Temporal variations in nitrate concentrations in upper groundwater

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Summary
For the evaluation of measures to improve groundwater quality, environmental research institutes, national and regional governments and agricultural organizations are putting a lot of effort into the monitoring of upper groundwater quality. However, trend detection in upper groundwater quality is often hampered by the large temporal variability in the groundwater quality measurements. This variability is mainly caused by variable meteorological conditions, that cause strong variability in groundwater recharge. The objective of this study was to understand and quantify this weather-induced variability in shallow groundwater quality. The effects of meteorological variations on upper groundwater quality are shown using measurements from De Marke, an intensively monitored experimental farm in The Netherlands. Using a 1D model for water and solute transport, the effects of dry and wet periods on solute concentrations in shallow groundwater were evaluated. The same model was used to quantify the effects of meteorological variability on nitrate concentrations at De Marke. The results show that solute concentrations in the upper groundwater at this field site can vary between 55% and 153% of the average concentration due to meteorological variability. The quantification method was successfully used to distinguish weather related variability from human-induced trends at De Marke.

The results of this study show the importance of involving the weather-induced variability in the interpretation of groundwater quality monitoring data. This prevents misjudgment of the effectiveness of policy measures to improve groundwater quality. We also evaluated different common upper groundwater sampling methods. Sampling from fixed wells produces less weather-induced temporal variability than sampling from temporary open boreholes. From this we conclude that sampling from fixed groundwater wells is most suited for the detection of human-induced trends.

Keywords: groundwater quality, weather-induced temporal variability, monitoring, nitrate