
Identification of nitrate sources, hot spots, and dilution in the Danube Basin using a multitracer approach

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Open Questions for discussion

- **Isotopes indicate that nitrate is derived from wastewater. But it could be also (at least not excluded) in-situ nitrification. We find also NH_4 , caffeine and carbamazepine, which indicates urban wastewater.**
- **How to approach possible in-situ nitrification processes?**
- **Which parameters or correlations?**

- **We can determine snowmelt water fractions using water stable isotopes.**
- **Which pollutants in general or specific in the Inn River may derive from snowmelt for a correlation study?**

- **Nitrate concentrations are similar since 2 decades**
- **What does this tell us about land and wastewater management strategies**

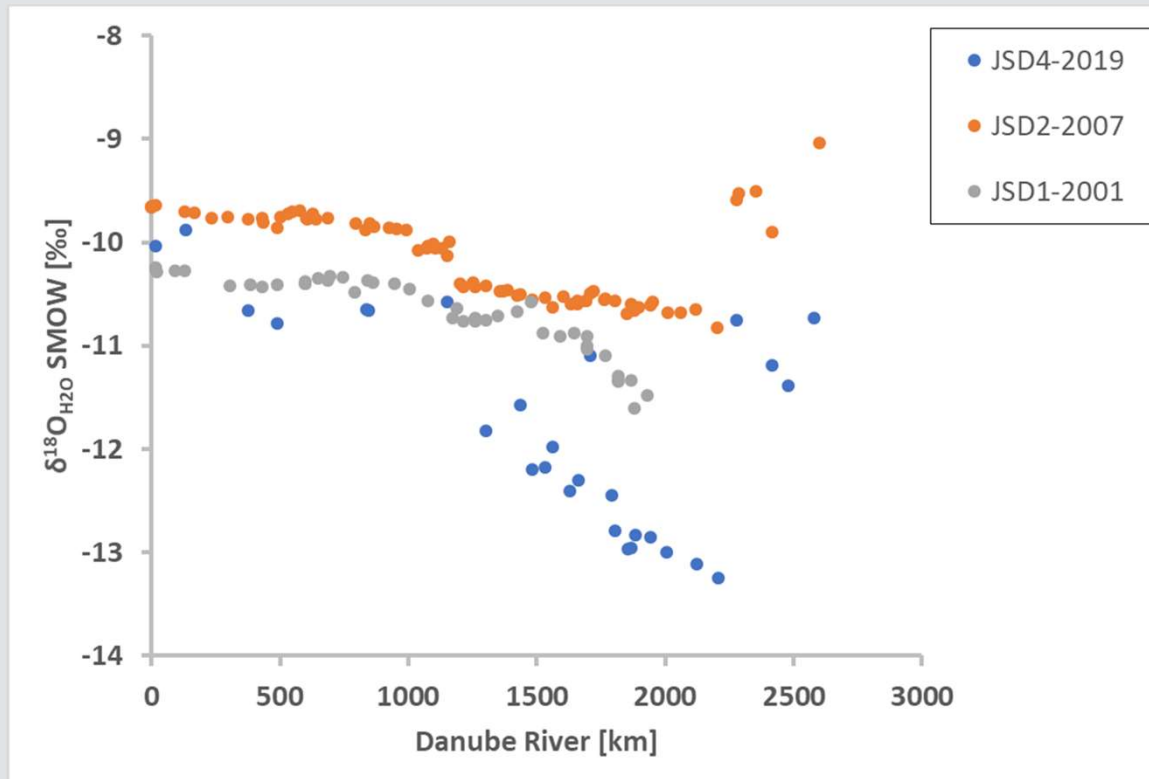
- **Any other comments?**

Stable Isotopes of Water and Nitrate

- **We participated in the Joint Danube Survey in summer 2019 (JSD4)**
- **Water sampling (51 water samples) along the Danube stretching from Germany to the Black Sea**
- **Water samples were analyzed for water stable isotopes and stable isotopes (^{15}N and ^{18}O) of nitrate as well as major ion analysis**
- **Results were compared to surveys from 2001, 2007, and 2013 and chemical physical parameters from the TNMN database from the ICPDR (International Commission for the Protection of the Danube River)**

What we can learn from this multitracer approach:

- **Water stable isotopes** tell us that the snowmelt (ice) contribution during 2019 JSD4 was high (about 72 %)
- This adds an important dilution factor to many pollutants measured during the survey

