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INSIGHTS ON NITROGEN DYNAMICS IN THE EVROTAS RIVER BASIN – PRELIMINARY RESULTS

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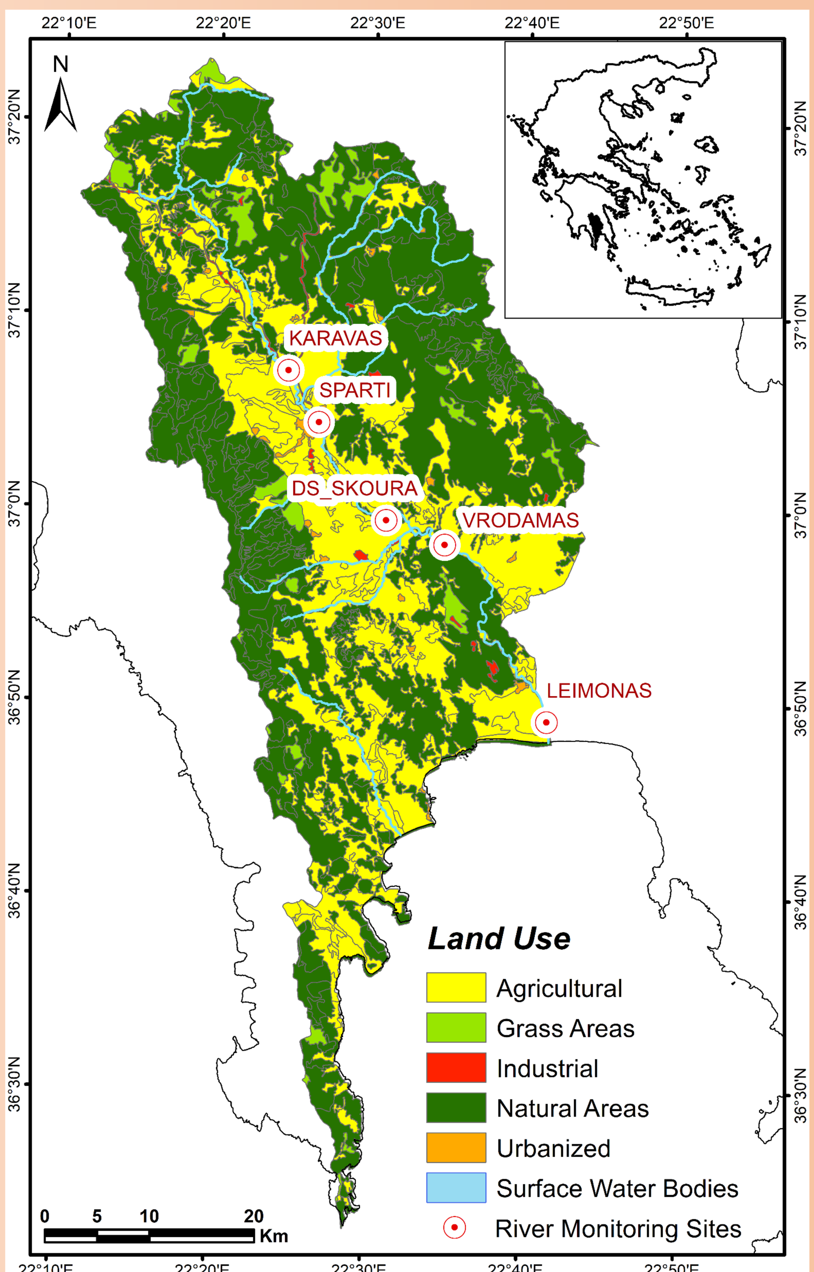
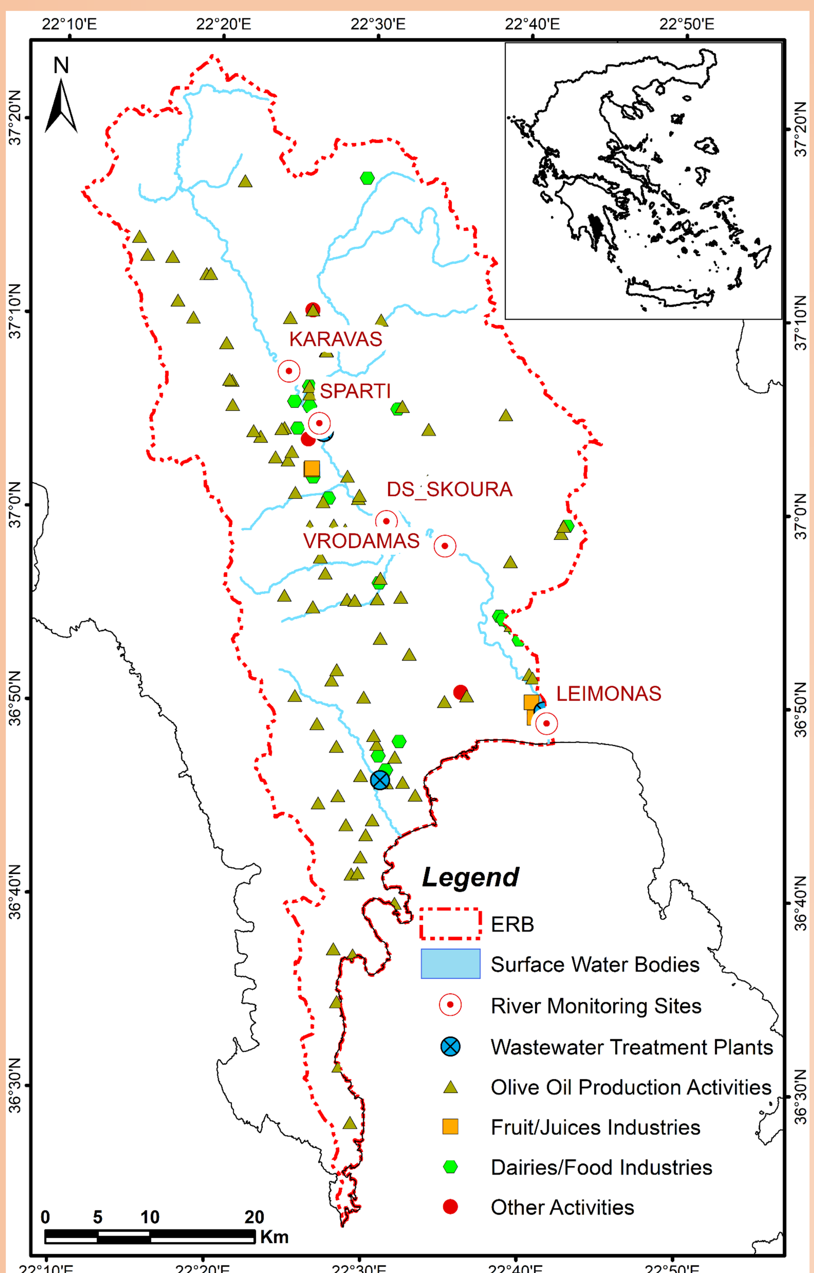
Introduction

