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Identification and characterisation of potential sources of nitrate pollution in the Marano Lagoon (Italy) applying a multi-isotope approach

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The isotopic composition of nitrate (δ^{15}N, δ^{18}O and Δ^{17}O), boron (δ^{11}B) and water (δ^{2}H and δ^{18}O) were used to identify and characterize of multiple nitrate pollution sources in the Marano Lagoon (Italy) and part of its catchment area. The stable isotopes in nitrate measured by the denitrifier method have been adopted to differentiate among nitrate coming from agriculture (synthetic and natural fertilizers), airborne nitrate and nitrate from nitrification processes in soils. Boron isotopes have been used to identify the impact of domestic wastewaters to the aquatic system using the LA-MC-ICP-MS method. The combined use of NO_3 and B isotopes has proved to be an effective means in identifying multiple nitrate pollution sources because these isotopes co-migrate in many environmental settings, their isotopes are fractionated by different environmental processes, and because wastewater and fertilizers may have distinct isotopic signatures for N and B. The stable isotopes of water have been used to calculate mixing ratios between sea and fresh water as well as to estimate the mean altitude of the recharge area of surface waters. Additionally, the stable isotopes of sulphate (δ^{34}S and δ^{18}O) have been adopted to trace natural and anthropogenic sources of sulphur in agricultural watersheds as well as in coastal systems. In order to characterize the chemical composition of the different water types the concentration of Ca^{2+}, Mg^{2+}, Na^{+}, K^{+}, NH_4^{+}, NO_3^{-}, NO_2^{-}, Cl^{-}, Br^{-}, SO_4^{2-}, HCO_3^{-}, PO_4^{3-}, total phosphorus and total boron have been analyzed. Moreover, the physicochemical parameters such as pH, electrical conductivity, dissolved oxygen, salinity and temperature have been measured. To identify the origins and fate of nitrate a water monitoring program was implemented in the Marano lagoon and part of its catchment area. The water monitoring program involved the collection of water samples from the lagoon, its tributary rivers, the groundwater up-welling line, groundwater, sewer pipe and open sea on a quarterly interval from 2009 to 2010.