



Belgium is a federal state with three highly autonomous regions: Flanders in the north, Wallonia in the south, and the Brussels-Capital Region. Groundwater monitoring systems reflect this regional administration. The regional monitoring network of Wallonia is described below.

## Flanders

### INSTITUTIONAL SETTING

The application of Flemish and European legislation made it necessary to implement various target-specific monitoring networks.

The primary groundwater monitoring network in Flanders is managed by the Department of Operational Water Management of the Flanders Environmental Agency (VMM), and it is used for quantity, quality and operational monitoring.

For a better overview of the immense dataset, every monitoring well, (including the individual filters in the case of multilevel wells), is assigned to a specific measuring network. The classification is as follows (number of monitoring network and description):

1. Origin/manager unknown
2. Primary network – monthly measuring from VMM department Operational Water Management
3. Uncertain quality: mostly deeper measuring wells - initially part of the primary network, but with uncertain quality of monitored data and available well information from VMM department Operational Water Management

4. Measuring wells used for temporary projects from VMM department Operational Water Management
5. Wells from other Flemish and Belgian authorities or bodies
6. Wells from drinking water companies
7. Wells from private companies
8. Groundwater extraction wells
9. Phreatic monitoring network, especially shallow measuring wells, used for qualitative and operational monitoring from VMM department Operational Water Management
10. Usually phreatic shallow wells with a limited diameter from the WATINA (WATER IN NATURE) database operated by the Institute for Nature and Forest Research (INBO) and other nature conservation organizations. Biweekly for manual measurements and daily for measurements with a data logger
11. Wells that are constructed in the Flemish Regulations about Environmental Permits section 55 (VLAREM)

Some wells can belong to two different measurement networks, in particular networks 1 and 2. This occurs often at the level of screens.

### PROCESSING

The VMM, the Department of Environment and the Department of Mobility and Public Works (MOW) work in a partnership to manage the Database Underground Flanders (DOV), which groups all information about the subsurface in the area of Flanders.

VMM produces two types of groundwater level indicators, namely for relative and for absolute status of groundwater. The analysis includes only phreatic aquifers and wells with continuous measurements for 11 years or more and an average head of 10 m-mv (meters below ground level) or less. The indicators are prepared monthly, and during very dry weather – also weekly. Performed analyses determine whether the groundwater level has increased or decreased compared to the last month and

predict groundwater levels for the next month. Moreover, the locations of measurements are selected in a way to avoid the influence of human interventions as water extraction and drainage. The indicator shows the climate variability of the level.

Level measurements are supported by a SWAP model (Soil, Water, Atmosphere and Plant model). The model predicts the groundwater level for each measurement site based, among other things, on soil characteristics, the observed daily rainfall and evaporation. The results of the daily modelling are then combined with the monthly level measurements. The time series of daily simulated groundwater levels obtained in such way are processed into the indicator.

## 1. Indicator for the relative status of groundwater – What is the situation this time of the year?

For each monitoring location, the simulated groundwater level (combination of monthly level measurements and daily modelling with the SWAP) per day is compared with the simulated groundwater levels of the same day for the past 30 years. In statistical terminology: the percentile that corresponds to the groundwater level simulated for this year is read on the empirical cumulative distribution. The percentiles are divided into 5 classes: very low/very high (lower/higher occurs less than once in 10 cases), low/high (lower/higher occurs 1 to 3 times per 10 cases) and normal. The graph shows per day the percentage of monitoring stations that registered a very low, low, normal, high or very high groundwater level.

