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PRELIMINARY ASSESSMENT OF NITROGEN ORIGIN IN THE PINIOS RIVER BASIN

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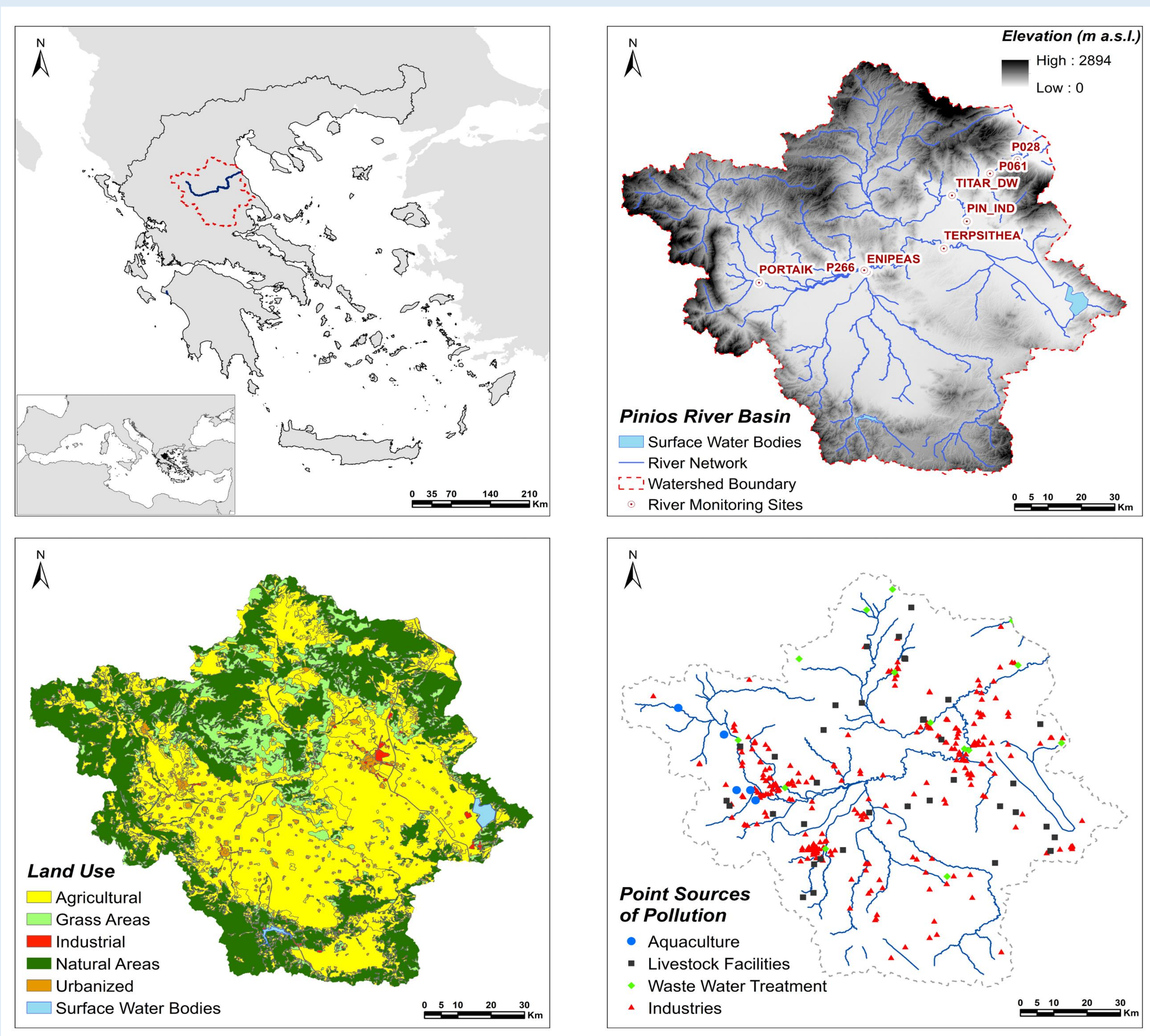
Introduction

The Pinios River Basin (PRB) is one of the most important agricultural areas of Greece suffering by water shortages, and hosts three main cities of a total population of ~400.000 citizens. The PRB also hosts 14 wastewater treatment plants and > 300 industrial units mostly related to dairies and food industries. In the PRB, there is a significant number of animal breeding facilities. The delta of the river belongs to the Natura 2000 Network (GR1420015) because it hosts important bird species and is one of the few wetlands in the area.

