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**Publication date**

2019

**Document Version**

Final published version

**Citation (APA)**

Zaadnoordijk, W. J., Bootink, W., Oudega, M., Gunnink, J., & Bierkens, M. F. P. (2019). *Preparing for a pump/injection test in a coastal area in the Netherlands: determination background variations and local response of groundwater heads to tides, precipitation, evaporation and surface water levels*. Poster session presented at IAH 2019: 46th Congress of the International Association of Hydrogeologists, Malaga, Spain.

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

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

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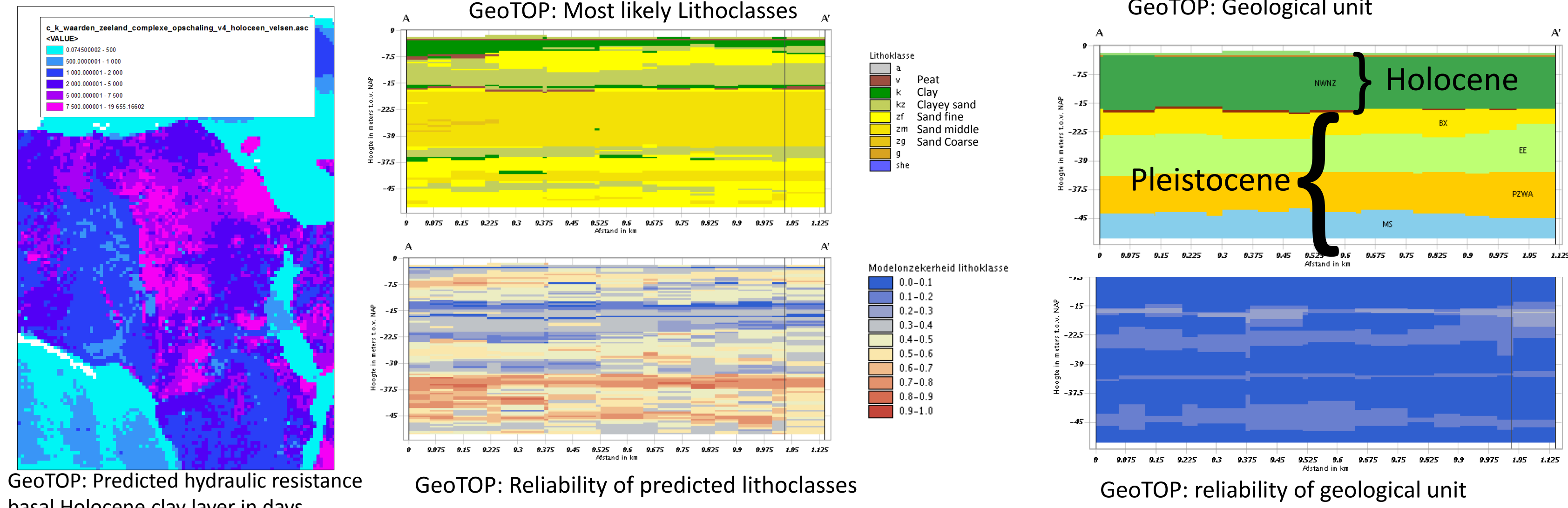
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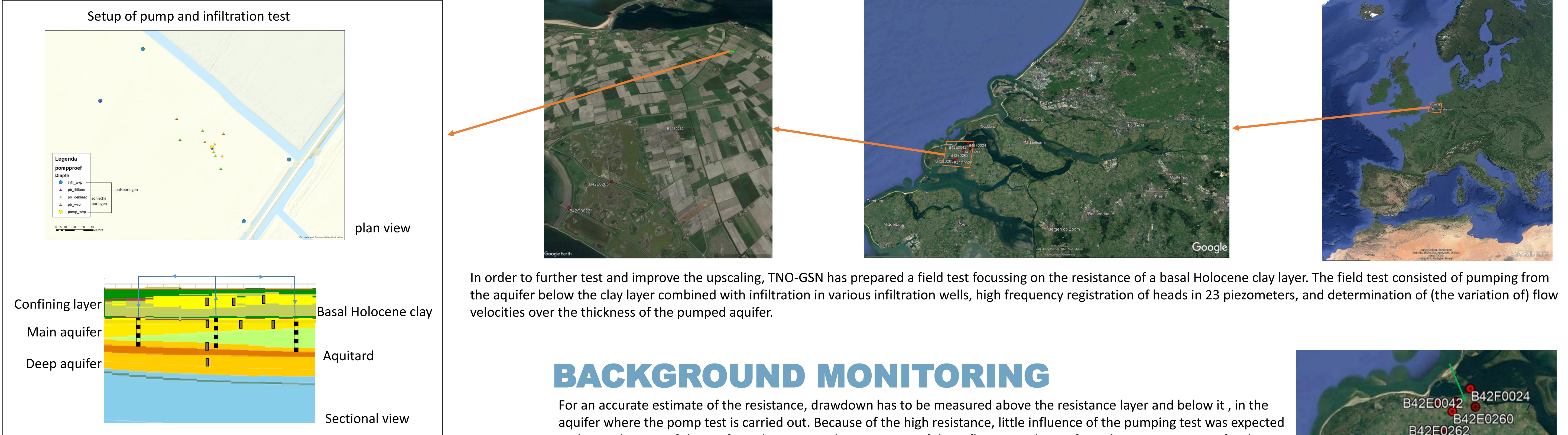
## INTRODUCTION



