Data description document for

groundwater level measurements

Cabauw Experimental Site for Atmospheric Research (CESAR)

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1 Measurement

Groundwater levels have been measured since August 2003 in two fields south of the tower. Nine piezometers were placed in a row. Initially, 6 of those piezometers contained pressure transducers (of the brand Keller) to measure levels automatically every 4 hours. On 9 July 2010, the temporal resolution was increased to hourly. Several sensors have stopped working since 2003. Piezometers that were not measured automatically were measured during each filed visit, which was initially every 2 weeks, but has become longer towards the end of the measurement period. For more information, see Brauer et al. (2014a,b); Brauer (2014).

Note that next to these groundwater level measurements performed by Wageningen University, groundwater levels have been measured by the KNMI. Those data are also available through the CESAR database.

2 Dataset

There are data files for each year, with daily and hourly resolution:

- `cesar_groundwater_leveldaily_la1_t1d_v1.0_yyyy.nc`
- `cesar_groundwater_levelhoury_la1_t1d_v1.0_yyyy.nc`

The CESAR database contains time series of groundwater levels with hourly and daily resolution (Table 1). Groundwater levels are measured with respect to mean sea level. Note that

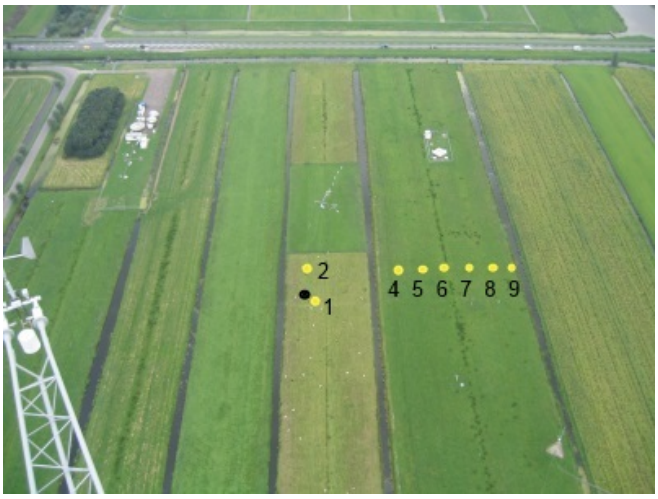

Figure 1: Location of the piezometers (yellow dots) and other hydrological sensors (black dot), after piezometers 1–3 had been moved in April 2009, as seen from the tower (looking southward).

Figure 2: Data collection: reading data from a Keller sensor (small iron disc on the tube (the top of the actual sensor), cable, PDA) and equipment for manual measurements (black disc with measuring tape and clipboard).

