Grondwater head measurements can tell stories about sustainability

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VISUALIZATION OF GROUNDWATER MONITORING IN CONTEXT OF GEOLOGY AND METEOROLOGY TO PRODUCE RELEVANT INFORMATION

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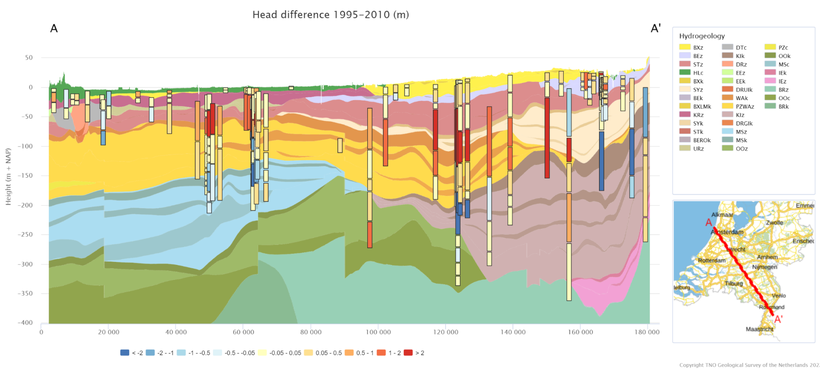
Introduction

In the Netherlands, a national database of groundwater levels has been established in 1948. The database evolved from a paper archive to an electronic database with public access containing more than half a billion groundwater levels from 80,000 piezometers. Recently, groundwater monitoring wells and groundwater levels have been added to the Key Registry for the Subsurface to increase the quality of the data, further promote its use and underline the importance.

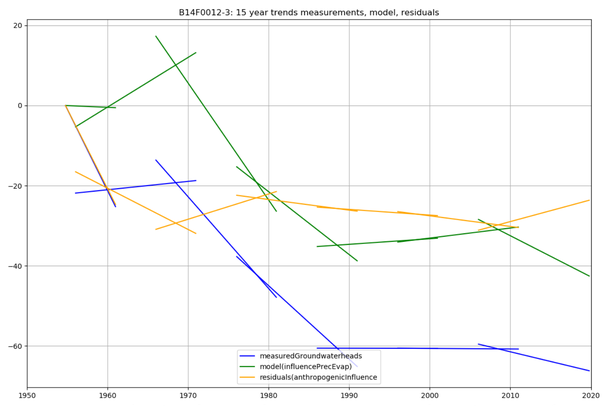
Variation in depth

Groundwater heads vary not only laterally but also vertically. Upward vertical flow is important for many groundwater dependent ecosystems.

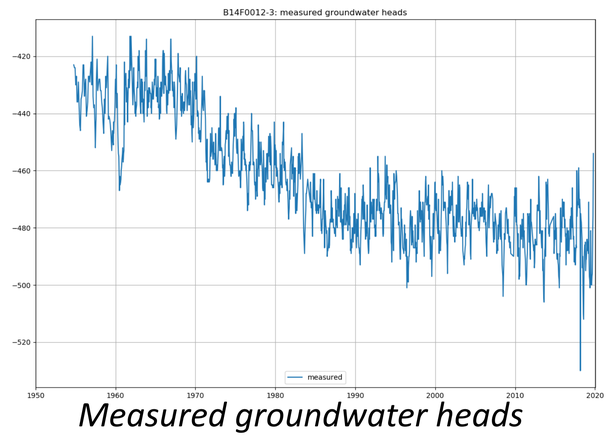


Temporal trends

Presence of a temporal trend in groundwater levels is important input for groundwater management, with a distinction between natural and anthropogenic influences. Time series modelling with precipitation and evaporation can be used to determine the natural (meteorological) influences. A first approximation is to assume the remainder are anthropogenic influences. Trends in the measured heads, natural and anthropogenic influences may be quite different.



Trends in heads, meteorologic and (anthropogenic) influences



Measured groundwater heads

Response time

Groundwater heads respond to natural recharge (precipitation minus evaporation) at multiple timescales, which must be realized when interpreting trends for evaluation of (groundwater)management.

