

NVE's groundwater reference dataset for climate change studies

Last updated in December 2021 by Heidi Anette Grønsten (HF) and Siri Ane Hestad (HH).

1.1 Available data

All daily groundwater series stored in NVE's Hydra II database classified as active were considered for the selection of reference stations, in total 81 stations.

1.2 Selection of groundwater stations

Five different criteria for including a groundwater series in the hydrological reference dataset are used:

1. Stable land-use conditions including absence of significant regulations, diversions or water use. Including both natural and agricultural sites.
2. Record length. Minimum 20 years in total and more than 10 years of daily groundwater measurements.
3. Active data collection. Currently active and is expected to continue monitoring ground water level.
4. Good data quality.
5. Adequate metadata. Adequate metadata should be available to support the previous four conditions.

1. Stable land-use conditions

Main land cover units according to European Environment Agency's *Coordination of information on the environment* (CORINE) programme are included in the metadata for the groundwater stations. Stations that are located in areas characterized as land unit 112 – artificial surfaces or 412 – wetlands, are excluded from the list of potential climate reference stations, as they are not considered to reflect natural climate variability.

Stations on agricultural land are considered insignificantly influenced and it is expected that these areas will experience only small changes in water use in the future. Activities such as forestry will to a larger degree affect water use in an area, as will the elevation of the tree line due to climatic change over time.

2. Record length

Due to the natural multi-year and decadal variability in the climate system, climate change related studies and studies on trends should in general use records with at least 30 years of data. For selection of groundwater series, only stations with more than 20 years (until 2020) of registrations and 10 years of daily data were listed in the HRD. These series have the

potential to reach at least 30 years of data soon. It is therefore important that data collection at these stations is maintained, and that high quality of the data is ensured.

3. Active data collection

Only stations that are currently active (2021) and expected to be continued have been considered as potential reference stations.

4. Data quality

Data quality was checked by an explorative graphical analysis. The series were checked for missing data, unnatural jumps, signs of sinking or ascending of the groundwater pipe, extreme values, and other non-regularities. Supporting information was found in the stations' metadata, and corrections were made for some of the series.

In general, there is a higher uncertainty related to peak ground water measurements of earlier periods, e.g. due to weekly or monthly manual measurements as opposed to automatically registering loggers used today. Most of the groundwater stations were equipped with automatic measuring devices around 2000. From 2012 all stations are recording continuously.

5. Adequate metadata

Hydra II contains metadata about how the stations have been operated, including instrumentation, measurement location, control measurements. The station description in Hydra II further specifies station type and other variables measured at the station.

1.3 List of groundwater series

The final list of groundwater stations to be included in the HRD by 2021 is shown in Table 1 below. It distinguishes the start of registrations from the beginning of continuous monitoring, for each groundwater station. The last column gives information about missing data, of about one month or more. Shorter periods of missing data may occur although it is not written here. If only parts of the available data should be used, this is also stated under *Comments*.

Tabell 1: The table shows a list of groundwater stations with data series that are sufficient in quality and length to be included as reference stations (HRD).

| Hydra-Id | Station name | Start registrations | Daily values from | Comments |
|-----------|--------------|---------------------|-------------------|---|
| 2.717.4 | Fura | 1973 | 2000 | Missing 11.1995-06.2000. Missing 06.2001-02.2002, 01.-09.2020. To be used from 2000. |
| 2.718.2 | Dombås | 1981 | 2002 | Missing 02.2002-05.2002. |
| 2.725.1 | Abrahamsvoll | 1969 | 1999 | Missing 11.2007-03.2008, 03.-04.2014, 03.-05.2017. |
| 2.727.0 | Kise | 1991 | 2000 | |
| 12.343.12 | Modum | 1979 | 2001 | |
| 12.368.1 | Hol | 1983 | 2005 | |
| 16.232.1 | Groset | 1949 | 2004 | Missing 06.2003-09.2003, 12.2007-04.2008. |
| 21.81.3 | Lislefjødåi | 1972 | 2004 | Missing 03. and 05.-06.2005, 01.-04.2006, 08. and 10. 2006, 03.-04.2010, 11.-12.2010, 12.2015-03.2016. |
| 23.17.1 | Lindesnes | 1980 | 2010 | |
| 56.3.2 | Fana | 1978 | 2003 | |
| 84.25.3 | Moskog | 1979 | 2008 | Missing 2019. Exclude 19.12.2011-20.01.2012, as the station was not logging due to storm, and the period show extreme and obviously false values. |
| 89.3.1 | Nordfjordeid | 1979 | 2008 | Missing 02.-03.2009 and 04.-05.2011. Some corrections done in 2009/2010 and 2013/2014. To be used from 1995. |
| 124.33.0 | Værnes | 1992 | 1999 | Missing 11.2012 - 01.2015. |
| 151.37.2 | Svenningdal | 1980 | 2007 | Missing 06.2009-03.2010. |
| 173.28.1 | Skjomen | 1983 | 2001 | Missing 01.-09.2001, 06.-10.2005, 05.2013 - 08.2013. |