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 parametrization 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 magnitude 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

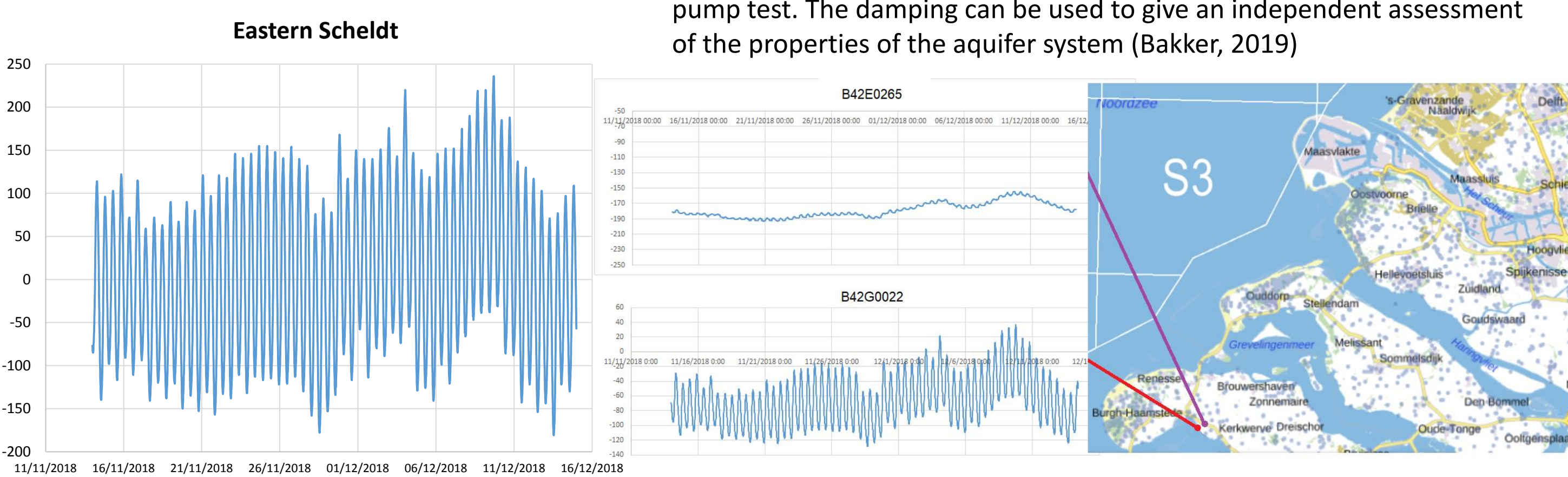


Exploratory model simulations have shown that 1) a reliable estimate of the resistance requires the measurement of a drawdown above the clay layer, and 2) only a small drawdown will develop above the clay layer even though the pumping will run for several months. This means that a small drawdown due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