Nitrate isotopes (^{15}N and ^{18}O of NO_3^-) can help identify the origin of nitrate contamination and provide valuable information about N cycling in aquatic systems. The Evrotas River is one of the major rivers in southern Greece. The Evrotas River Basin (ERB) is a complex hydrological system with perennial, intermittent, ephemeral and episodic river flows and interactions with groundwater in different parts of the basin. The main land uses are low vegetated areas, coniferous and mixed forests (~70 %), whereas the rest is covered by agricultural areas and < 1% by urban settlements. The ERB hosts three wastewater treatment plants and other pollution sources, such as olive oil refineries (>70 %) and dairies/food industries (15 %). The Total Nitrogen and Total Phosphorus can escalate up to 14 and 0.5 mg/l, respectively (http://wfd.hcmr.gr/).

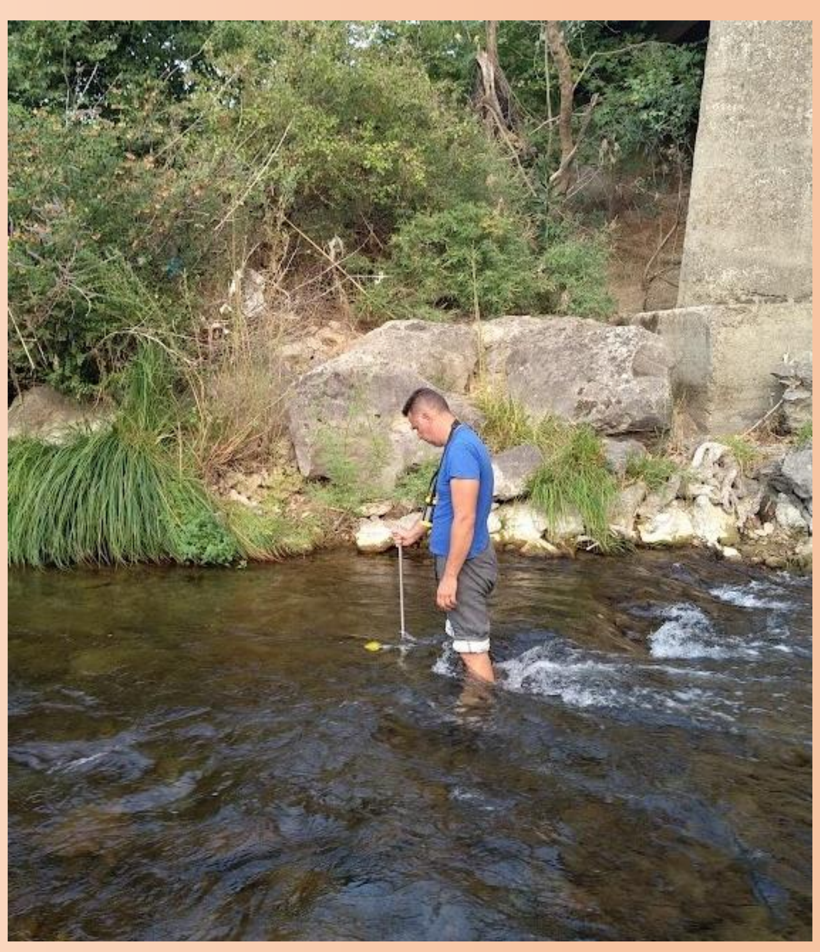
The purpose of this work was to trace the origin of nitrate in the ERB that will assist in the implementation of EU policies, such as the Water Framework Directive (2000/60/EC).

