The controlling mechanism of nitrogen dynamics across a large river basin

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EARTH, OCEAN AND ATMOSPHERIC SCIENCES 地球与海洋大气科学

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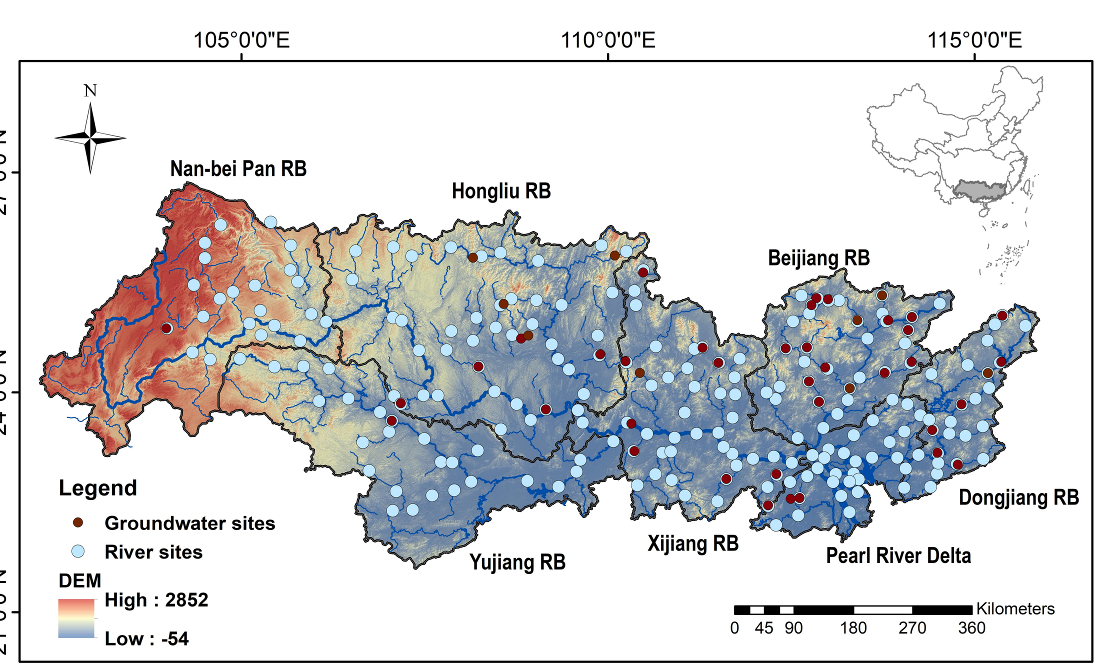
1. Introduction

- Investigating nitrogen (N) in river networks is essential for environmental management and pollution control.
- Past field studies mostly focused on parts of the watershed ecosystem. However, the large basin-scale distribution and the controlling mechanism of N dynamics across is not well understood.
- Therefore, we examined the water of Pearl River Basin (2nd largest in China in terms of discharge) using isotopes (including ^{15}N-NO_3^-, ^{18}O-NO_3^- and ^{2}H-H_2O, ^{18}O-H_2O, ^{222}Rn) and biogeochemical methdologies to seek for the mechanisms and controlling factors of N dynamics.

