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Tracing sources of nitrate in a porous aquifer using stable isotope (15N, 18O) analysis

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Conserving a good groundwater quality is a major challenge because of its importance as a reservoir for drinking water. Particularly in agricultural areas this quality can be affected by diffuse pollution of nitrate. Therefore, a suitable management practice needs in-depth knowledge about the possible sources of pollutants in a groundwater catchment area. Isotopic analysis is a useful tool for the identification of the nitrate origin. To identify the dominant sources of nitrate in a porous aquifer, investigations are accomplished with a focus on stable isotope measurement (δ^{15}N-NO_3^- and δ^{18}O-NO_3^-) as well as the concentration of nitrate. The groundwater catchment area ($\sim$250 km^2) is located in southern Germany confirming the porous aquifer. Most of the land use is organic farming as well as forestry and land settlement. This results in potential sources of nitrate in the investigation area being mainly fertilizers, sewage and deposition of nitrogen compounds. The groundwater sampling was done at three sites (sites A, B, C) affected by agriculture. One reference site was chosen representative for forestry. Groundwater sampling and measurements included the concentration of nitrate, electrical conductivity, water temperature, pH and oxygen. In addition isotopic analysis of δ^{18}O-NO_3^- and δ^{15}N-NO_3^- was carried out by using an IRMS (reference gases N_2 (AIR) for ^{15}N-NO_3^- and CO (VSMOW) for ^{18}O-NO_3^-). The local isotopic signature of precipitation, organic and mineral fertilizer as well as nitrogen in the topsoil will be detected soon. Although differences in the concentration of nitrate between the three sites influenced by agricultural could be measured (A:9.6$\pm$(1.9)mg/L, B:12.2$\pm$(4.5)mg/L, C:6.3$\pm$(1.9)mg/L), the isotopic values for δ^{15}N-NO_3^- were all in the same range (0.9–7.5($\pm$1.3)‰). Lower concentrations of nitrate (5.9$\pm$(1.9)mg/L) and δ^{15}N-NO_3^- isotope values (-0.8–3.5($\pm$0.6)‰) were found at the reference site (influence by forestry). The values of δ^{18}O-NO_3^- were equal for all sites ranging from 0.3 – 9.9($\pm$3.8)‰The isotope values of the investigation area were compared with data from literature. From a dual isotope plot of these data it can be concluded that the nitrogen in the investigation area had its origin in soil nitrogen and ammonia from fertilizer. Together with the isotope values of oxygen the data indicates strongly that the nitrate found in the groundwater originates from microbial activity instead from direct contamination by fertilizers.