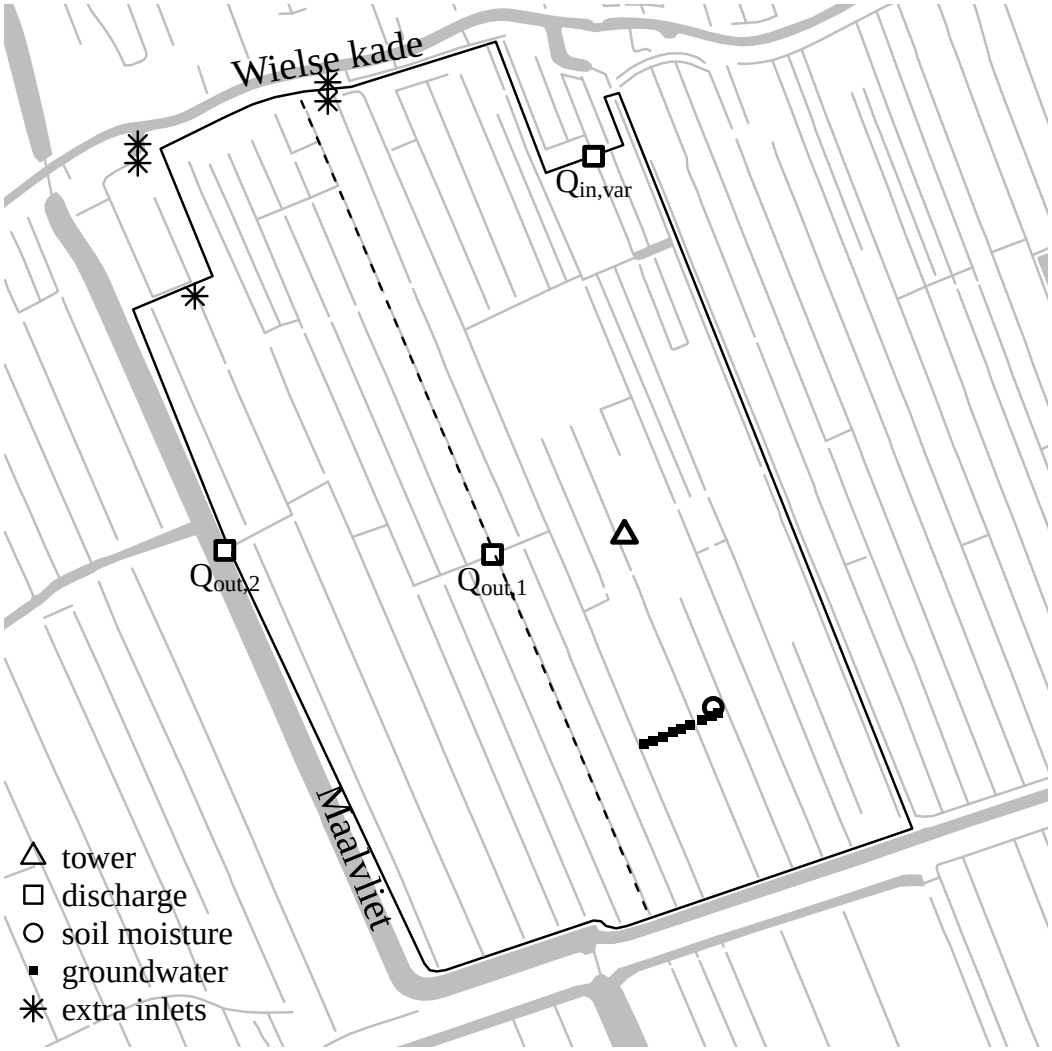

Figure 3: Location of groundwater and other hydrological measurements.

Figure 4: The piezometer between the TDR sensors in the eastern field (number 1).

Figure 5: The row of six piezometers in the western field.

Table 1: Specifications of the piezometers.

Piezometer number	Distance from east ditch [m]	Local soil elevation [m a.m.s.l.]	Measure-ment type	Measurement period
1	8.5	-0.753*	automatic manual	2009-04-29 – 2009-10-21 2009-10-21 – 2011-10-21
2a	8.5	-0.799*	automatic	2003-08-12 – 2009-04-29
2b	25.5	-0.785*	automatic	2009-04-29 – 2011-10-21
4	44	-0.720	automatic	2003-08-12 – 2011-10-21
5	54	-0.831	automatic	2003-08-12 – 2011-10-21
6	63.5	-0.886	manual	2003-08-12 – 2011-10-21
7	74	-0.653	automatic manual	2003-08-12 – 2009-10-21 2009-10-21 – 2011-10-21
8	84	-0.608	automatic	2003-08-12 – 2011-10-21
9	91	-0.837	manual	2003-08-12 – 2011-10-21

* piezometers 1, 2 and 3 were moved on 2009-04-29

the soil surface is a little below sea level as well. The three easternmost piezometers (numbers 1, 2 and 3) were moved on 29 April 2009. Piezometer 1 was moved between the TDR sensors. Data from piezometer 1 before 29 April 2009 and from piezometer 3 are not in the dataset (because the filters of these piezometers were often blocked and hence the data quality was low). The dataset of piezometer 2 has been split into a pre- and post-move part (hence the 2*a* and 2*b*).

The elevation of the soil surface varies slightly between the measurement locations and also in time. The values shown in Table 1 should therefore be interpreted as estimates.

Table 2: Order of filling gaps with data from other piezometers (based on the goodness of fit of the regression line).

Piezometer number	filling order 1st	2nd	3rd	4th
2a	7	8	4	5
2b	7	8	4	5
1	2b			
6	5	4		
4	5			
5	4			
9	7	8	5	
8	7	5		
7	8	5		

3 Gap filling

Measurements have been corrected and gaps have been filled. A quality code is supplied with every measurement:

1 Original measurement.

0 Value obtained with gap filling.

In the hourly times series, gaps smaller than 2 days are filled with linear interpolation. For the daily time series, all measurements on one day have been averaged to obtain the daily average groundwater level.

Relations between piezometers obtained with linear regression have been used to fill gaps (Table 2).

4 Set-up NetCDF files

The NetCDF files contain the following columns:

- `date`: date (as yyyymmdd) or date-time (as yyyymmddhh)
- `GWL1`, `GWL2a`, ..., `GWL9`: groundwater level for each piezometer, measured with respect to sea surface
- `code1`, `code2a`, ..., `code9`: data quality code for each piezometer

- `DOY`: all days in the year in question (belongs to `valid_dates`)
- `valid_dates`: vector with 1 and 0 indicating if data for that day are available

Acknowledgements

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References

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