

ASSESSMENT OF NITROGEN-BEARING COMPOUND SOURCES IN THE LOMELLINA RICE-PADDY AREA THROUGH NITROGEN AND OXYGEN ISOTOPE ANALYSIS IN THE LOCAL PHREATIC AQUIFER

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Nitrate pollution in groundwater represents a global issue, with significant impacts on water resource quality. Despite its relevance, few studies have investigated the origin and transformation processes of nitrate derived from nitrogen-based fertilizers in European rice-paddy contexts such as the Lomellina area, within the main rice-producing district in Italy.

This study aims to systematically apply $\delta^{15}\text{N}$ - $\delta^{18}\text{O}$ dual isotope analysis of nitrate in the phreatic aquifer of the Lomellina area, where groundwater depth ranges from less than 1 m to about 15 m, in order to trace the sources and transformations of nitrogen-bearing compounds in this rice-paddy district.

Between June 2024 and December 2025, thirteen geochemical monitoring campaigns were conducted at 25 monitoring points tapping the phreatic aquifer. Data obtained from the dual isotopic analysis of nitrates in groundwater (represented using a version of the Kendall Plot adapted to local conditions) were integrated with nitrate concentration, land use data and details on the type of fertilizers applied in the study area.

The results suggest that although nitrate concentrations in groundwater (measured up to 164.49 mg/L) mainly originate from NH_4^+ -based inorganic fertilizers ($\delta^{15}\text{N}$ between -5 and +15‰; $\delta^{18}\text{O}$ between 0 and +5‰), significant contributions also come from the natural nitrogen cycle in soil and

from atmospheric deposition. In some samples, nitrate concentrations of approximately 5-15 mg/L can be interpreted as a mixture of these different sources, whereas in others, anomalous $\delta^{15}\text{N}$ and $\delta^{18}\text{O}$ values in nitrate prevent the clear identification of nitrogen-bearing compound sources.

The study's findings provide a solid basis for future monitoring activities and for the sustainable management of fertilizers, both within the study area and in other regions where it is necessary to identify the contribution of nitrogen-based fertilizers to groundwater nitrate.

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