Correlating satellite remote sensing signals with groundwater head time series

Universiteit Utrecht

NWO Netherlands Organisation for Scientific Research

SRON Netherlands Institute for Space Research

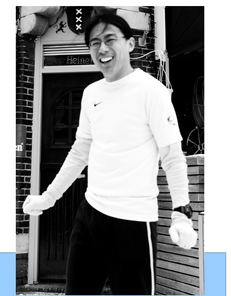
TNO

Deltares Enabling Delta Life

Edwin H. Sutanudjaja, *Steven M. de Jong, Frans C. van Geer and Marc F.P. Bierkens*

Dept. of Physical Geography, Faculty of Geosciences, Utrecht University, The Netherlands

✉: ***e.sutanudjaja@geo.uu.nl***

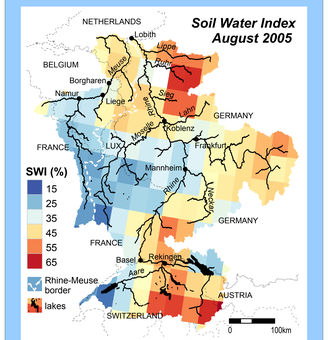


Can we monitor groundwater from space?

Purpose:

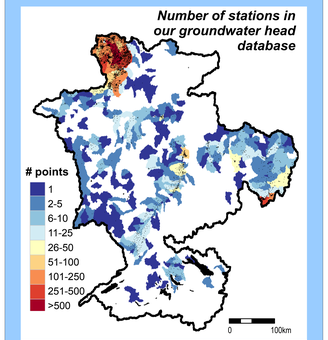
To check whether remote sensing signals carry information on groundwater levels. Currently, we focus on the ERS Soil Water Index (SWI) fields (Wagner et al, 1999), time series of which are compared to more than 5000 groundwater head time series in the Rhine-Meuse drainage basin.

ERS Soil Water Index



- Derived from European Remote Sensing (ERS) **active scatterometer** signals.
- Represent **soil moisture** contents (%) in **the first 1 m of soil**.
- **25-50 km** spatial resolution.

Groundwater head

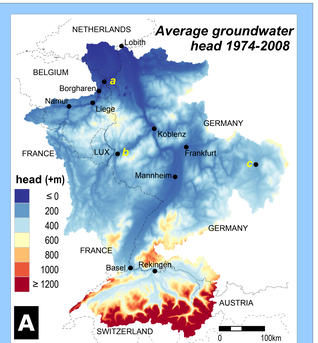


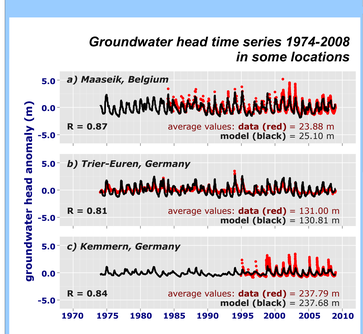
- **Ground measurements** from various institutions in the Rhine-Meuse basin.
- Only time series from the **first upper aquifer** were used (> 5000 points).
- **Point scale**.

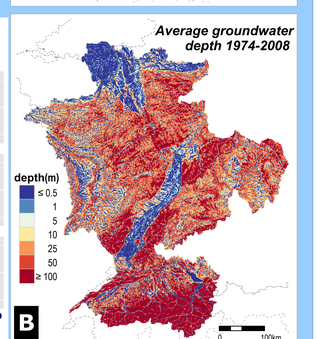
Study area: Rhine-Meuse Basin

The combined basin has **ample** groundwater head time series.

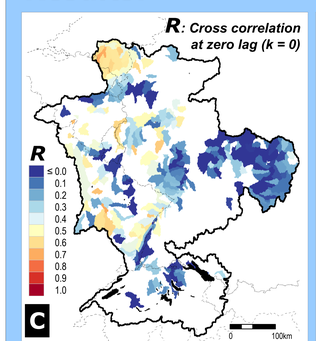
Figure **A** and Figure **B** illustrate **mean groundwater head and depth** for the period 1974-2008 calculated by using the model of Sutanudjaja et al (2010).