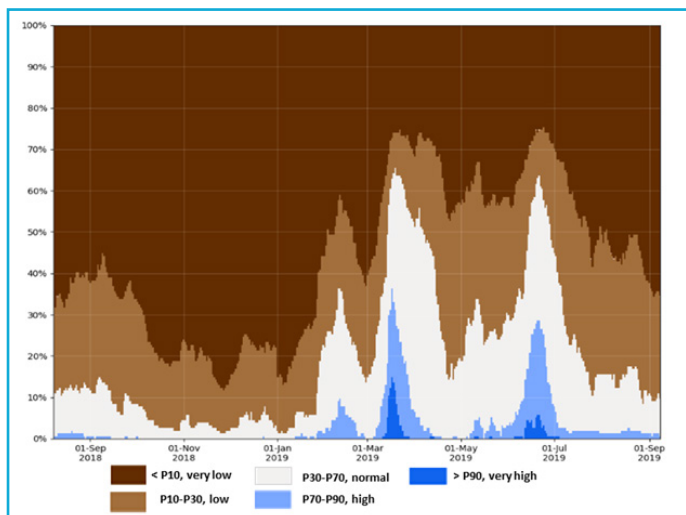


Figure 1 – Relative status of the groundwater level for selected period (September 01 2018 to August 26 2018)

## 2. Indicator for the absolute status of groundwater – Is the groundwater historically low or high?

The simulated groundwater level (combination of monthly level measurements and daily modelling with the SWAP model) per day is compared to the simulated groundwater levels of all days in the past 30 years. The method shows the percentage of cases the groundwater level is lower (or higher) than the simulated groundwater level for the day in question. The percentiles are divided into 5 classes: very low / very high (lower / higher occurs less than 10% of the days), low / high (lower / higher occurs 10 to 30% of the days) and normal.

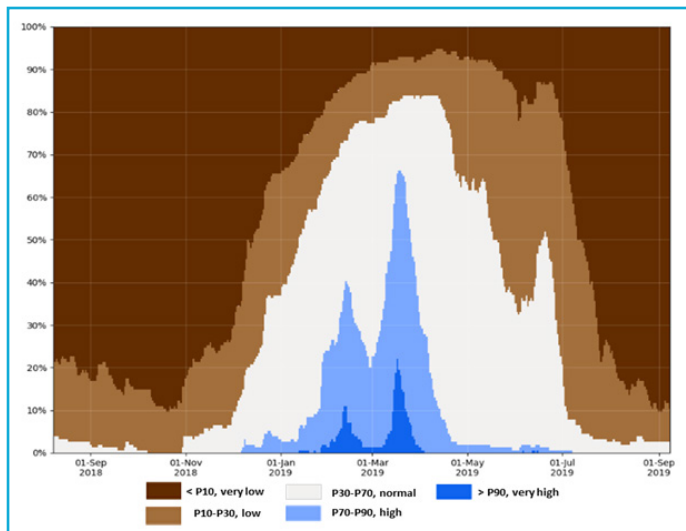


Figure 2 – Absolute status of the groundwater level for selected period (September 1, 2018 to September 1, 2019)

## 3. Increase or decrease of the water table

This is determined by comparing the current groundwater level with the groundwater level of the previous month. If the change in the groundwater level at a measurement location is more than 5% of the difference between the 10th and 90th percentile of the groundwater level at that measurement site, this is regarded as an increase or decrease. Otherwise, the situation is considered stable.

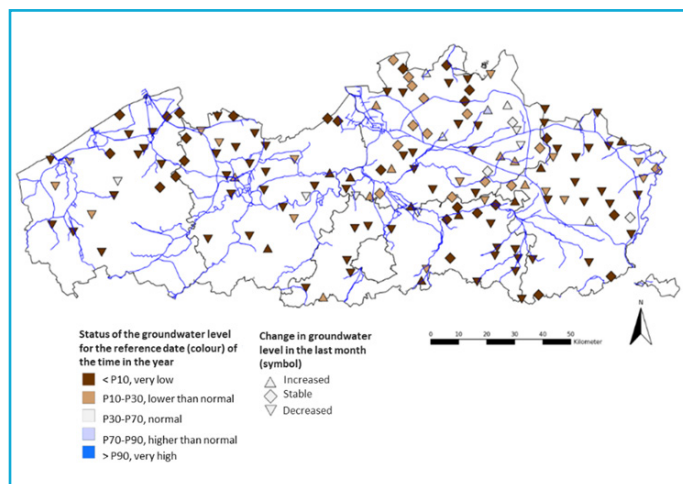


Figure 3 – Example of groundwater level changes map

## 4. Prediction of groundwater levels

Three scenarios are modelled to predict future groundwater levels: a wet, a normal and a dry situation for the next month. The amount of precipitation in these scenarios correspond to a historical precipitation period from the Royal Meteorological Institute of Belgium (KMI) in Ukkel. For the wet and dry scenario, a month with a precipitation that occurs every 10 years is selected. For the normal scenario, a month with an average rainfall is chosen. The expected groundwater levels according to the three scenarios are compared in relative terms (all measurements on the same day of the year) and absolute (measurements on all days of the year) with the groundwater levels of the past 30 years. A warning is only given if the expected groundwater levels are very high / low historically or for the time of the year.

