The Netherlands

Capital city: Amsterdam
Inhabitants: 17.3 Million

INSTITUTIONAL SETTING AND PURPOSE

The Ministry of Infrastructure and Water Management is in charge of the national groundwater monitoring programme in the Netherlands. Groundwater monitoring networks are managed on a national, regional and local levels. Provincial authorities and water boards take up the responsibility at the regional level, and municipalities and water supply companies are in charge of the groundwater monitoring at the local level. The establishment of the monitoring network started in 1970 with a goal to provide insights into the spatial distribution of hydraulic heads per aquifer.

CHARACTERISTICS OF THE NETWORK

The primary groundwater level monitoring network is developed and maintained by 11 provinces. In the past, the network used to measure the groundwater level every 14 days, but now data loggers collect it every hour. Total number of sites are 1,000 with 49,000 monitoring wells, 74,000 piezometers and 130 million groundwater levels/heads, Figure 1.

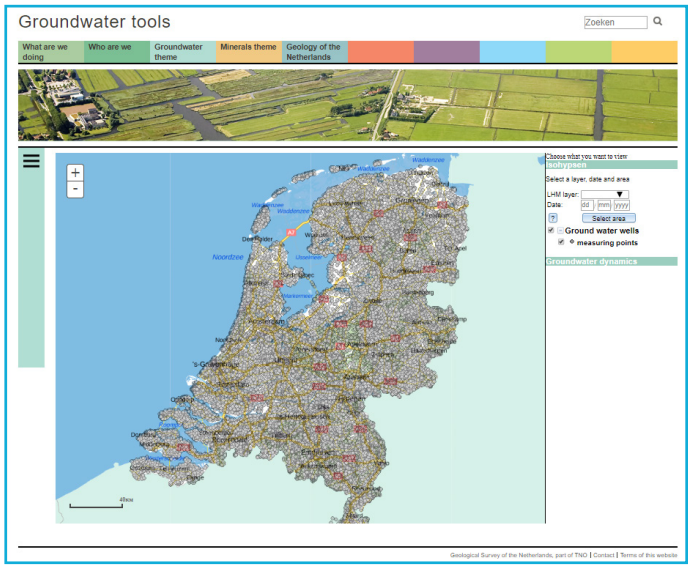


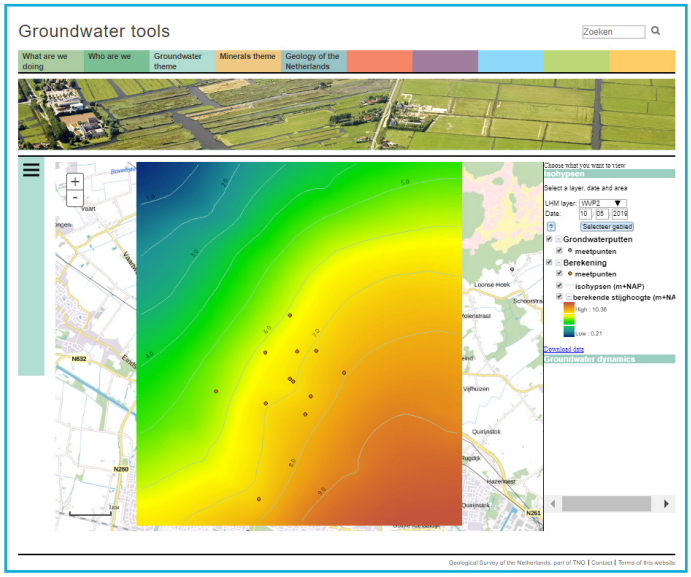
Figure 1 -Groundwater monitoring points in the Netherlands. Source: Grondwatertools viewer

The information on quantity and quality of the groundwater in the Netherlands can be accessed through DINOloket. The data are currently supplied in a format that the user can easily view in a spreadsheet (Excel format). However, a limited amount of data are currently being offered.

Grondwater Tools is an interactive portal designed to share information about groundwater in the Netherlands. The Groundwater Tool viewer allows the user to visualize the locations of monitoring wells in the Netherlands and use two powerful analysis tools: Contour lines (Isohypsen) and Groundwater Dynamics (Groundwaterdynamiek).

Contour lines

Contour lines are the lines with the same groundwater level on a map. They show the spatial pattern of levels and help to understand the direction of the groundwater flow. Grondwater Tool allows to choose for which date and in which aquifer a user want to see the contour lines, Figure 2. The data are downloadable and the file includes piezometric levels (Excel format), semivariance graph, Figure 2 (jpeg), Krigging results (Excel format) and contour lines (shape file). The contour lines are calculated based on rising ranges (groundwater levels) from the DINOloket, the NHI (Dutch Hydrological Instrumentation) and 3.0 hydraulic heads from the Deltares.