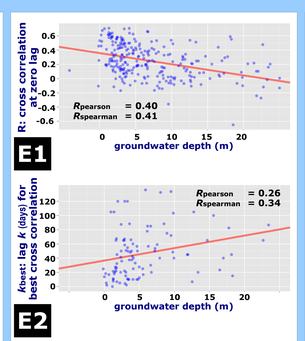


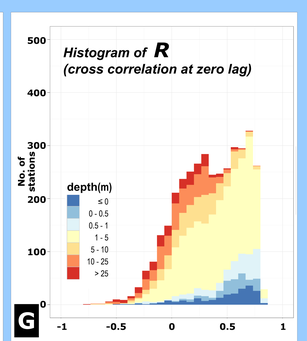


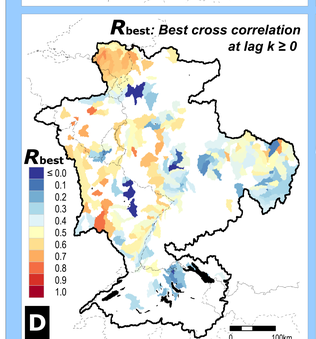


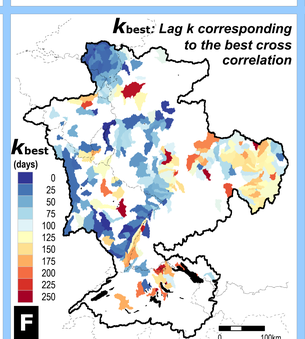
Results:

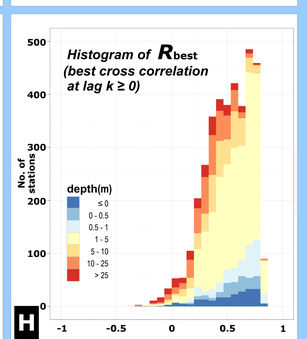












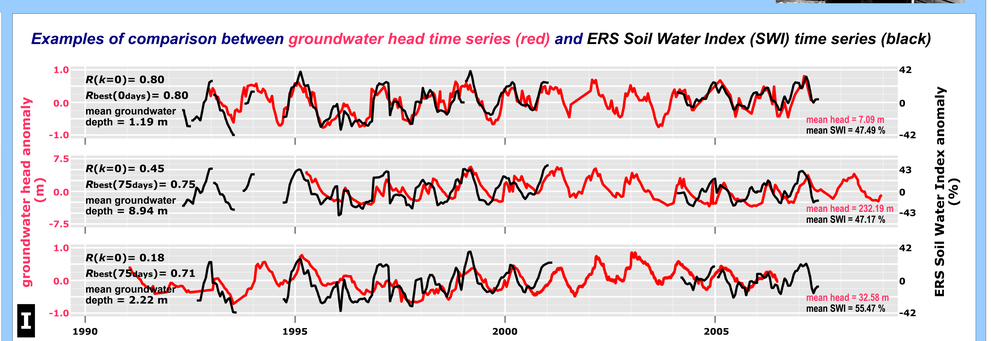


Figure I shows examples of comparisons between groundwater head and ERS Soil Water Index (SWI) time series. For each comparison, we calculated the cross correlation (***R***) between both time series, without considering lag-time (***k***=0). We also calculated the cross correlations at positive lags (head time series of which are shifted forwardly by ***k*** days). Then, we identified the best cross correlation coefficient (R_{best}) and its corresponding lag-time (k_{best}). ***R***, R_{best} and k_{best} were calculated for all stations and summarized in histograms and maps.

We see most of groundwater head time series have **strong correlation** to SWI time series (**Figure G**), especially in shallow groundwater areas (**Figures E1** & **C**). By considering lag-time and identifying k_{best}, we see even considerably stronger correlation (**Figures H** & **D**). Moreover, values of k_{best}, which may be physically defined as average water residence time in unsaturated zone, generally increases with average groundwater depths (**Figures E2** & **F**).