Here, we present the results of the first systematic monitoring (2019-2022) of nitrate isotopes and related proxies in a river basin in Greece. The objective were to:

1) trace the origin of nitrate pollution and its spatio-temporal evolution
2) study the N-cycling processes in the basin
3) identify linkages between nitrate isotope results, land-uses and point sources of pollution

The monitoring was done under the framework of the International Atomic Energy Agency (IAEA) Global Network of Isotopes in Rivers (GNIR).



Methods and Materials

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). Water isotope ratios ($^{18}O/^{16}O$ of H_2O) analysis was done at the Isotope Hydrology Laboratory of the IAEA (Vienna, Austria) using a Los Gatos Research Liquid-Water Isotope Analyzer (TLWIA-912). The analytical uncertainties were: ±0.2‰ for $\delta^{15}N$, ±0.4‰ for $\delta^{18}O$ of NO_3^- and ± 0.1‰ for $\delta^{18}O$ of H_2O.

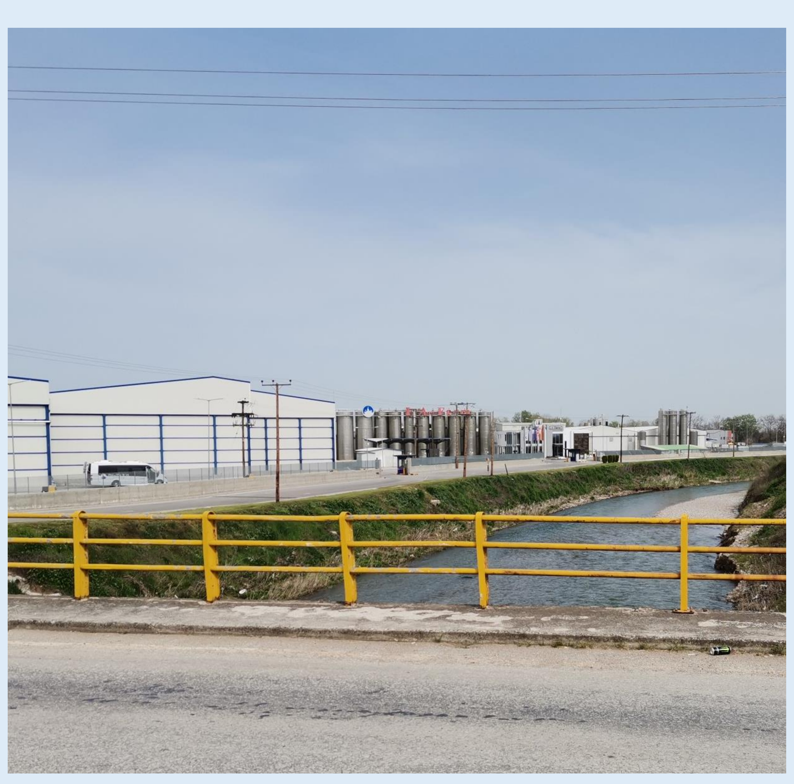
The Land Use Index (LUI) and the Point-Source pollution Index (PSI) were calculated for each sub-catchment as follows:

