Groundwater quality trend detection at the regional scale: effects of spatial and temporal variability

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Abstract The EU Directives require the aggregation of trends in individual monitoring points to areas or groundwater bodies. This aggregation is delicate because spatial variations in solute inputs, groundwater age and reactive processes are large, and temporal variations due to climatological factors largely influence the time series at shallow depths in the aquifers. In principle, the monitoring of the recently infiltrated uppermost groundwater yields the fastest response to changes in agricultural practices. However, the trend analysis results and model results both indicated that trend monitoring using the uppermost groundwater suffers from large temporal and spatial variability. In our cases, this seriously hampered the detection of trends that are due to changing agricultural practice. Trend analysis results from the configurations with deeper permanent screens showed less temporal variability, but the trend results only became meaningful when the age of the groundwater was considered. Tritium-helium age dating showed that variations in groundwater age at 7-12 m depth are larger than theoretically expected. Therefore, scaling of the time series according to the recharge year of the groundwater was profitable. Using the tritium-helium age scaling, the concentration time series confirmed the impacts of increasing manure loads between 1950 and 1990 and indicated the first signals of improvement after 1990. The trend reversal was apparent for indicators which behave conservatively in groundwater. Trend reversal for retarded polluants may take much longer to be detected; reactive processes have large effects on trend detection.

Keywords: trend analysis; groundwater age; tritium-helium; spatial and temporal variability