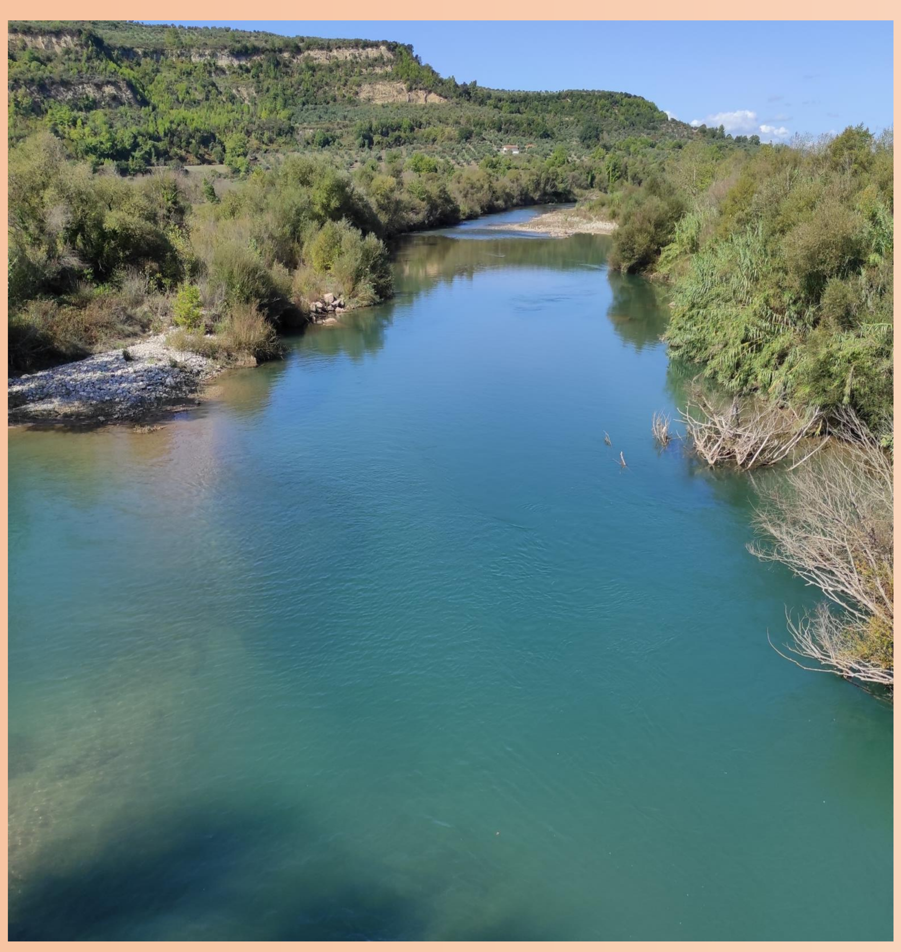




Methods

River water samples from 5 monitoring sites in the ERB were collected on a monthly basis in 2019-2021. The samples were collected in 30 mL high density polyethylene (HDPE) bottles with screw caps and were field filtered with 0.45 μm acetate filters. The samples were analysed for nitrate isotope ratios ($^{15}N/^{14}N$ and $^{18}O/^{16}O$ of NO_3^-) at the ISOFYS lab of the University of Ghent (Belgium) using the bacterial denitrification method coupled with a TG-IRMS. The isotope values were expressed in delta (δ) units with a per mil (‰) notation relative to AIR for $\delta^{15}N$ and to Vienna Standard Mean Ocean Water (VSMOW) for $\delta^{18}O$ of NO_3^-.





Mixing model (*simmr* in R):