Parts of precipitation response

Conclusion

Grondwatertools.nl provides context to the Dutch national groundwater level monitoring data that enables the extraction of information relevant for attaining the Strategic Development Goals.

References

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Zaadnoordijk, W.J. (2022) Comment on "How Good is Your Model Fit? Weighted Goodness-of-Fit Metrics for Irregular Time Series", Groundwater, 60, no.2, p.162-164, doi: 10.1111/gwat.13175

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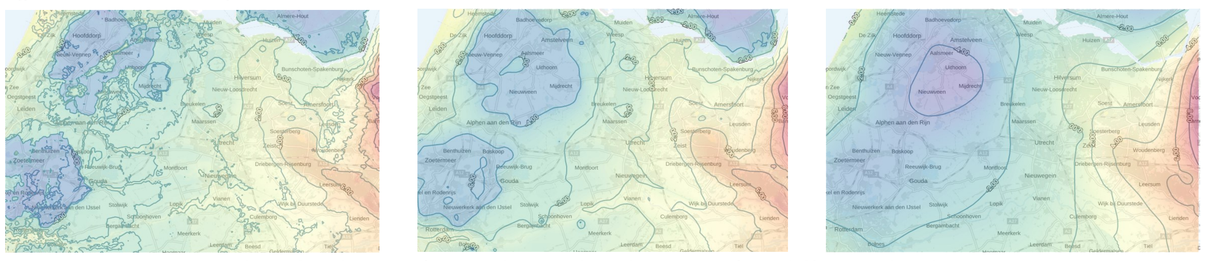
The TNO-GSN Grondwatertools (https://www.grondwatertools.nl/gwsinbeeld/) provides geological and meteorological context for the groundwater levels in the Dutch national database. It offers: A) flow directions, B) changes over time, C) contribution of precipitation and evaporation to the variation in time [1]. From the groundwater flow directions, groundwater flow systems can be derived that determine sustainability of groundwater abstraction and the migration of groundwater of various qualities.

Flow directions

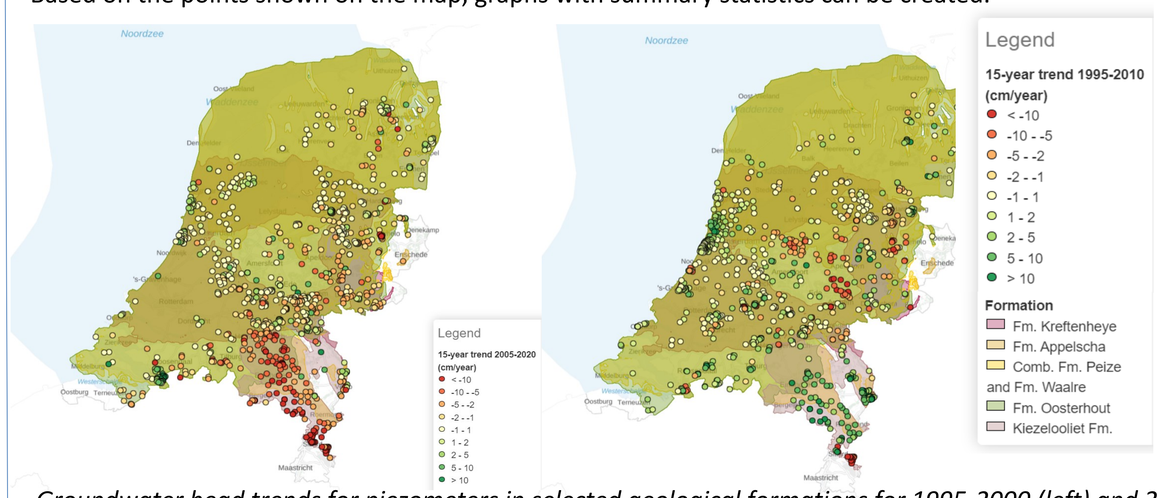
Isohypses illustrate lateral flow directions. Vertical head differences downward or upward seepage (upper figure in left column).