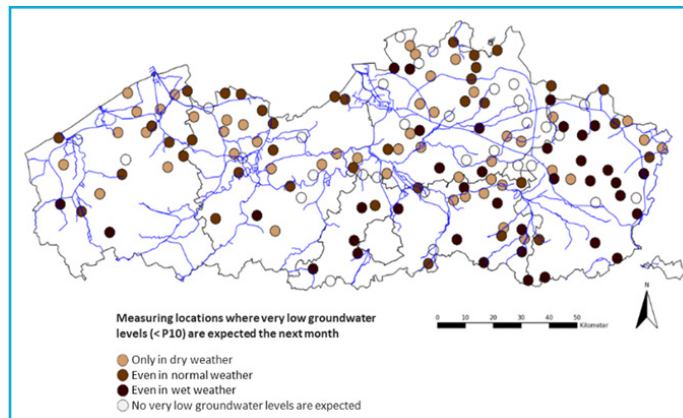


Figure 4 – Example of groundwater levels projection for the next month

## DISSEMINATION

All wells are currently available in the DOV database through its web-based portal (DOV-Explorer).

In total, it is possible to access the data of 62.443 wells, of which 17.109 screens correspond to level measurements and 12.590 to screens from which a groundwater sample was taken.

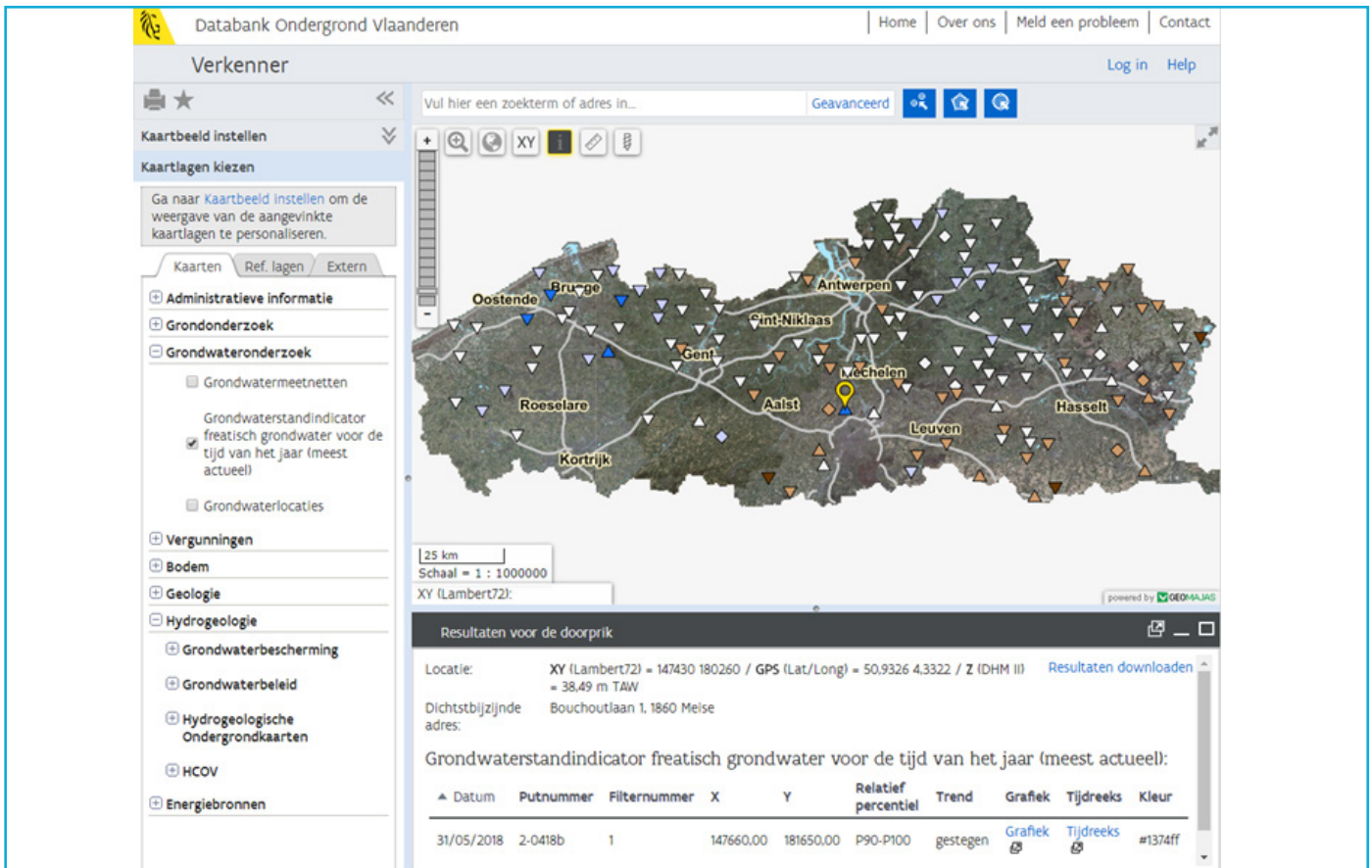


Figure 5 – Groundwater monitoring network of Flanders, DOV-Explorer

## Wallonia

### INSTITUTIONAL SETTING

The Directorate of Groundwater (part of the Department of Environment and Water, General Directorate of Agriculture, Natural Resources and Environment) is responsible for both quality and quantity groundwater monitoring networks in Wallonia including the acquisition and the maintenance of the network.

### CHARACTERISTICS OF THE NETWORK

The general quantitative monitoring network comprises more than 260 monitoring stations, where 235 are equipped with an automatic measurement system. Manual measurements are taken monthly to yearly depending on the availability of personnel, conditions of accessibility to the station, and others. Stations, where quantitative status is measured (178 in total), are part of a groundwater monitoring program that is setup according to the EU WFD and measuring changes in groundwater

bodies as the basic units. The DCE monitoring network consists of 553 monitoring stations and both quantity and quality of groundwater is measured at 20 locations.

There is a separate emergency network set up for several karst aquifers equipped with automatic, real time measurements of water levels and discharge.

## PROCESSING AND DISSEMINATION

Most of the data recorded via automatic data loggers is retrieved by remote transmission (GSM/GPRS). The data are then imported automatically into the AQUALIM database developed by the Directorate of Non-Navigable Watercourses (DCENN). The recorded hourly measurements are checked regularly via validation software that allows, if necessary, the correction of

anomalies. Once validated, the data are consolidated into daily data and automatically transferred to the Dixsous database.

Groundwater level data are available via the portal PIEZ'EAU, where locations, meta data and time series are available for visualization and downloading.

