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PREPARING FOR A PUMP/INJECTION TEST IN A COASTAL AREA IN THE NETHERLANDS

100 YEARS OF GEOLOGICAL MAPPING

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DETERMINATION OF BACKGROUND VARIATIONS AND LOCAL RESPONSE OF GROUND-WATER HEADS TO TIDE, PRECIPITATION, EVAPORATION, AND SURFACE WATER LEVELS

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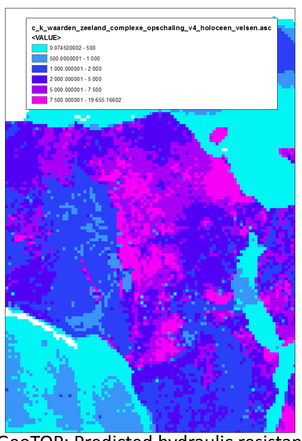
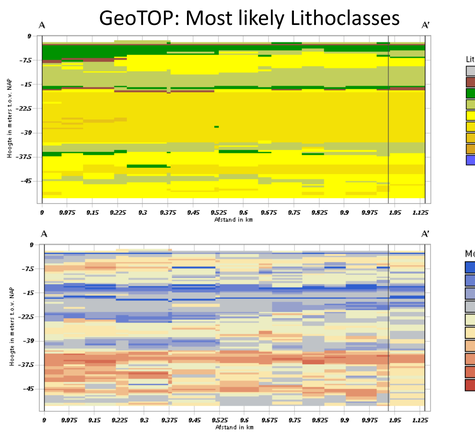
INTRODUCTION

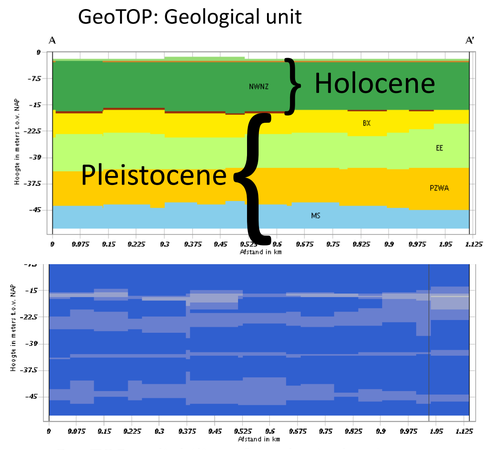


GeoTOP: Predicted hydraulic resistance basal Holocene clay layer in days



GeoTOP: Most likely Lithoclasses

GeoTOP: Reliability of predicted lithoclasses



GeoTOP: Geological unit

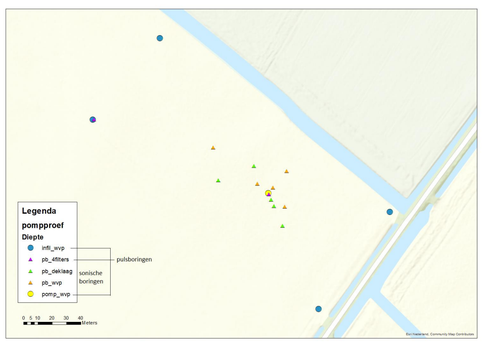
GeoTOP: reliability of geological unit

The Geological Survey of the Netherlands (TNO-GSN) provides public information on the subsurface (http://www.dinoloket.nl). Among this information are (hydro)geological models with hydraulic parametrization. GeoTOP is a voxel model of the upper 50 meters with voxels of 100m x 100m x 0.5m. The basis of the hydraulic parametrisation is a large collection of laboratory measurements of the hydraulic conductivity determined for samples from undisturbed cores, which TNO-GSN collects systematically throughout the Netherlands. The values are upscaled from laboratory to voxel scale for each combination of geological unit and lithoclass.

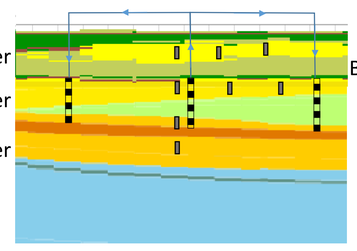
The hydraulic parametrization of GeoTOP for the province of Zeeland (TNO-GSN, 2016) resulted in very high resistances of the confining layer covering the main regional aquifer. The high resistance was predicted for a large area, which made it feasible to validate it. The magnitiude of the resistance is important for the salinization risk for the shallow groundwater and the increase of this risk due to sea level rise.

DESIGN

Setup of pump and infiltration test



plan view



Sectional view

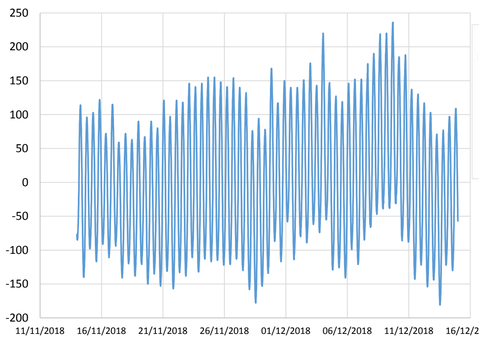
Exploratory model simulations have shown that 1) a reliable estimate of the resistance requires the measurement of a drawdown above the clay layer, and 2) only a small drawdown will develop above the clay layer even though the pumping will run for several months. This means that a small drawdown due to the pumping has to be separated from the background influences.

