Developing a simple method for the evaluation of redox conditions in superficial groundwater at the Pan European Union scale

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Denitrification potential is an important information to know for adequate and efficient management and assessment of groundwater vulnerability, chemical status and the fate and migration of different types of contaminants. This parameter is highly variable in space and time.

Different methods exist to evaluate the denitrification potential in groundwater such as i) geological – determined by sediment/rock chemistry i.e. the presence of electron-donor minerals, ii) isotopic using $\delta^{18}NO_3$ and $\delta^{15}NO_3$ tracers, iii) hydrochemical indicators, based on dissolved redox sensitive ions and gases (Eh, O_2, NO_3, NO_2, Fe, Mn, SO_4, CH_4, H_2S or N_2). The methods can be combined and results refined by geochemical modelling.

At the large-scale and using data acquired within various groundwater monitoring networks and for different purposes, data quality and quantity may not be sufficient to allow a strict determination of the presence of denitrification. In the GEOERA HOVER project, the determination of the redox transition from nitrate containing water to iron-reduced water with no nitrate was preferred to a strict delineation of denitrification status due to the need for a pan EU overview of this information using data available in various countries. There was also a need for a simplified approach to map reduction potential in a common way without the need for further extensive data collection.

Based on the existing data in each of the participating countries and previous experiences in mapping nitrate attenuation patterns a classification tree was proposed using a minimum number of parameters. The classification tree is based on nitrate concentration, presence at defined concentrations of Mn, Fe, O_2 and NH_4. After being tested in some regional scale case studies, the method was applied at national scale in France, Denmark, UK, Ireland, Latvia, Spain, Cyprus and in catchments in the Netherland, Croatia/Slovenia.

After distinguishing between groundwater containing nitrate and groundwater without nitrate, the first step of the method allows for the classification of groundwater with iron (anoxic) or without iron (oxic). Water having iron at low concentration or iron but no nitrate is falling into a “mixed” category. The method can either end here or if needed continue in a second step for mixed samples. The second step considers NH_4 and O_2 concentrations.

After applying the methodology to individual sampling points the results were aggregated to groundwater bodies. Mapping challenges were considering depth and spatial variability. Temporal evolution because of changing denitrification processes (due for example to overexploitation and water table decline) could not be considered at this large scale.

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