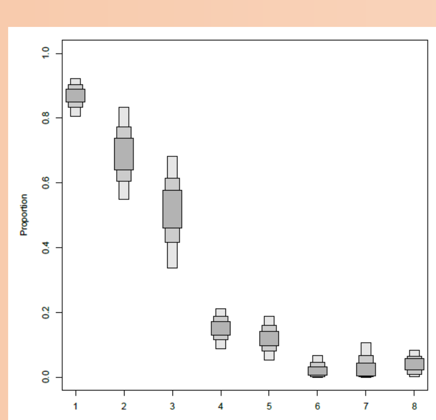
simmr

$$X_{ij} = \sum_{k=1}^{K} p_K(S_{jk} + C_{jk}) + \varepsilon_{ij}$$

$$S_{ij} \sim N(\mu_{jk}, \omega_{jk}^2)$$

$$C_{jk} \sim N(\lambda_{jk}, \tau_{jk}^2)$$

$$\varepsilon_{jk} \sim N(0, \sigma_j^2)$$



Acknowledgments

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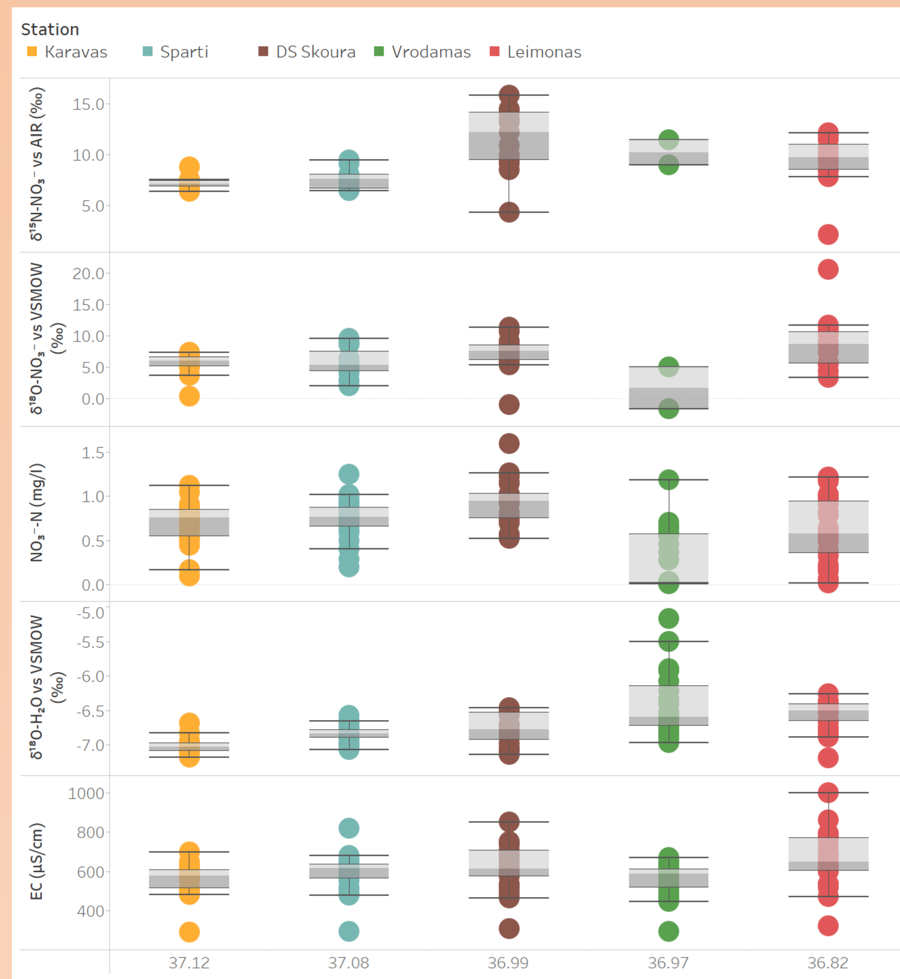