## BACKGROUND MONITORING

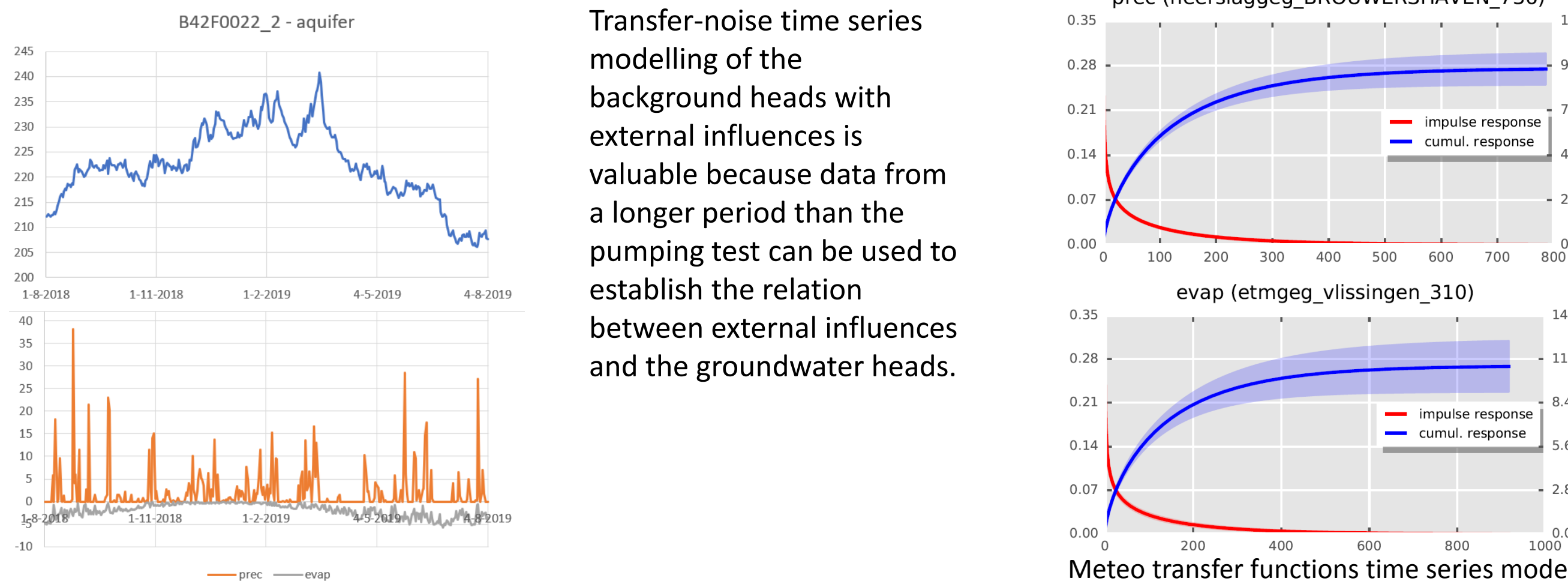
For an accurate estimate of the resistance, drawdown has to be measured above the resistance layer and below it, in the aquifer where the pump test is carried out. Because of the high resistance, little influence of the pumping test was expected in the sandy parts of the confining layer. Since determination 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. Therefore, existing piezometers near the site selected for the pump test have been equipped with automatic pressure transducers half a year before the start of the test.

## TIDAL INFLUENCE



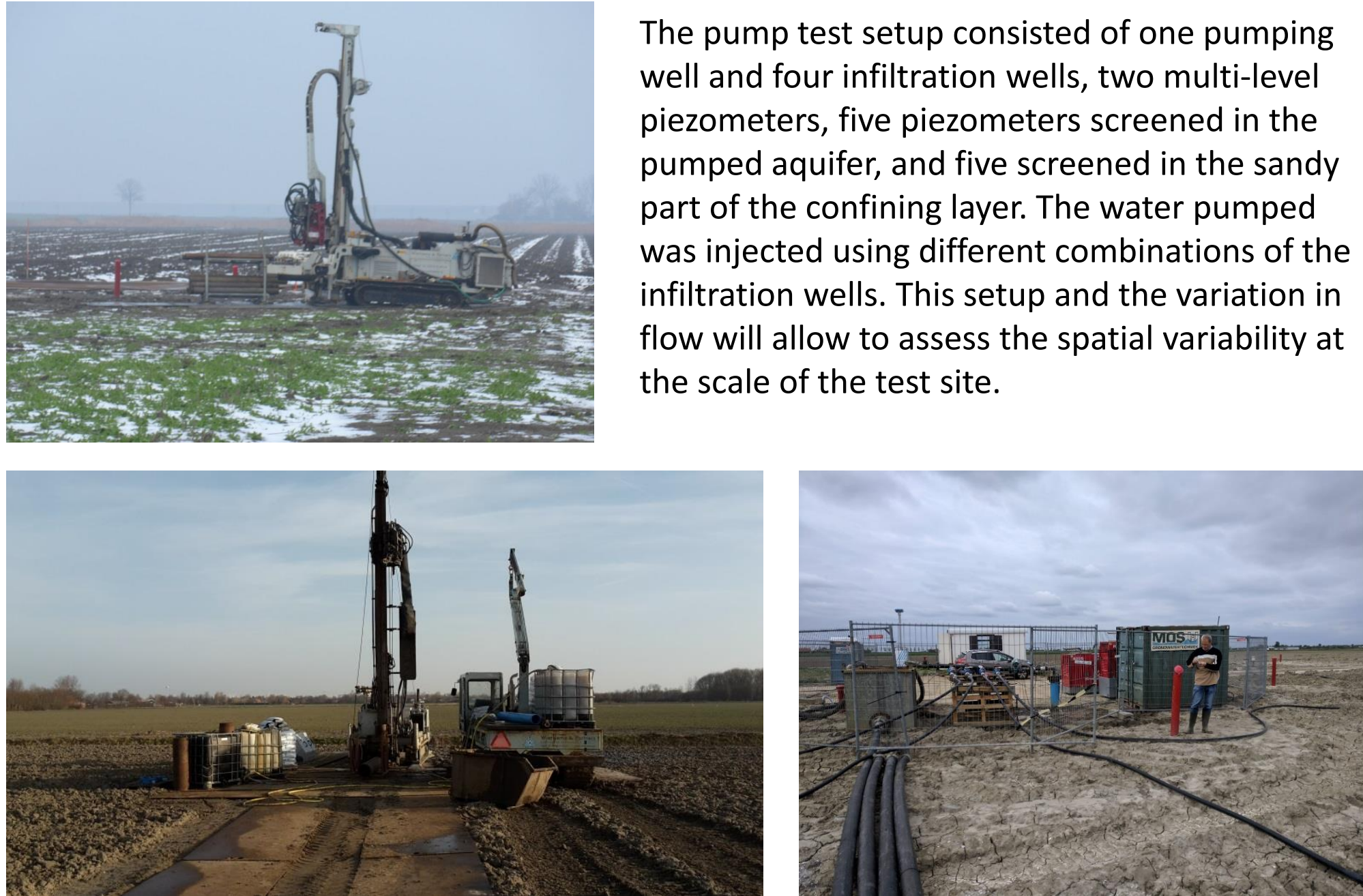
The tide in the Eastern Scheldt seems to be completely damped within a few kilometers, so that it can be neglected for the interpretation of the pump test. The damping can be used to give an independent assessment of the properties of the aquifer system (Bakker, 2019)

