



An approach to derive groundwater and stream threshold values for total nitrogen and ensure good ecological status of associated aquatic ecosystems – example from a coastal catchment to a vulnerable Danish estuary.

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Nitrate, which typically makes up the major part ($\sim >90\%$) of dissolved inorganic nitrogen in groundwater and surface water, is the most frequent pollutant responsible for European groundwater bodies failing to meet the good status objectives of the European Water Framework Directive generally when comparing groundwater monitoring data with the nitrate quality standard of the Groundwater Directive (50 mg/l = the WHO drinking water standard). Still, while more than 50 % of the European surface water bodies do not meet the objective of good ecological status "only" 25 % of groundwater bodies do not meet the objective of good chemical status according to the river basin management plans reported by the EU member states. However, based on a study on interactions between groundwater, streams and a Danish estuary we argue that nitrate threshold values for aerobic groundwater often need to be significantly below the nitrate quality standard to ensure good ecological status of associated surface water bodies, and hence that the chemical status of European groundwater is worse than indicated by the present assessments.

Here we suggest a methodology for derivation of groundwater and stream threshold values for total nitrogen ("nitrate") in a coastal catchment based on assessment of maximum acceptable nitrogen loadings (thresholds) to the associated vulnerable estuary. The applied method use existing information on agricultural practices and point source emissions in the catchment, groundwater, stream quantity and quality monitoring data that all feed data to an integrated groundwater and surface water modelling tool enabling us to conduct an assessment of total nitrogen loads and threshold concentrations derived to ensure/restore good ecological status of the investigated estuary. For the catchment to the Horsens estuary in Denmark we estimate the stream and groundwater thresholds for total nitrogen to be about 13 and 27 mg/l (~ 12 and 25 mg/l of nitrate). The shown example of deriving nitrogen threshold concentrations is for groundwater and streams in a coastal catchment discharging to a vulnerable estuary in Denmark, but the principles may be applied to large river basins with sub-catchments in several countries such as e.g. the Danube or the Rhine. In this case the relevant countries need to collaborate on derivation of nitrogen thresholds based on e.g. maximum acceptable nitrogen loadings to the Black Sea / the North Sea, and finally agree on thresholds for different parts of the river basin.

Phosphorus is another nutrient which frequently results in or contributes to the eutrophication of surface waters. The transport and retention processes of total phosphorus (TP) is more complex than for nitrate (or alternatively total N), and presently we are able to establish TP thresholds for streams but not for groundwater. Derivation of TP thresholds is covered in an accompanying paper by Kronvang et al.