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Finding the origin of salinity in pumping station Nuland by a modeling exercise

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In the south of the Netherlands, near the town of Nuland, is a well field used for drinking water production, at around 130 m below surface level. This well field has been used for over 100 years, and since a few decades has problems with rising chloride levels in some of the wells (>500 mg/l).

The owner of the well field, Brabant Water, wants to increase production, but is worried about the increasing chloride-concentration. Therefore the source of the chloride needed to be traced, before predictions could be made. Between the exploited aquifer and the freshwater-saltwater interface (-200 m) is another aquifer at around -160 m, which remains fresh (100 mg/l). Therefore, the most obvious hypothesis about the source of the salinity, straight from below, was disproved.

The area of the well field has been studied quite extensively. Many head measurements and water quality samples are available from the recent pasts, as well as the pumping rates per well. Around the year 2000 the Geological Survey of the Netherlands conducted vertical temperature measurements and two seismic profiles, which showed some discontinuities of the bottom confining layer, close to the well field.

So could the increased chloride concentrations be explained by these discontinuities, while keeping the aquifer below the pumping wells fresh? To answer this question an existing steady state MODFLOW groundwater model was modified into a transient SEAWAT-model. It showed that the retrieved chloride-concentration depends heavily on the locations of the discontinuities, but with some tweaking the measured concentrations could be simulated quite well. Aided by the accurate pumping rate data, the pattern in time in almost all wells was matched by the model.

The fresh aquifer beneath the pumping station stayed fresh, and the model even showed that it is probably getting fresher. By combining chemical data and temperature measurements with a hydrological model we can better understand the flow paths below the well field. With the model we can accurately calculate the chloride-concentrations in the different drinking water wells, and the effects of an increased production can be predicted.