## METEO INFLUENCE



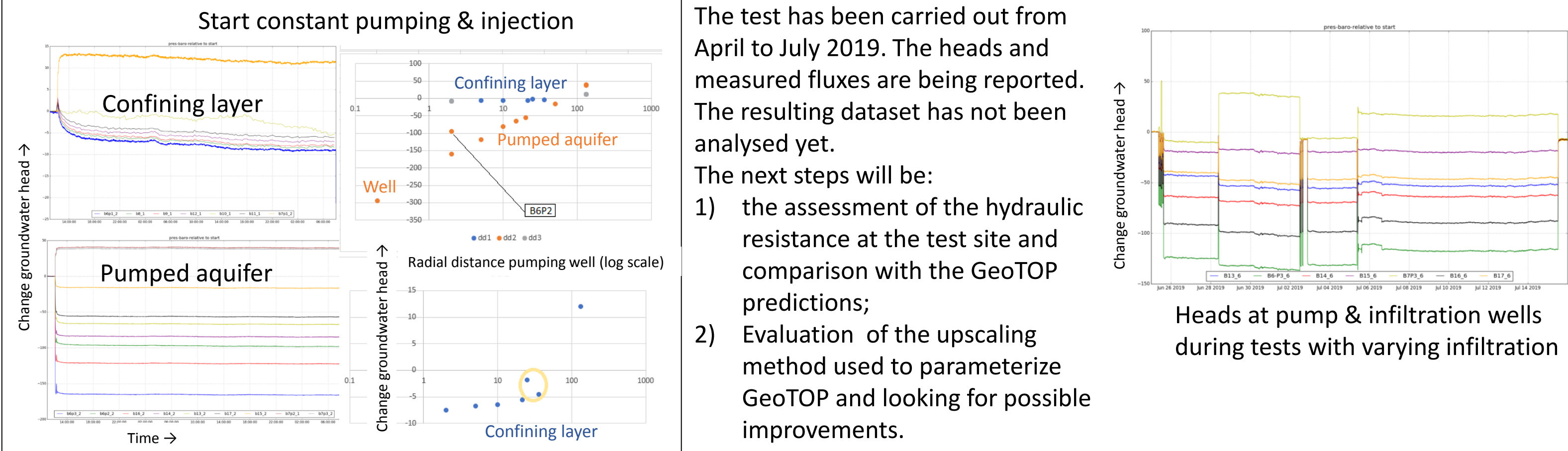
Transfer-noise time series modelling of the background heads with external influences is valuable because data from a longer period than the pumping test can be used to establish the relation between external influences and the groundwater heads.

## 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.

## 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 (Eastern Scheldt estuary and Lake Grevelingen) and two existing monitoring wells East and West of the test site have been equipped with automatic pressure transducers set at 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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