An evolution of infiltration capacity was observed since the start-up in 2002. In the first years the infiltration was better compared to the designed ratio between extraction and infiltration (1,4). Since 2009, on three exceptions, the yearly ratio exceeded 1,4. The loss of infiltration capacity was more obvious during the first 4 months of the year. Temperature was identified as the dominant factor. Temperature causes variation of kinematic viscosity and influences the hydraulic conductivity in the soil.

To increase the infiltration capacity IWVA added 'subterranean' or 'subsurface' infiltration to the scheme. Infiltration boxes; 0,60 m heigh and 4,8 m wide, were placed at a depth of approximately 1,6 m under ground level and recovered with 1 m of dune sand. The initial length of 50 m, realized in November 2014, was expanded to a total of 300 m early 2016. Since then, the subsurface infiltration was used according to the temperature of the infiltration water: as infiltration capacity in the open infiltration decreases in Autumn, the feed to the subsurface infiltration is then gradually increased. The opposite is done once the temperature of the infiltration water increases again.

The part of subsurface infiltration into the total capacity of the initial infiltration varied between 12,68 and 15,74% between 2017 and 2020. 36,76% of it was infiltrated in the coldest quarter, being the first and 26,78% in the last quarter of the year. During the summer only 13,51% of the total amount of subsurface capacity was infiltrated.

Subsurface infiltration proved the ability to enhance infiltration capacity and is mainly used during the colder periods. The advantage of subsurface infiltration is the constant temperature, contrary to open air where the temperature can substantially drop during colder periods, and the absence of clogging as it is protected from open air. The increased infiltration capacity was a major asset during the past years where in Flanders, and broader in Europe, periods of longer draught were observed. The combination of water reuse and MAR proved a robust combination to cope with these).

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Uncertainty Quantification Of Salinity In Costal Aquifer (Binah Thuan Province, Vietnam) Using Bel1D Inversion Of Transient Electromagnetic Data

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Vietnam south central provinces have been facing saltwater intrusions problems for many years, particularly in Binah Thuan province. Binah Thuan has a hyper-arid climate and during the dry season, seawater penetrates the river estuaries and contaminates the fresh groundwater reservoirs. Recent hydrogeological and geophysical data have shown that saltwater intrusion was not limited to river but was likely the results of a complex situation involving fossil saline water heterogeneous sediments and anthropogenic activities. To determine the state of salinity transient electromagnetic (TDEM) soundings were collected along the Luy River, where the situation is most problematic.

TDEM data can reveal the vertical variation in electrical conductivity. An inversion was carried out with SimPEG, an open-source Python package for solving the electromagnetic forward and inverse problem. It revealed the conductivity transition of different layers from the surface until about 40 meters depth, with a gradual increase in electrical conductivity showing the encroachment of salt- water in the shallow aquifer. Deeper, a decrease in conductivity shows the presence of bedrock.

However, SimPEG's inverse solution is deterministic and, thus, provides only one possible solution among many others.

For an uncertainty quantification of the salinity, we apply a new stochastic inversion approach named Bayesian Evidential Learning 1D imaging (BEL1D). BEL1D is combined with SimPEG to solve the forward problem. BEL1D bypasses the inversion step by generating random samples from the prior model distribution (with predefined ranges for thickness, electrical conductivity and salinity for the different layers). It then directly generates the corresponding data in order to learn a direct statistical relationship between data and model parameters. From this relationship, BEL1D can generate posterior models fitting the field observed data, without additional forward model computations, making it a very efficient way to stochastically solve the inverse problem. The output of BEL1D shows the range of uncertainty for subsurface models. It enables to identify which model parameters are sensitive and can thus be accurately estimated from TDEM data. In our case, it reveals the uncertainty on the depth of fresh saline interface as well as the total dissolved solid content of groundwater.

The application of BELID together with SimPEG for stochastic TDEM inversion is a very efficient approach as it allows to estimate the uncertainty at a limited cost. We thus expect our approach to be also valuable for the inversion of airborne data sets.

Keyword: saltwater intrusion, groundwater, Luy River, transient electro-magnetic data, SimPEG, uncertainty, BEL1D

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Installation Of An Iot System For The Real Time Monitoring Of Hydraulic Heads In The Vicinity Of Groundwater Extraction Sites

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The groundwater of the 'Centraal Kempisch Systeem' is one of the main sources of freshwater in Flanders. Approximately 140 Mm^3 groundwater is extracted each year from the aquifer of which 90 Mm^3 is used for the production of drinking water. The aquifer, which is for the largest part phreatic, is mainly formed by the Miocene sands of the Diest and Berchem Formations. In the last 4 dry years (2017-2020), the pressure on the aquifer has increased due to the grown demand on (ground)water. Pidpa, has started to roll out an internet of things (iot) monitoring system in 2021 to ensure sustainable extraction of the aquifer combined with real time monitoring data.

For the iot monitoring system a careful selection of about 150 monitoring wells has been made. The selected monitoring wells are situated at different distances from the production sites as to include both the influence from the extraction as well as from drought/climate.

In the monitoring wells the hydraulic heads will be recorded hourly and transmitted once a day to a central location. The median value of the recorded values will be used for long term analysis and put into our ERP. The hourly records are kept for ad-hoc analyses and quality control.

Currently most of the selected monitoring wells are finished just below ground-level in (partially metallic) road boxes. By using recent NB-iot technology and absolute pressure sensors Pidpa tries to prevent bringing them above ground in protective sleeves to avoid visual pollution in natural environments. To ensure reliable communication and vandalism protection the road boxes are however changed to a synthetic version with locks. By using absolute pressure sensors the issue of damp within the road boxes should be overcome. In the rare cases where transmission (or other) issues are expected the monitoring wells are above ground-level and covered with a protective sleeve.

The barometric pressure compensation for the acquired records is done by using meteorological data from different meteorological observing stations around the wells. By using inverse distance weighted calculations a local barometric pressure compensation can be calculated for each location. Simulations with historic data show good results with expected errors below 0.5 hPa (= 0.5 cm water column).

As the roll out has started this year the first results are expected in the second half of this year with the system fully up and running in the spring of 2022.