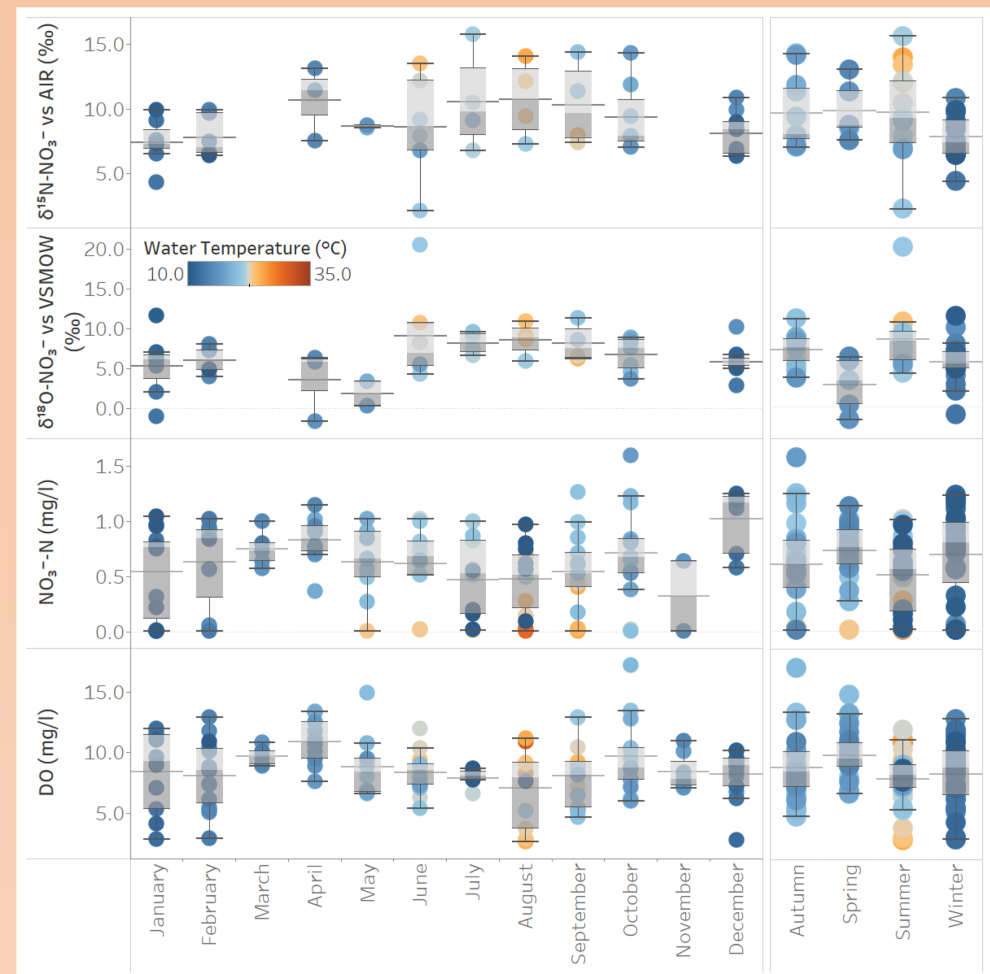
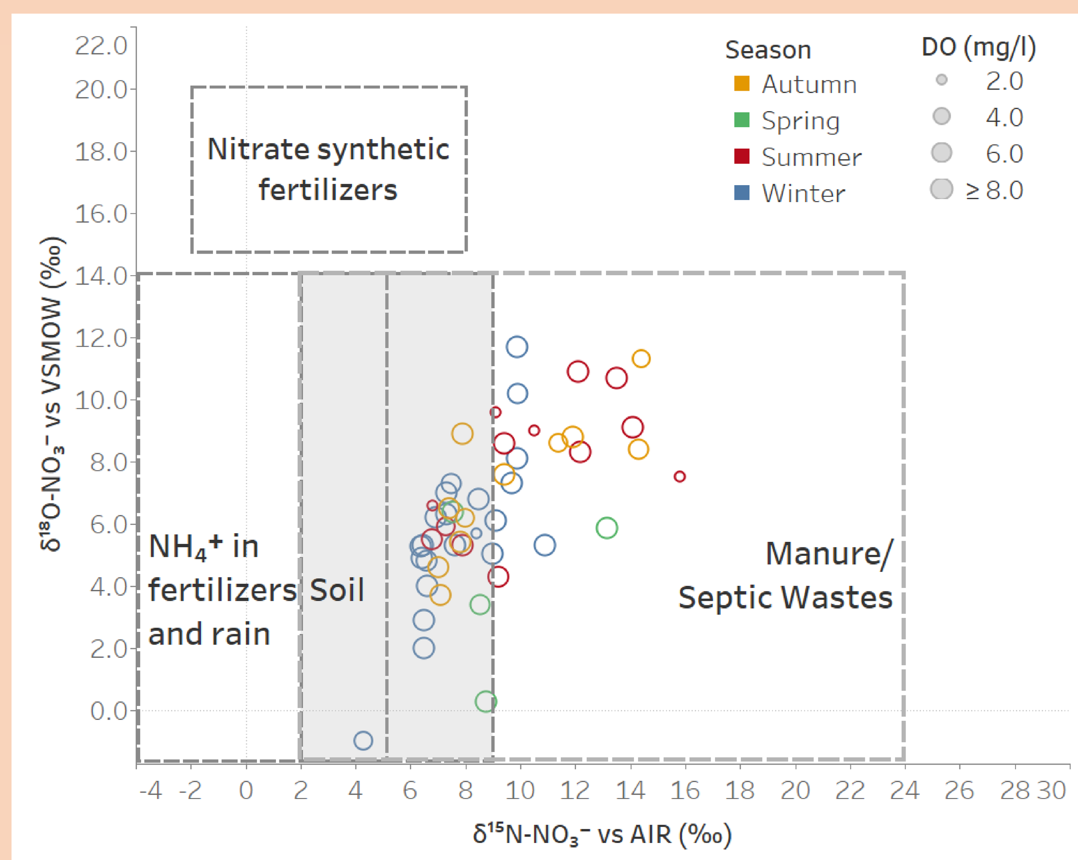
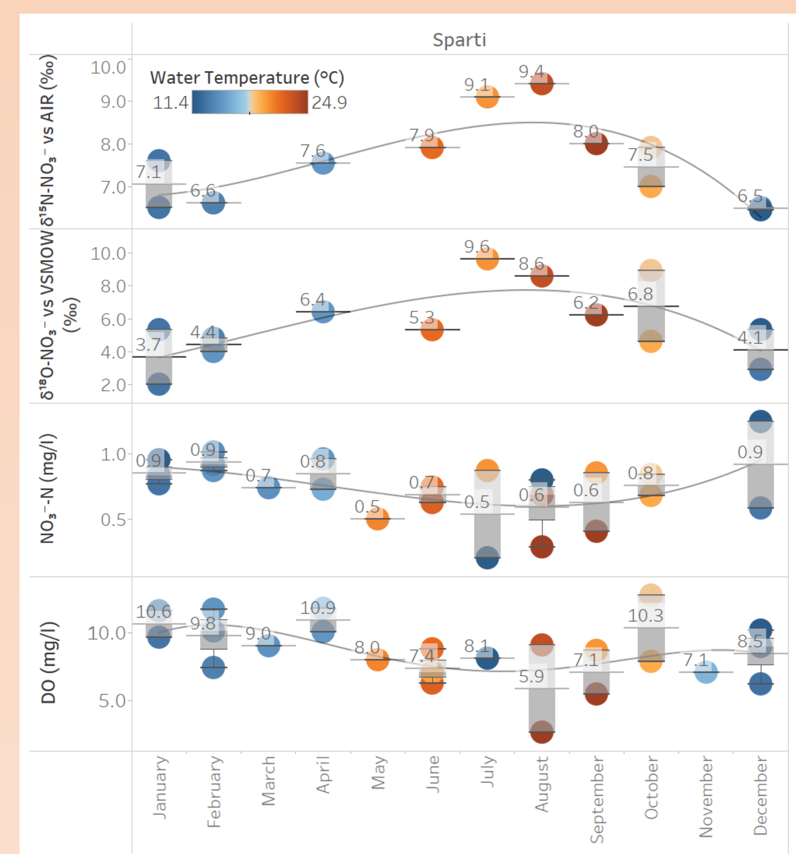
Results & Discussion

