropped below acceptable levels, already. This means that additional treatment steps are required before the groundwater can be used for industrial processes or drinking water purposes; with significant -financial- consequences for users. In this session we are zooming in on the origin of the problem, parties confronted with the problem and solutions.

Problem

The origin of the problem may be easily summarized as a result of wide-spread industrial and agricultural activities. As specific sources of contamination could be mentioned:

- the use of nutrients for fertilization and pesticides by farmers,
- residues of medicines, hormones, microplastics and Teflon coating flushed via the sewage system to surface waters by consumers,
- former landfills,
- other soil contaminations which are not complete removed,
- etc.

By groundwater flow, contaminants migrate over time and cause deterioration of vast and growing volumes of groundwater. The process is facilitated by activities in the underground, like injudicious use of aquifer thermal energy storage (ATES) systems, which could perforate aquitards and enhance contaminant migration. See figure 1.

This is only one part of the story. As awareness on environmental issues evolved at the end of last century, many successful programs were carried out to protect the groundwater. Soil and groundwater remediation and emission restrictions contributed to that goal. Plans were made for smart combinations of activities such as ATES integrated with groundwater remediation. However, due to presumed enormous future costs, many actions needed were not taken. Policy changes often interfered with actual remedial and protection measures; on paper solutions were found but in reality, problems were not resolved. So, now we realize that our groundwater is going grey.

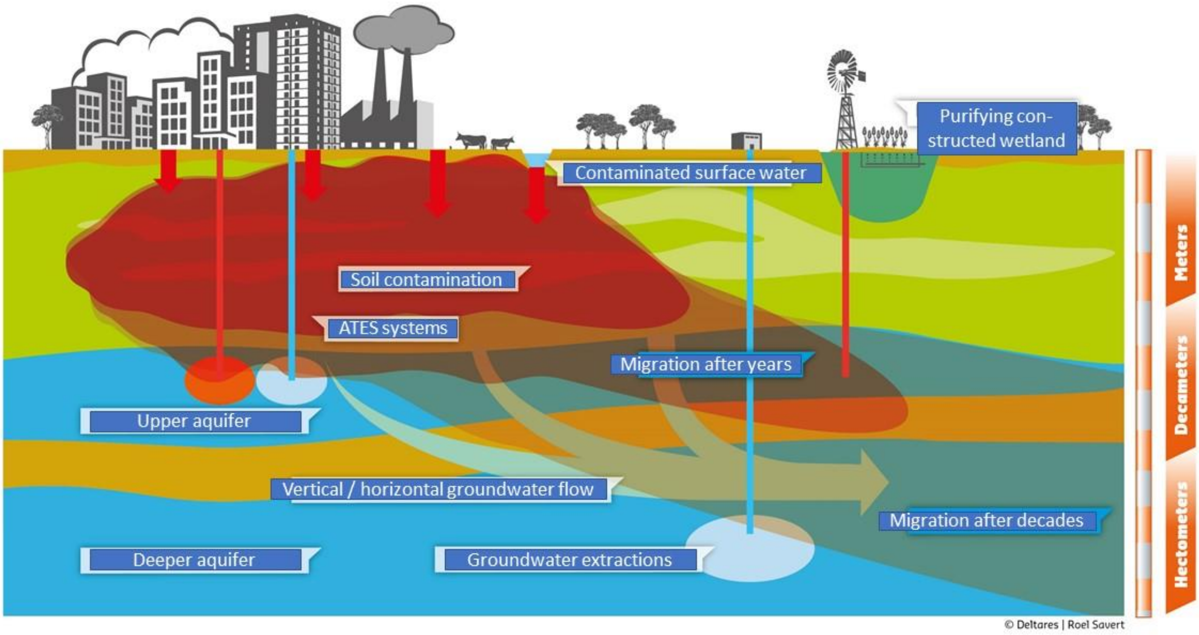

Figure 1: How our groundwater goes gray. © Deltares

Parties

An important party confronted with this problem is of course the drinking water producing industry that uses groundwater as their main ingredient. But also, food and beverage companies use groundwater in large volumes for their products. Their water wells are often located in industrial areas where the groundwater has been impacted already. Slowly, they start to realize that the groundwater is not an easily available and trusted resource for the production process any more. New types of pollutions, conflicting underground activities and periods of drought are now also imminent threats. How are they coping, what are the choices they are facing in order to continue their business?

Solutions

What are the solutions? Can we really protect the groundwater and is it still possible to repair the impacts? Conventional remediation solutions are available, but because of the scale of the impacted volumes, these approaches are very costly and would cause high CO_2-emissions. However, affordable solutions already exist. In our session, we look in detail into the development of biological remediation of groundwater based on the constructed wetland methodology. How does this work and what have recent projects taught us? Why is this a viable -and financially sound- solution to treat contaminated groundwater? We present some in-depth know-how that holds a lot of promise for the future.

With the presented nature-based approach, the quality deterioration trend of grey groundwater can be reversed in a cost-effective and energy-efficient way, by using constructed wetlands. Such biological groundwater treatment plants could be situated in green public areas. For three cases in the Netherlands, the results of constructed wetland implementation will be presented. Also, the cost aspects will be addressed. With these project examples we will show that this application is a promising affordable way of future groundwater remediation, which can be incorporated in urban groundwater management and other schemes of sustainable land management and land stewardship.