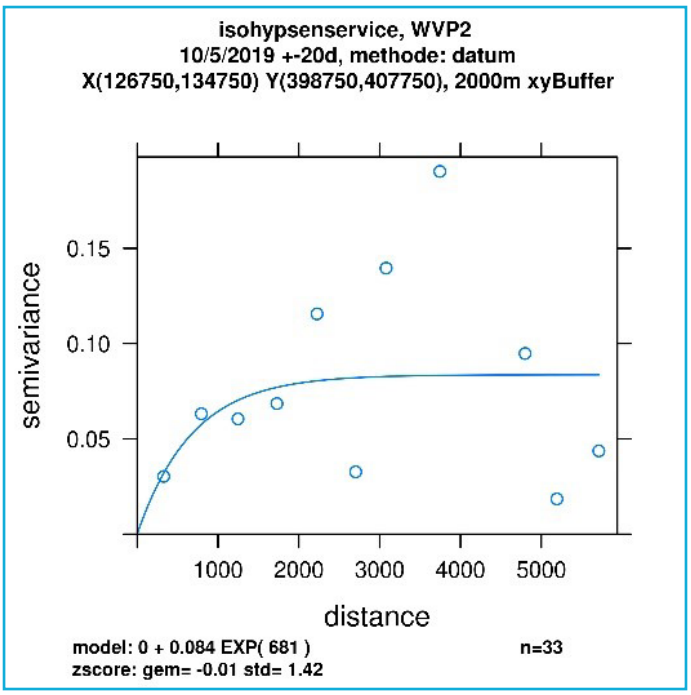


Figure 2 - Contour lines for Leikeven area, Tilburg, the Netherlands (previous page) – Grondwatertools viewer (above) – semivariance for groundwater levels from the selected area

Groundwater Dynamics

The system makes use of a transfer function-noise model with precipitation and evaporation as independent variables. An automated quality control is performed through a several steps in order to filter out time series that do not comply with the following criteria:

- Observations provide enough information about groundwater dynamics (enough amount of measurements in a long time period);
- Time series do not have a high number of errors (outliers, steps, drift);
- Small effect from other influences than precipitation and evaporation; and
- Linear behaviour of the groundwater system.

The three levels of model results are presented:

1. Groundwater levels time-series and associated statistics;
2. Components of time-series that can be explained by precipitation and evaporation; and
3. Regime curve based on at least 20 years simulation with the time-series model.

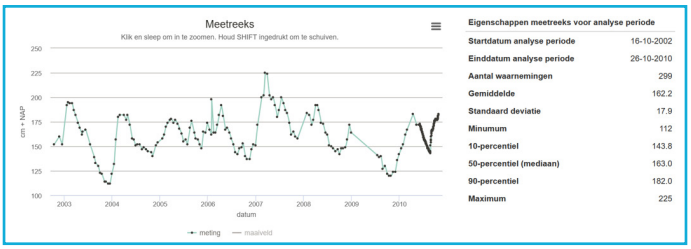


Figure 3 - Level 1 for one monitoring well. Source: Grondwatertools viewer

For Level 1 no specific criteria are used for the further interpretation. Statistics includes the average, standard deviation, maximum, minimum, and the percentiles 10, 50 and 90, Figure 3.

Level 2 presents the result of the time-series modelling, requiring automated evaluation of the model results. Two sets of criteria are defined:

1. The first set of criteria assess the length and number of observations of the dataset;
2. The second set of criteria evaluates the model output. This step will be performed only if the first set of criteria is satisfied.

Level 3, or the regime curve, Figure 4, is presented in the Grondwater Tools viewer when Level 2 is satisfied (e.g. if the calibrated time-series model is applied for the simulation). Furthermore, more criteria are added to evaluate the predictive performance of the model.

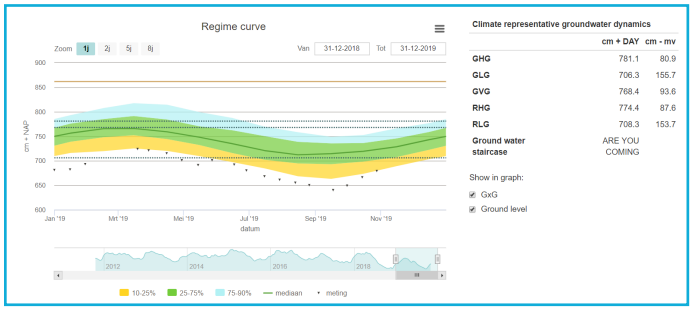


Figure 4 - Regime curve and climate representative groundwater characteristics for one monitoring well. Source: Grondwatertools viewer

To properly calculate the influence of the annual seasonal pattern (periodicity), several years of measurements are required; characteristics of groundwater regime are automatically calculated using the last 8 years of measurements. Then, the climate-representative groundwater characteristics are simulated over a period of 20 years.