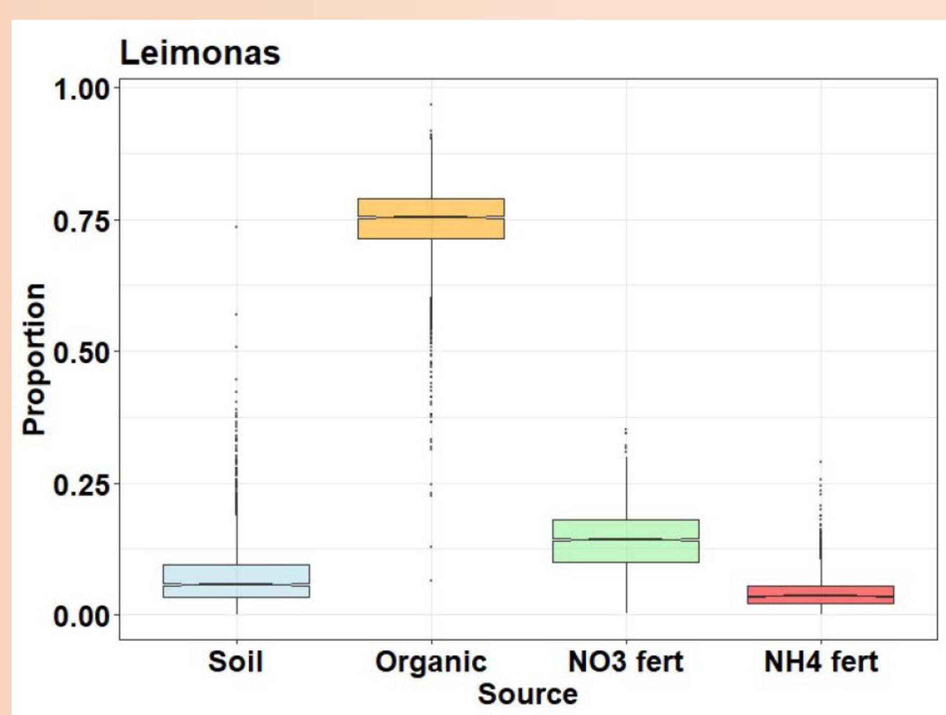
The $\delta^{15}N$ and $\delta^{18}O$ of NO_3^- values averaged +9.1 ‰ and +6.8 ‰, respectively, and ranged from +4.3 ‰ to +15.8 ‰ and from -1.0 ‰ to +11.7 ‰, respectively. Almost 50 % of the nitrate isotope data in the ERB indicated an anthropogenic organic nitrogen origin (> +9 ‰) although the nitrate concentration values were low and almost constant throughout the year (from 0.2 to 0.9 mg/l as NO_3^--N). These high $\delta^{15}N$-NO_3^- values can be due to olive oil industries, which are scattered in the basin, and whose effluents are disposed in the river uncontrolled. Additionally, the sharp increase of the $\delta^{15}N$-NO_3^- values at Ds_Skoura site (+11.6 ‰), especially during summer, compared to the upstream sites was attributed to the influence from the local wastewater treatment plant. The relationship between $\delta^{15}N$-NO_3^- and $\delta^{18}O$-NO_3^- per season showed a slope close to 0.5 in autumn and summer, which could be indicative of denitrification.