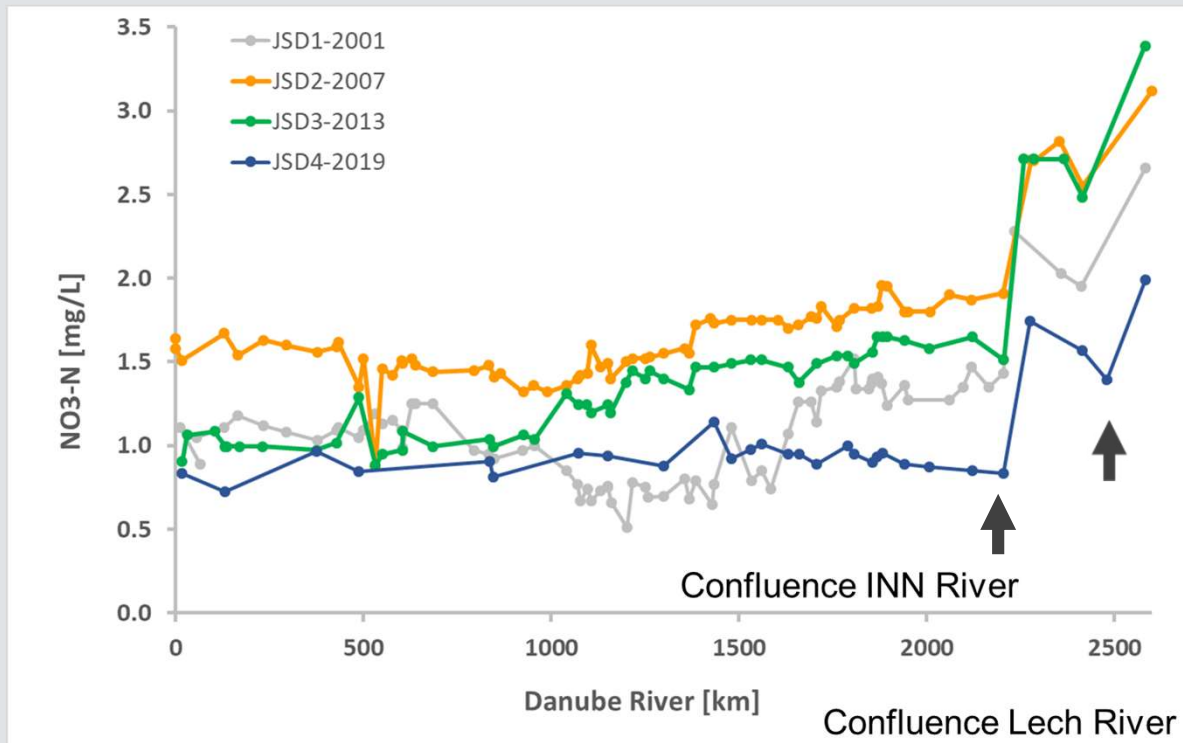


JSD1 and JSD2 data from Rank et al. 2009



What we can learn from this multitracer approach:

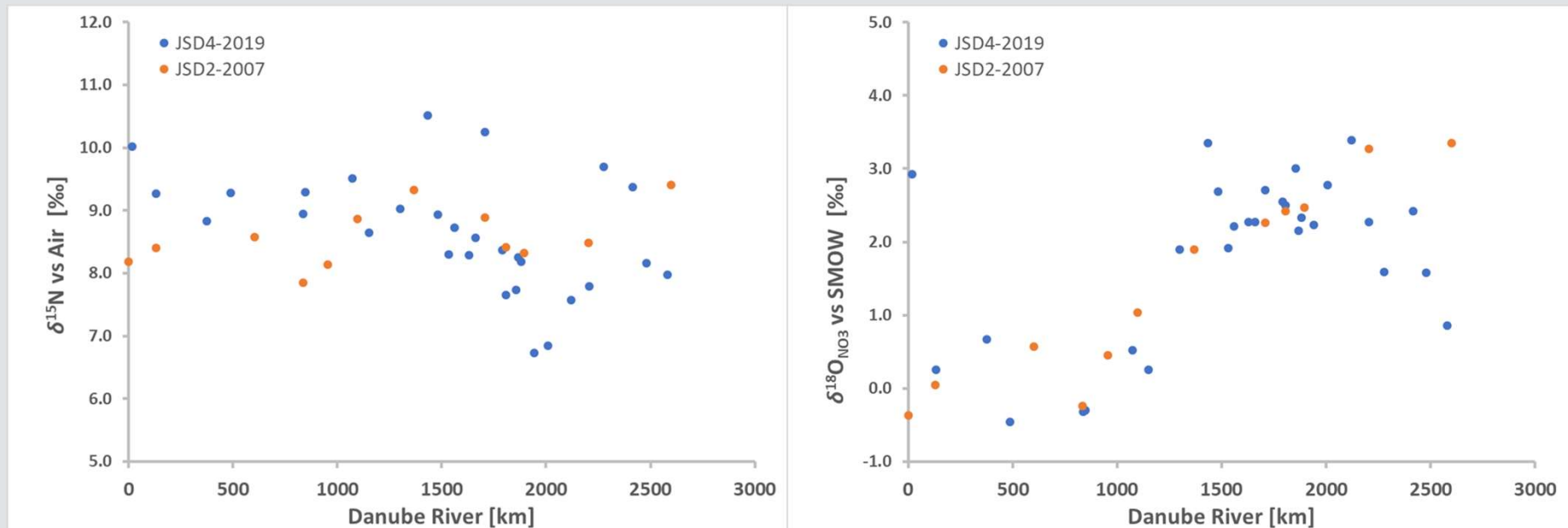
- **Nitrate concentrations** have not significantly changed over the last 2 decades (considering different discharge and analytical error)
- **Although nitrate and wastewater management has changed within the basin!**



(Nitrate concentrations for JSD1, JSD2, JSD3 are taken from the TNMN database)

What we can learn from this multitracer approach:

- **Isotopes of nitrate** indicate that sources and mixture of nitrate seem to be the same over the last 12 years as isotopic compositions are similar
- **Artificial fertilizer** seems not to play an important role
- **The relatively low ^{18}O values** indicate an important contribution of wastewater derived nitrate



(Nitrate isotopes for JSD2 are taken from Newman et al. 2014)