This climate-representatives are:

- GHG: Average highest groundwater levels, which occur mainly in winter and early spring;
- GLG: Average lowest groundwater levels, which usually occur in late summer;
- GVG: Average spring groundwater level;
- GxG: The data set of GHG, GLG and GxG;
- RHG: 90-percentile based on the time-series model simulated over a period of at least 20 years;
- RLG: 10-percentile based on the time-series model simulated over a period of at least 20 years; and
- Grondwatertrap (groundwater stairs/category): This value is based on the values of GHG and GLG, (Table on next page).

Grondwatertrap	GHG (cm-mv)	GLG (cm-mv)
I	<20	<50
II	<40	50-80
IIB	25-40	50-80
III	<40	80-120
IIIB	25-40	80-120
IV	>40	80-120
V	<40	>120
VI	40-80	>120
VII	>80	-
VIII	>140	-

Figure 5 - Value ranges for groundwater categories

Groundwater Dynamics tool also provides an analysis of daily influence of precipitation and evaporation components (the distance from the shading to the explained part, figure below) on the groundwater levels.

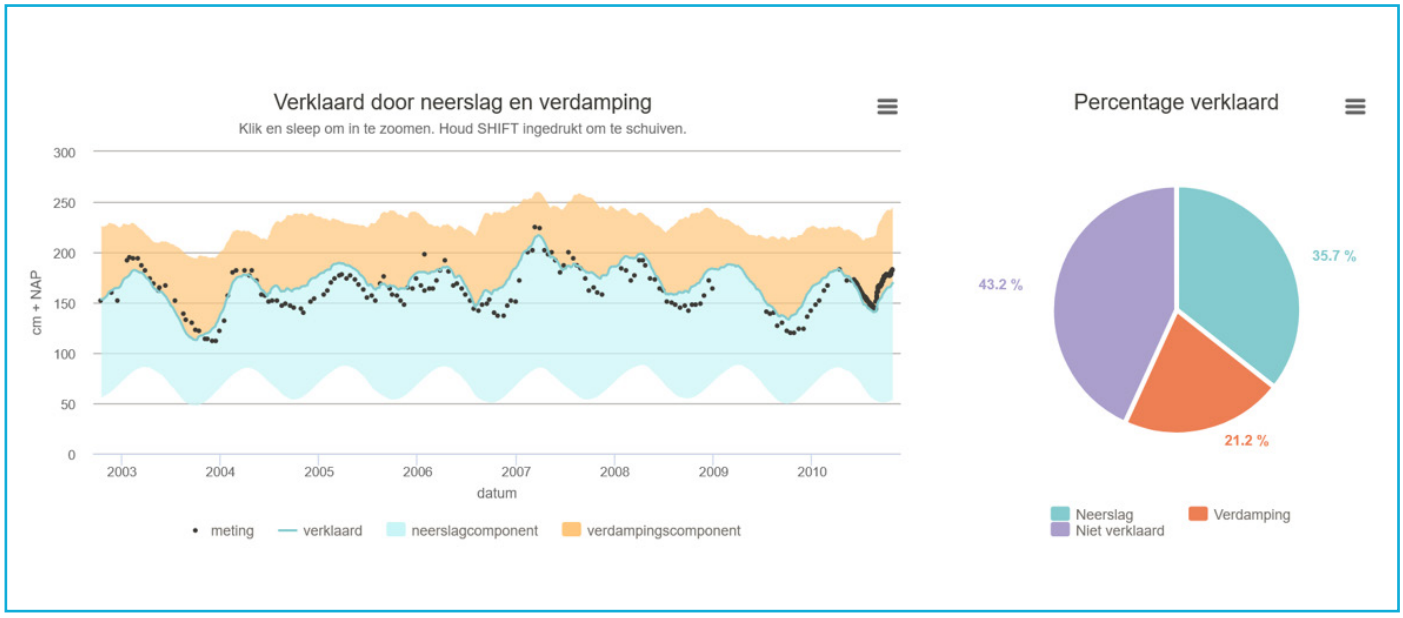


Figure 6 - Influence of precipitation and evaporation on groundwater levels for one monitoring well. Source: Grondwatertools viewer

Sources

- **DINOloket, Data and Information of the Dutch Subsurface. Levels** - https://www.dinoloket.nl/en/levels;
- **DINOloket, Subsurface models** - https://www.dinoloket.nl/ondergrondmodellen;
- **Grondwatertools** - https://www.grondwatertools.nl;
- **Grondwatertools** - https://www.grondwatertools.nl/regis-ii-0;
- **Grondwatertools** - https://www.grondwatertools.nl/isohypsen; and
- **Grondwatertools** - https://www.grondwatertools.nl/grondwatertools-viewer.