$$LUI = \sum(\% \text{ of Land Use} \times W)$$

$$PSI = \sum[(W_L \times A)+(W_D \times A)]$$

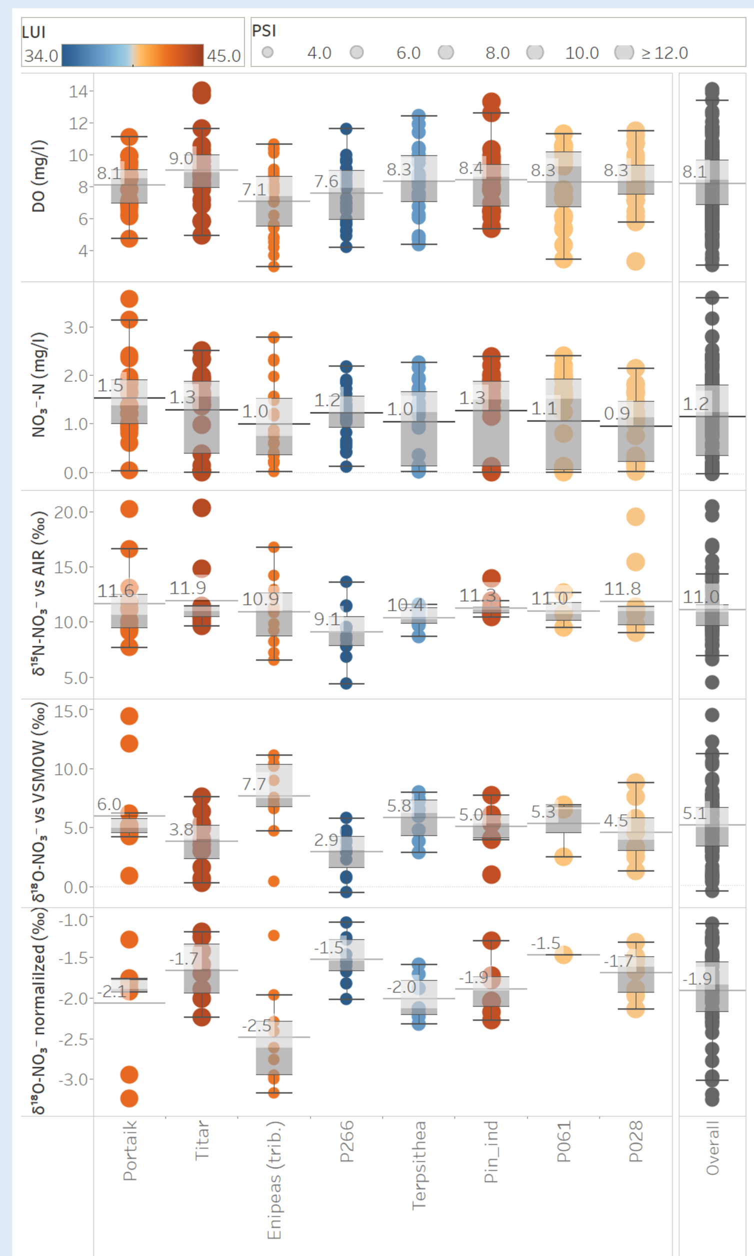
where W = weight of land use, W_L = the activity weight related to the potential N contamination load, WD = is the activity weight related to distance of the point source of pollution from the river, A is the type of point source activity.

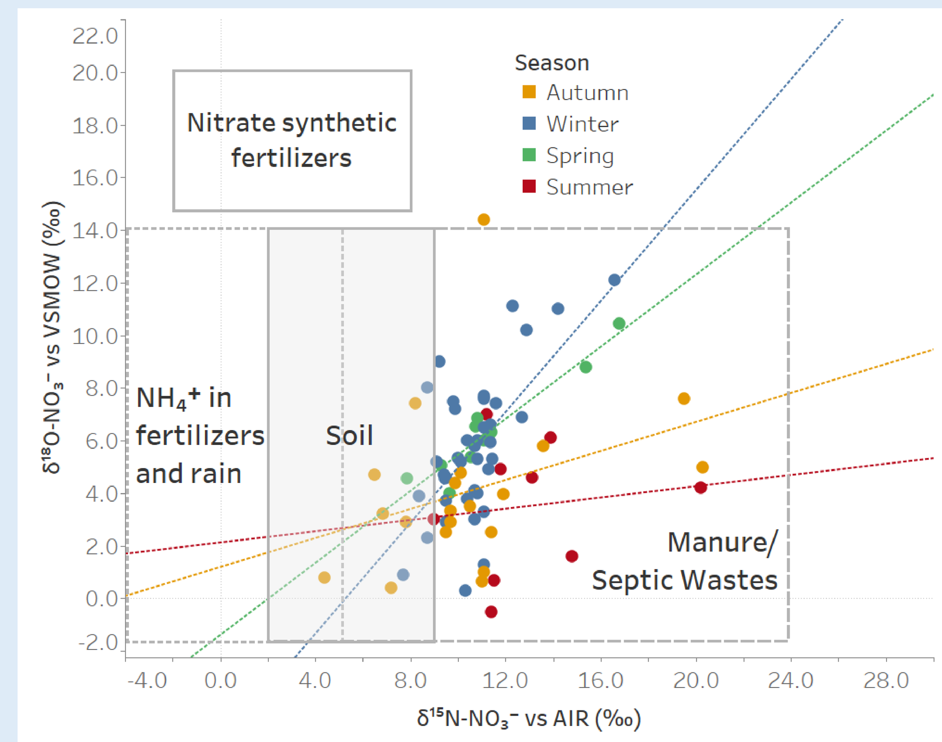
A Bayesian model (*simmr*) in R was applied for nitrate source apportionment.