Examples of Isohypses (groundwater head contours) at different depths

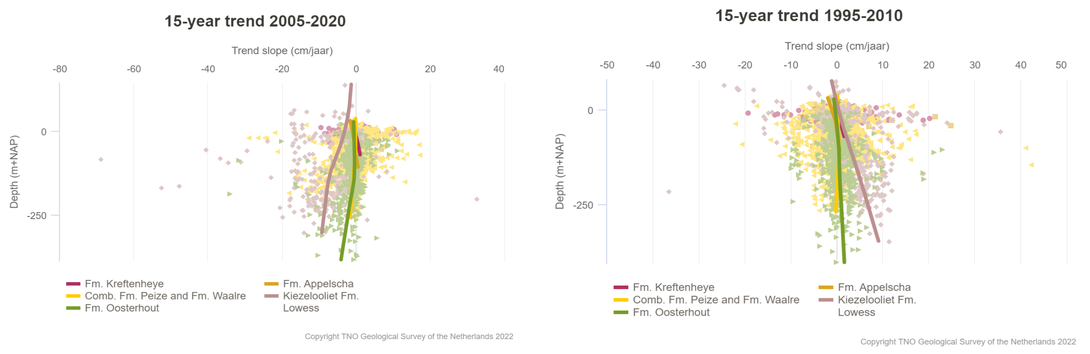
Changes over time

Temporal trends can be investigated per well, but this may reflect specific local influences. So they can also be visualized on a map with the option to select specific geologic formations.
Based on the points shown on the map, graphs with summary statistics can be created.



Groundwater head trends for piezometers in selected geological formations for 1995-2000 (left) and 2005-2020 (right).

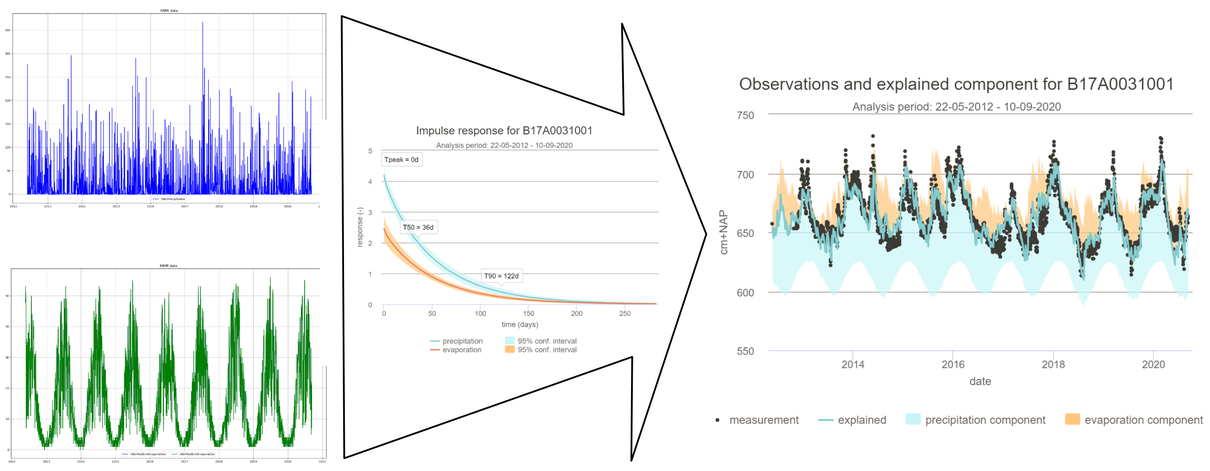
Aggregated groundwater 15-year head trends for selected geological formations.



Groundwater head trends for 1995-2000 (left) and 2005-2020 (right) versus elevation.

Influence meteorology on groundwater

Variation of precipitation and evaporation in time are often considered natural influences on groundwater levels. Timeseries analysis with transfer noise modeling gives insight in this influence without the need for additional information.



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TNO-GSN ground water tools with time series models

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TRENDS OF MEASURED GROUNDWATER HEADS IN THE NETHERLANDS

Aggregated trends for selected geologic formations

Extent of selected geologic formations with trends (2005-2020) at measurement points

Examples of trends at individual measurement locations

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