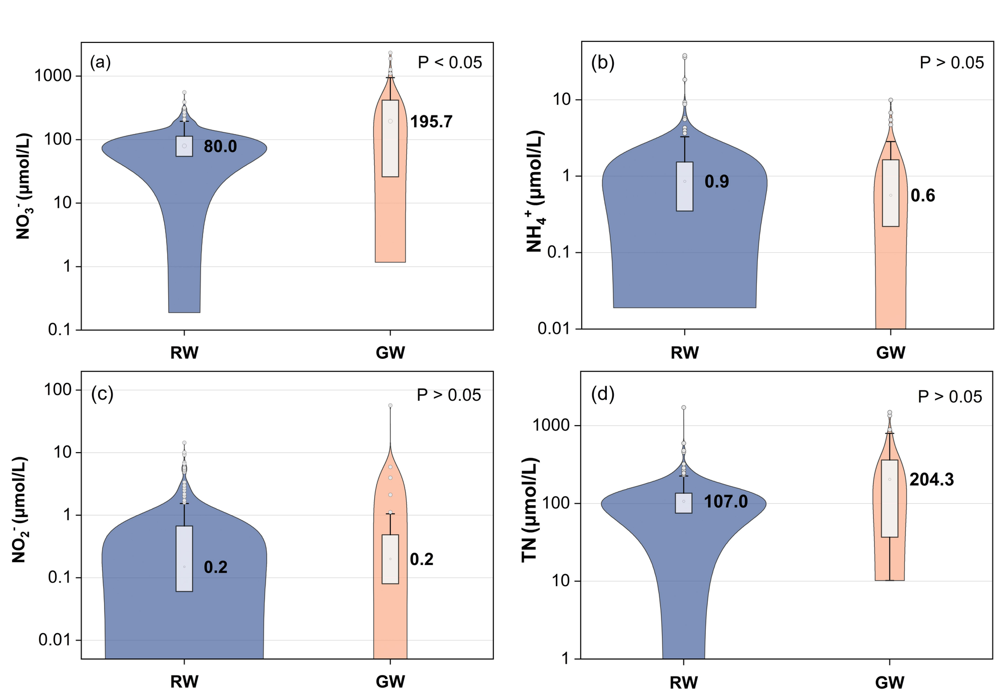
2. Field site and methodology



- 453,700 km²
- 236 river sites
- 48 groundwater sites
- Aug-Sep 2020
- Field sampling: environmental variables, nutrients, TOC, anions, cations, ^{15}N-NO_3^-, ^{18}O-NO_3^-, ^{2}H-H_2O, ^{18}O-H_2O, ^{222}Rn

Figure 1. Field sampling sites for the Pearl River Basin. 'RB' = 'River Basin'

3. Results- Overall N status



- *TN*: GW much higher than RW.
- *NO_3^-*: GW more than double that of RW.
- *NH_4^+ and NO_2^-*: same level between GW and RW. For NH_4^+, RW is slightly higher than GW.

Figure 2. River and groundwater comparison in nitrogen. Comparison of (a) nitrate (NO_3^-), (b) ammonium (NH_4^+), (c) nitrite (NO_2^-), (d) total nitrogen (TN). 'RW'='River Water', 'GW'='Groundwater'

3. Results-subbasin RW status

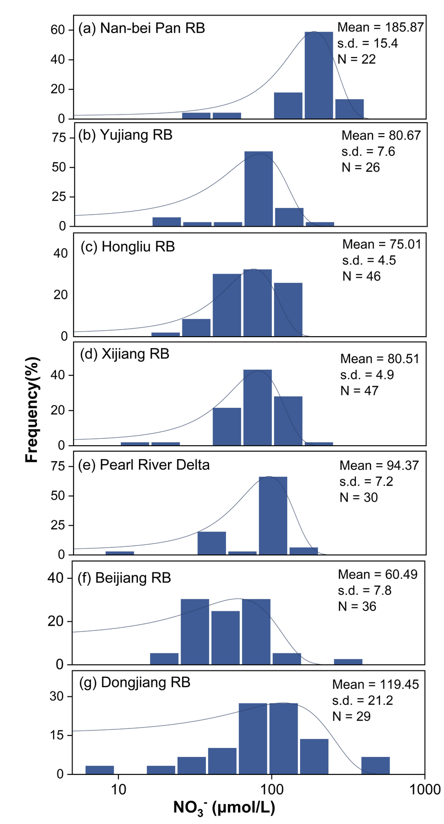


Figure 3. Spatial variation of the NO_3^- concentration in river across Pearl River Basin.