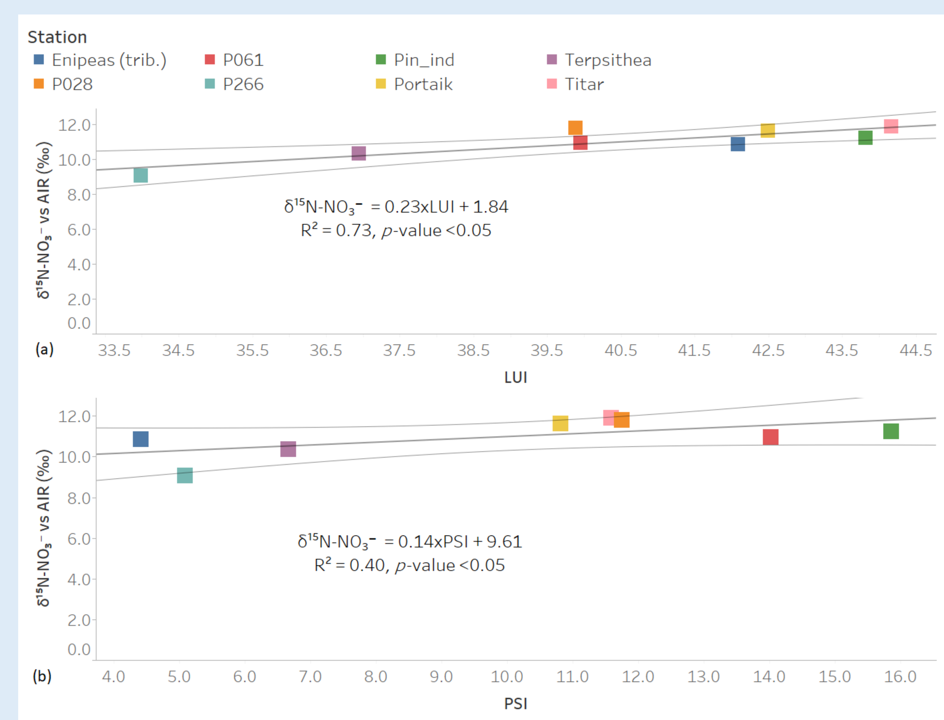


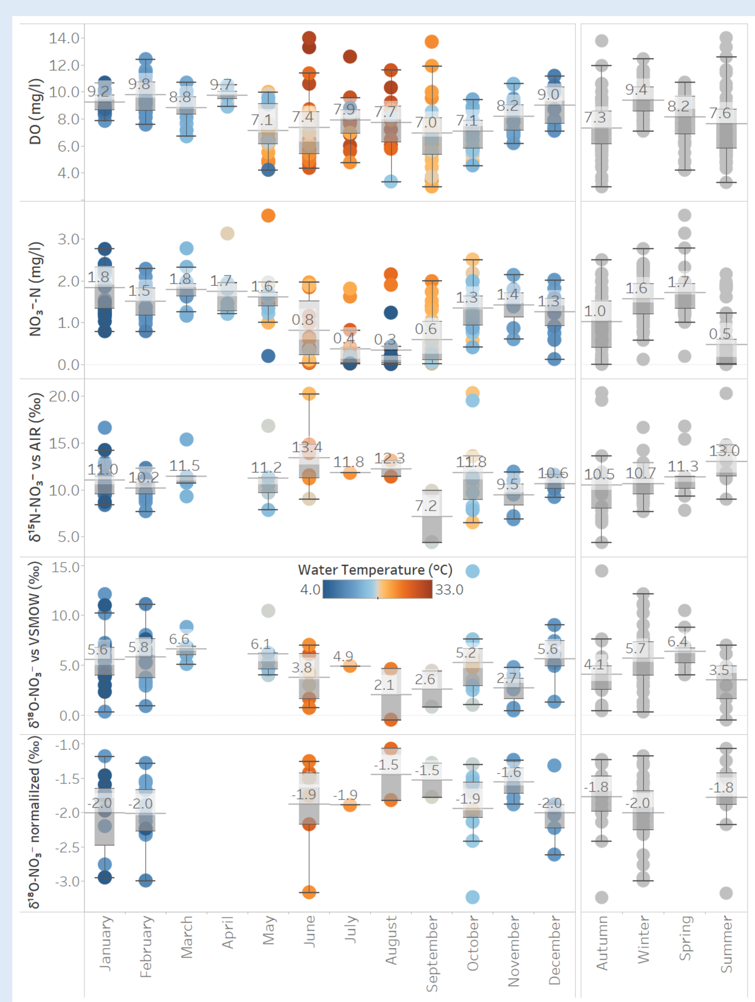
Results & Discussion

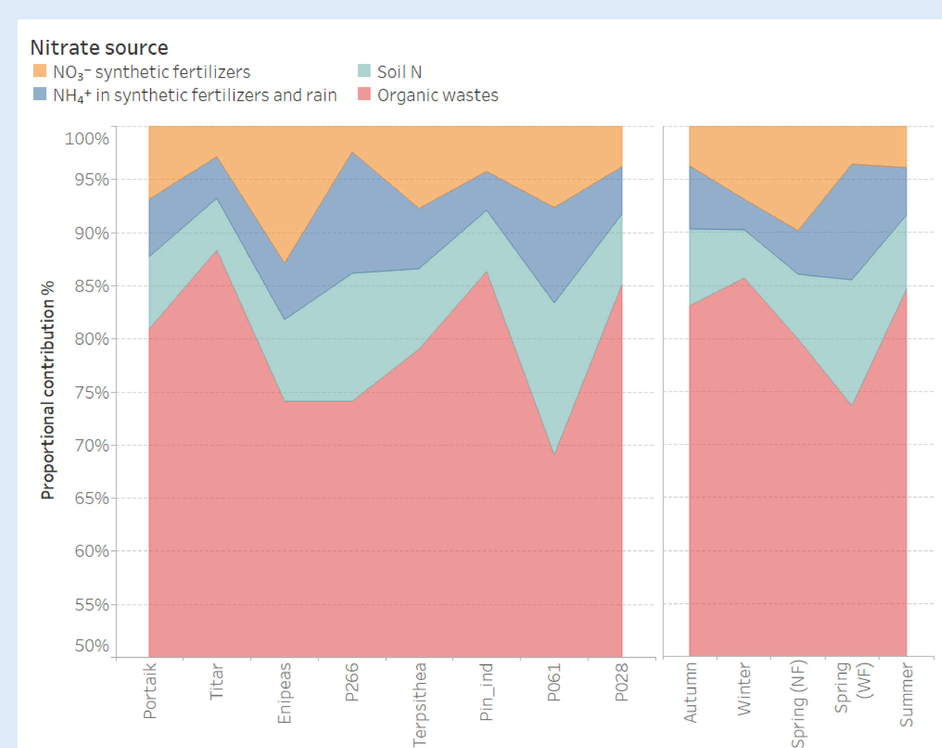
- The NO_3^--N concentration ranged between <0.1 mg/l and 3.6 mg/l.
- On average, the $\delta^{15}N$-NO_3^- values were > +11 ‰ in most river sites with no correlation with the distance from the headwater source.
- The sampling sites with the lowest LUI (P266 and Terpsithea) and PSI (P266, Terpsithea and Enipeas) showed the lowest average $\delta^{15}N$-NO_3^- values.
- Increased $\delta^{15}N$ and $\delta^{18}O$ values of NO_3^- during spring were partly attributed to assimilation.
- Nitrification and washout of soils due to runoff were responsible for nitrate concentration increase in winter.











Conclusions

The isotopic composition of NO_3^- revealed that nitrate is the result of point and non-point sources of pollution subject to N-cycling due to biogeochemical processes. Organic wastes, particularly from food industries and animal breeding facilities, which are disposed into the river, are mainly responsible for water quality degradation. The relative contribution of organic wastes was high throughout the year (> 70 %) and masked the isotopic signal from synthetic fertilizers, which are heavily applied in the area. The study showed that in a European level the river waters suffer from nitrate pollution mostly due to nitrification of organic N, and thus action towards the protection and sustainable management of water resources should be taken.

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Acknowledgments

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