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Heat transport in the vicinity of an artificial recharge site

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Since July 2002, the Intermunicipal Water Company of the Veurne region (IWVA) artificially recharges fresh water in the dunes of the western Belgian coastal plain by means of two recharge ponds. This recharge water is produced from secondary treated waste water effluent by the combination of ultra filtration and reverse osmosis. Extraction wells (112) are located north and south of the ponds. The artificial recharge project loops the water cycle: extracted water goes to the users and their waste water is purified and re-used. Therefore, it is an example of sustainable water management in coastal aquifers. Groundwater flow of this recharge site has been examined in the past by the use of a tracer test, hydrochemistry (environmental isotopes, conservative tracers) and groundwater flow modelling. Temperature, however, forms a relatively easy measurement which can add to or confirm the knowledge of the groundwater flow.

Temperature time series (temperature as function of time) were measured at different levels in a number of wells located between the recharge ponds and the extraction wells, and in one well south of the recharge and extraction area. Secondly, temperature logs (temperature as function of depth) were measured in these wells at different times over the course of 2 years. Finally, the temperature of the recharged and extracted water is constantly monitored by the water company.

The temperature of the recharge water shows a yearly fluctuation, ranging from 25 °C during summer to slightly above 0 °C during the winter. The temperature of the extracted water (combination of water extracted in all the wells) ranges between 17 °C during summer and 10 °C during winter. Minima and maxima in the extracted water are observed between 76 and 110 days (mean of 90 days and standard deviation of 13.5 days) later in the extracted water with respect to the recharged water. Measurements show that the difference in time when maxima and minima are observed in an observation well with reference to the ponds increases with depth (for instance from 28 days 4.1 m below surface to 154 days 10 m below surface for an observation well at 10 m from the ponds). This confirms previous flow modelling which showed that groundwater flows relatively rapidly laterally from the recharge ponds towards the extraction wells. Additionally, part of the recharge water flows in a deeper flow cycle towards the extraction wells. Residence times in this deeper flow cycle are evidently larger than in the direct lateral flow cycle from the ponds towards the wells. This explains the increase with depth. The 154 days (with respect to a mean time of 90 days) points to the fact that the extracted water contains a large spectrum of residence times with mean of 90 days for the heat transport, as was also derived by the flow modelling previously