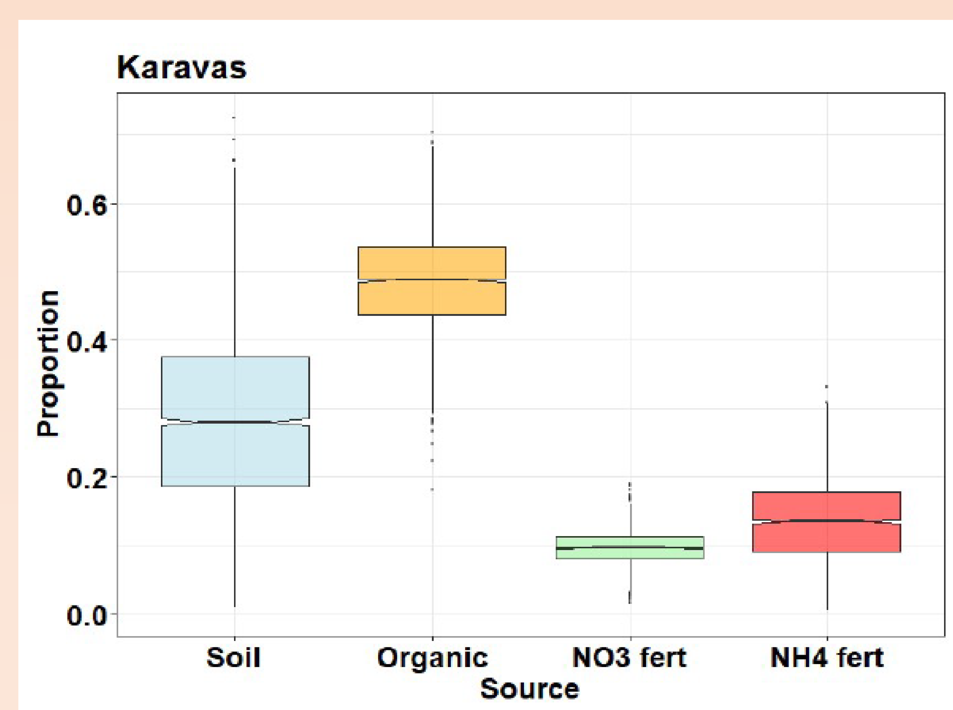












Conclusions

The survey showed that the ERB suffers from numerous olive oil refineries and food industries, whose effluents are responsible for the N dynamics. Despite the relatively low nitrate concentration levels, below the drinking water thresholds, the anthropogenic origin of nitrate was profound. The monitoring was done under the framework of the International Atomic Energy Agency (IAEA) Global Network of Isotopes in Rivers (GNIR).

References

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