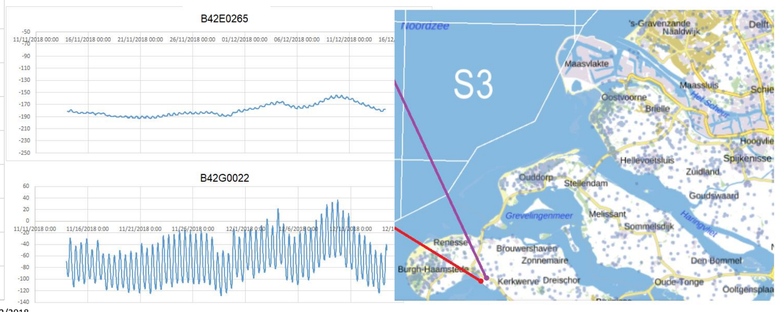
In order to further test and improve the upscaling, TNO-GSN has prepared a field test focussing on the resistance of a basal Holocene clay layer. The field test consisted of pumping from the aquifer below the clay layer combined with infiltration in various infiltration wells, high frequency registration of heads in 23 piezometers, and determination of (the variation of) flow velocities over the thickness of the pumped aquifer.

BACKGROUND MONITORING

For an accurate estimate of the resistance, drawdown has to be measured above the resistance layer and below it , in the aquifer where the pomp test is carried out. Because of the high resistance, little influence of the pumping test was expected in the sandy parts of the confining layer. Since determination of this influence in the confining layer is paramount for the accurate determination of the resistance, the background variations of the groundwater head have to be determined. Meteo (precipitation and evapotranspiration) and the tide in the Eastern Scheldt are the main background influences. Therefor, existing piezometers near the site selected for the pomp test have been equipped with automatic pressure transducers half a year before the start of the test.

TIDAL INFLUENCE

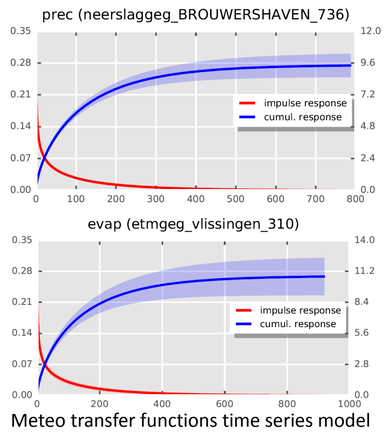




The tide in the Eastern Scheldt seems to be completely damped within a few kilometers, so that it can be neglected for the interpretation of the pump test. The damping can be used to give an independent assessment of the properties of the aquifer system (Bakker, 2019)

METEO INFLUENCE

Transfer-noise time series modelling of the background heads with external influences is valuable because data from a longer period than the pumping test can be used to establish the relation between external influences and the groundwater heads.

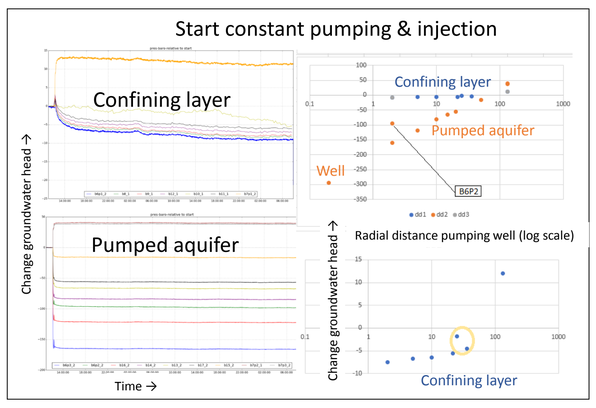


Meteo transfer functions time series model

PUMP TEST INSTALLATION

The pump test setup consisted of one pumping well and four infiltration wells, two multi-level piezometers, five piezometers screened in the pumped aquifer, and five screened in the sandy part of the confining layer. The water pumped was injected using different combinations of the infiltration wells. This setup and the variation in flow will allow to assess the spatial variability at the scale of the test site.

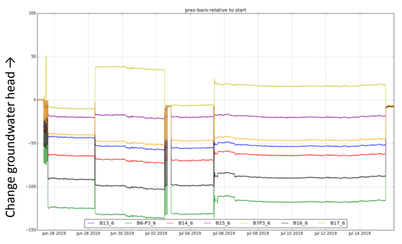
PRELIMINARY RESULTS



The test has been carried out from April to July 2019. The heads and measured fluxes are being reported. The resulting dataset has not been analysed yet.

The next steps will be:

1) the assessment of the hydraulic resistance at the test site and comparison with the GeoTOP predictions;
2) Evaluation of the upscaling method used to parameterize GeoTOP and looking for possible improvements.



Heads at pump & infiltration wells during tests with varying infiltration

CONCLUSION

A combined pump and infiltration test has been carried out to validate the high resistance predicted in the GeoTOP model for a basal Holocene clay layer. Due to the small drawdown expected above this layer, it is important to filter out background influences. For this purpose, a South-North transect of existing monitoring wells between the main surface waters (Easter Scheldt estuary and Lake Grevelingen) and two existing monitoring wells East and West of the test site have been equipped with automatic pressure transduces set an a 15 minute interval to detect groundwater head variations due to tide and lake level variations as well as precipitation and evapotranspiration.

The pump test lasted 4 months, and the background monitoring has been started 8 months in advance and is still continued. This improves the assessment of the background variations and thereby the accuracy of the hydraulic resistance of the basal Holocene clay and its variation at the scale of the site.

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CONCLUSION

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