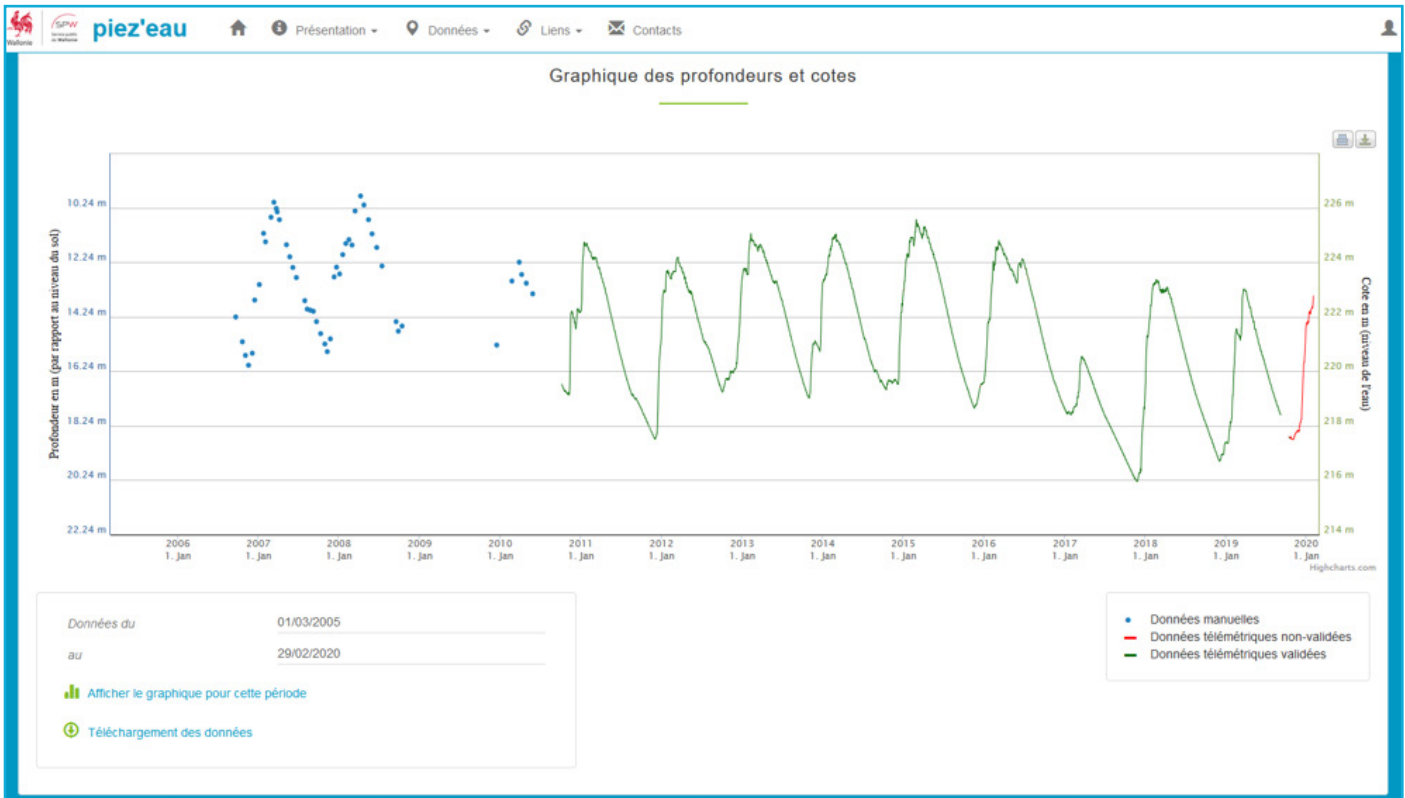


Figure 6 – PIEZ'EAU portal

Time series can be exported as an image in various formats and the observations can be downloaded in PDF format.

In Dixsous database, the Geocentric Approach tool allows to visualise locations of piezometers and production wells on a map in a circle around given coordinate of the centre and given radius.

## Sources

### Flanders

- **Database Underground Flanders (DOV)** - <https://www.dov.vlaanderen.be>;
- **DOV, Classification of groundwater networks** - <https://www.dov.vlaanderen.be/page/grondwatermeetnetten>;
- **DOV-Explorer** - <https://www.dov.vlaanderen.be/portaal/?module=verkenner&bm=9bba534d-0745-46ef-aa95-c31788c2266a>;
- **DOV, Groundwater level indicators** - <https://www.dov.vlaanderen.be/page/opbouw-grondwaterstandindicator>;
- **Feedback from VMM** - received on 20-02-2020; and
- **SWAP model** - <http://www.swap.alterra.nl>.

### Wallonia

- **Public Service of Wallonia. Status of Groundwater in Wallonia** - <http://environnement.wallonie.be/frameset.cfm?page=http://environnement.wallonie.be/de/eso/atlas>;
- **Dixsous database and Geocentric Approach tool** - <http://carto1.wallonie.be/10SousInt/Default.asp>;
- **Feedback from Wallonie Environment SPW** - received on 03-02-2020; and
- **PIEZ'EAU portal** - <http://piezo.environnement.wallonie.be/GeneralPages.do?method=displayStationsMap&time=2020-11-13%2016:29:49.621>.