



USE OF $^{15}\text{N}/^{14}\text{N}$ RATIO TO EVALUATE THE ANTHROPOGENIC SOURCE OF NITRATES IN SURFACE AND GROUNDWATERS IN THE UPPER ORONTES BASIN (CENTRAL SYRIA)

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The $^{15}\text{N}/^{14}\text{N}$ ratio of dissolved nitrogen species has long been used for the identification of the different sources of nitrate contamination of water systems [1-4].

This study, which aims at providing a practical example of the utility of the ^{15}N stable isotope in identifying the natural and anthropogenic sources of nitrate in surface and groundwaters in the upper Orontes Basin, was implemented within the framework of the IAEA Regional technical project entitled "Isotope Hydrology Techniques in Water Resources Management (RAW/8/002)".

The selected area for this work is located in the upper part of the Orontes River Basin, which occupies the central zone of the Syrian territories. This heavily populated region is characterized by intensive agricultural and industrial developments. Hence, the influence of the growing domestic activities is reflected by rapidly deteriorating of the surface and groundwaters qualities in this area.

The relief of the of the study area is dominated by the presence of the coastal Mts in the west, the Palmyrides Mts in the east, the Mts of Lebanon and Anti-Lebanon in the south, and the Homs depression in the central zone. The climate of the basin is of Mediterranean type, with a mean annual precipitation ranging from 150 to 800 mm/a. The Orontes River (Al-Assi), which originates in the Mts of Lebanon and Anti-Lebanon and flows northwards across the Homs plain and Al-Ghab graben, is the most important fluvial axis in this region. This river drains, mainly, massif calcareous rocks and joins the Mediterranean Sea at the Suwaidieh Gulf.

From a hydrogeological point of view the following water-bearing systems can be distinguished in the study area: the Cenomanian-Turonian complex, the basaltic Neogene aquifer, the continental Neogene aquifer and the shallow Quaternary aquifer. The groundwaters of these aquifers are the most potential resources being used for both drinking water supply and irrigation.

Water samples for this particular work were taken from about 20 sites covering selected locations on the Orontes River flow path, the Qattineh Lake, the Rastan Lake as well as some shallow dug wells drilled in the above mentioned aquifer systems. Samples for the determination of $\delta^{15}\text{N}$ analyses of nitrate in water were collected in special glass bottles according to the recommendation and procedures of the protocol DIN 38402, and analyzed for $\delta^{15}\text{N}$ composition in the Radioagronomic Laboratory of Juelich in Germany. In parallel, duplicate water samples were collected and analyzed for $\delta^{18}\text{O}$, $\delta^2\text{H}$, ^3H and major chemical species in other different laboratories in Syria, Jordan and the IAEA.

The interpretation of the chemical and isotopic results shows that surface water in the Orontes River is rather clean before the Qattineh Lake, and progressively becomes more polluted along

its flow path. This spatial evolution is clearly shown by the gradual increase of $\delta^{15}\text{N}$ value, total nitrogen composition as well as the concentrations of some other chemical species (Cl^- , K^+ , NH_4^+ , PO_4^{3-}). This evolution is also accompanied by identical decrease of both dissolved O_2 and pH. The probable source for this contamination is, mainly, due to the domestic waste disposable and sewage discharge into the river.

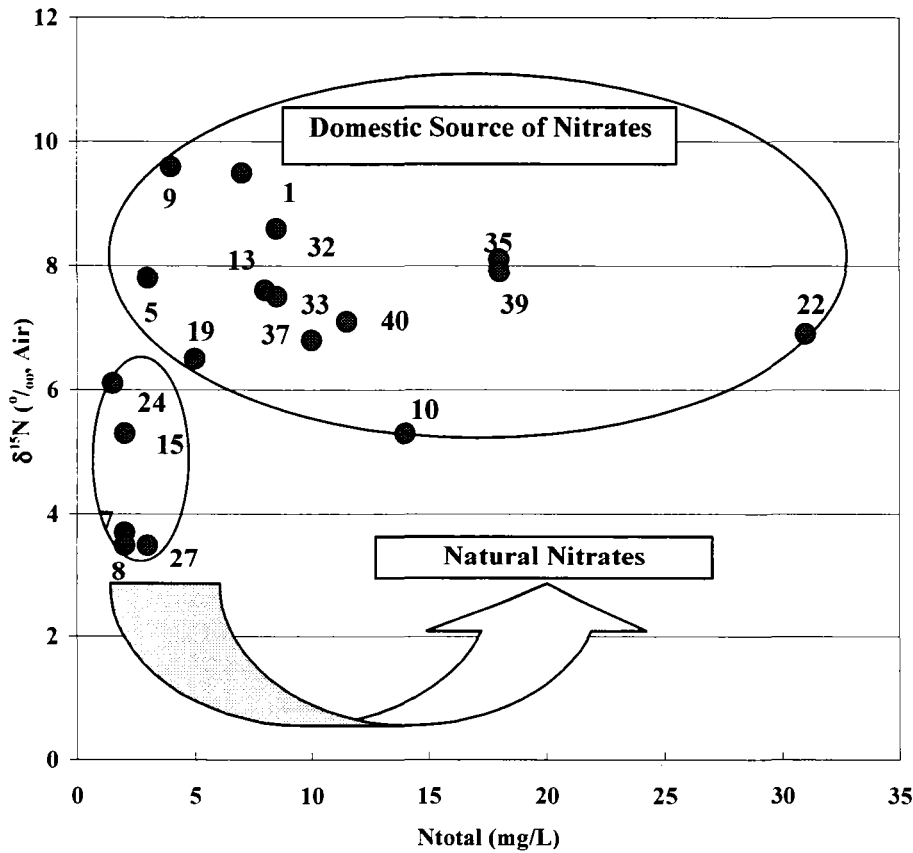


Fig. 1. $\delta^{15}\text{N}$ values versus total nitrogen (N_{total}) concentrations for surface and groundwaters from the upper Orontes Basin.

As it is shown in Fig. 1 the results of ^{15}N had also permit to distinguish between the following:

- The group of rather clean water bodies from the Orontes River (sites nos. 7 & 8), the Qattineh lake (sites nos. 15 & 24) and the groundwater of the well no 27. The water of this group is characterized by a low nitrogen content (less than 4 mg/L) and low $\delta^{15}\text{N}$ values (+3 to +6 ‰). It is concluded that the water of this group could reflect the nitrate originated from the natural source of the carbonate aquifers, from which the Orontes River takes its resources.
- The second group includes the waters from the remaining sites. The waters of this group show higher $\delta^{15}\text{N}$ values (+5.5 ‰ to +10.3 ‰) accompanied with high levels of nitrate or total nitrogen composition (3-31 mg/L). The nitrates of this group are probably

leached from fermentation of ammonium and organic matters originated from domestic sources. The high scatter of the representative water sampling points is related to the different intensity degrees of fermentation of the organic matters as well as the quantity of the waste disposable and sewage discharge into the river. The groundwaters with high concentrations in nitrate and other pollutant elements are found in specific locations near the river valley. These locations prove also the possibility of the interconnection between the river and the considered aquifer systems.

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