The three case studies are briefly introduced below and will be further elucidated in the session:

1. On a chlorinated solvent contaminated site in Amersfoort, a traditional soil remediation with groundwater extraction and purification with a stripping tower was replaced by a windmill to pump groundwater resulting in zero energy consumption and by a helophyte filter to degrade the solvents. Figure 2 shows the design.

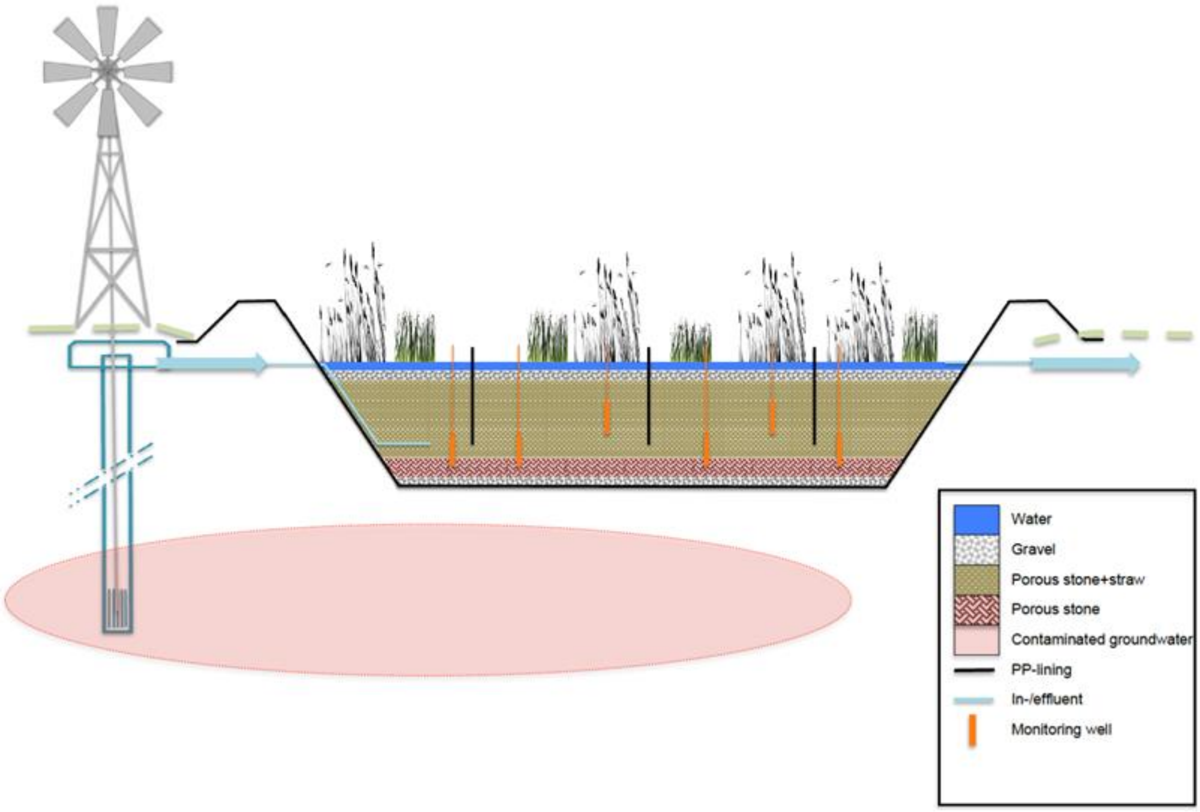

Figure 2: Schematic presentation of sustainable and nature-based remediation realized in Amersfoort. © Deltares / HMVT

Mother compound tetrachloro-ethene, which was persistent under the prevailing conditions in the soil, is degraded completely in the constructed wetland, as was proven by elaborate monitoring, see figure 3. Lessons learned at this site are used at the other two sites.

2. In the centre area of Zwolle all shallow groundwater is polluted with solvents. These contaminations are migrating to the drinking water extraction area ‘Het Engelse Werk’ situated close to the river IJssel. In the contaminant flow path, a groundwater extraction has been installed in order to prevent migration to the drinking water area. The extracted water is first used to heat a building and is then treated in a constructed wetland.

3. In Doorn, a large groundwater chlorinated solvent plume is present, caused in the 2nd half of the 20th century by a chemical laundry. Near ‘House Doorn’, residence of German emperor Wilhelm II in the 1st half of that century, two-stage purification is being realized in the moat. Most difficult issue was the historic value of the site, which lead to a complex design process in close consultation with the landscape architect of the owner (the Ministry of Defence). Underwater, a reactor is installed for anaerobic biological degradation of tetrachloro-ethene to trichloro-ethene. The rest of the moat is used for further anaerobic and aerobic degradation of CIS and cis-dichloro-ethene and vinylchloride. Via a weir the treated water is discharged to open surface water.

Figure 3: Elaborate monitoring on the Amersfoort site proves that constructed wetlands can purify grey groundwater even in winter. © Deltares/Welmoed Jilderda; featuring field worker André Cinjee