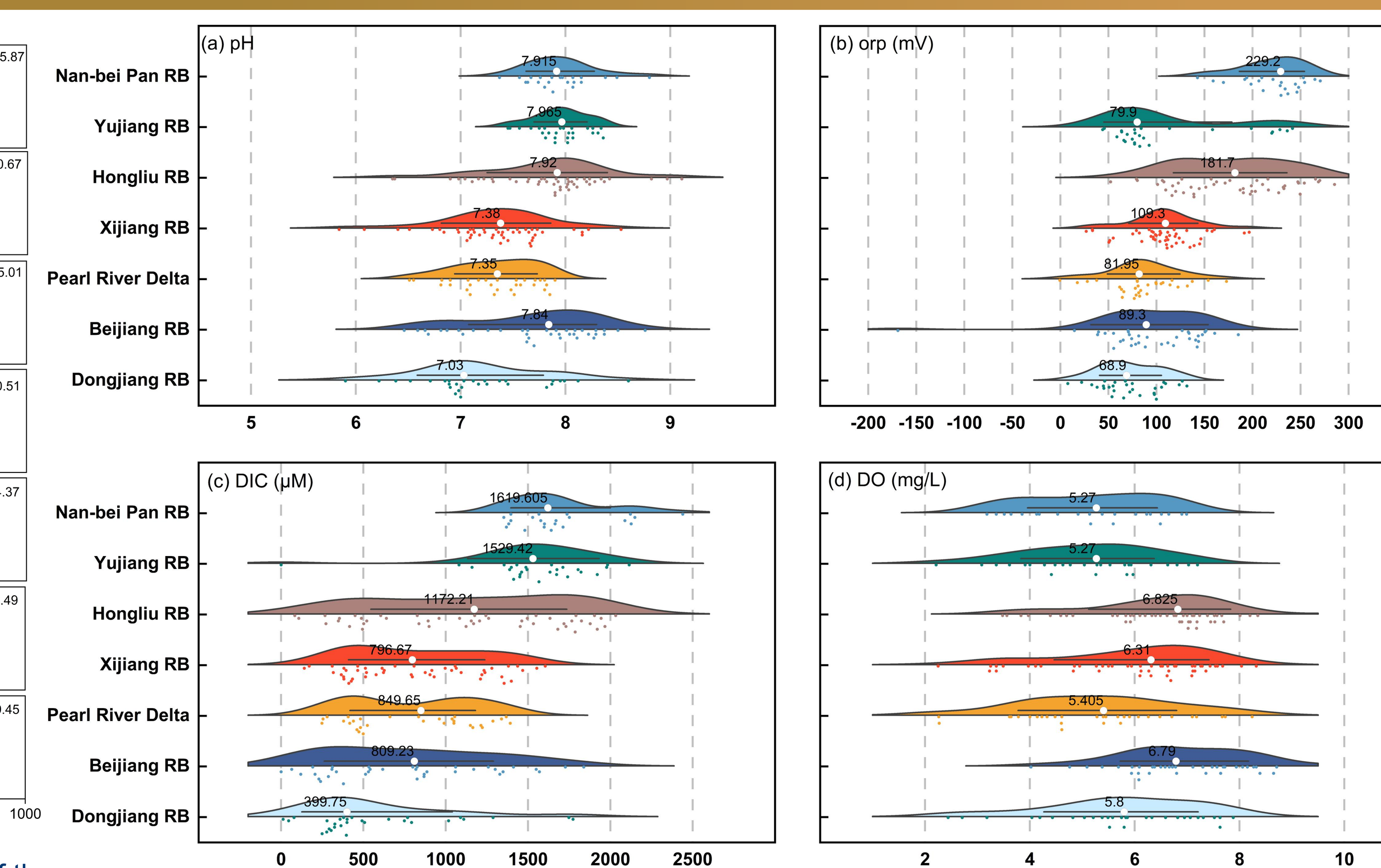


Figure 4. Spatial variation of the physicochemical variables in river. (a) pH, (b) orp, (c) DIC, and (d) DO.

4. Discussion-isotopes and human activities

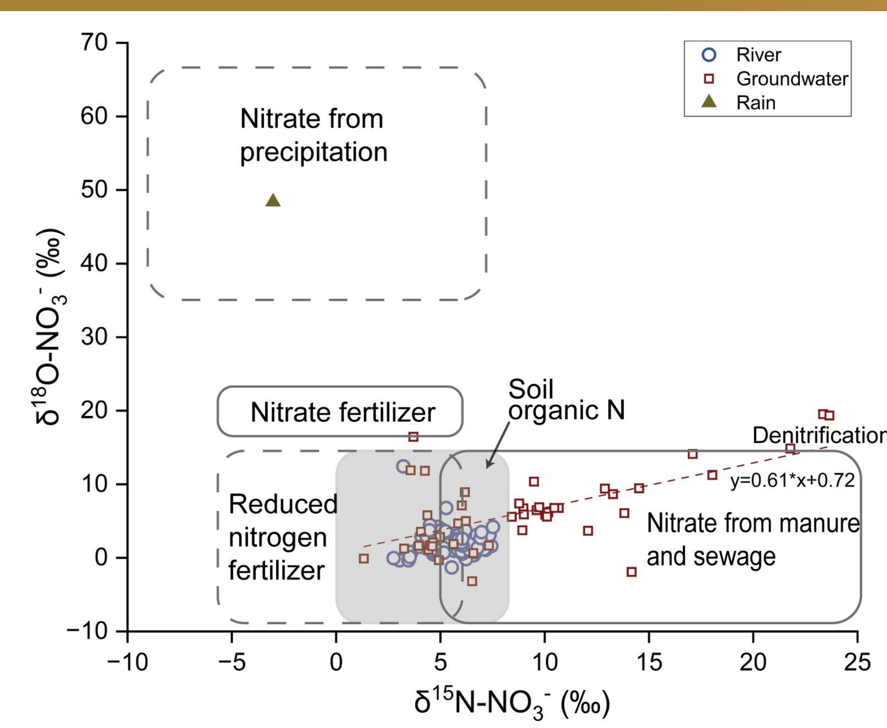


Figure 5. $\delta^{15}N$-NO_3^- vs $\delta^{18}O$-NO_3^- isotopes results.

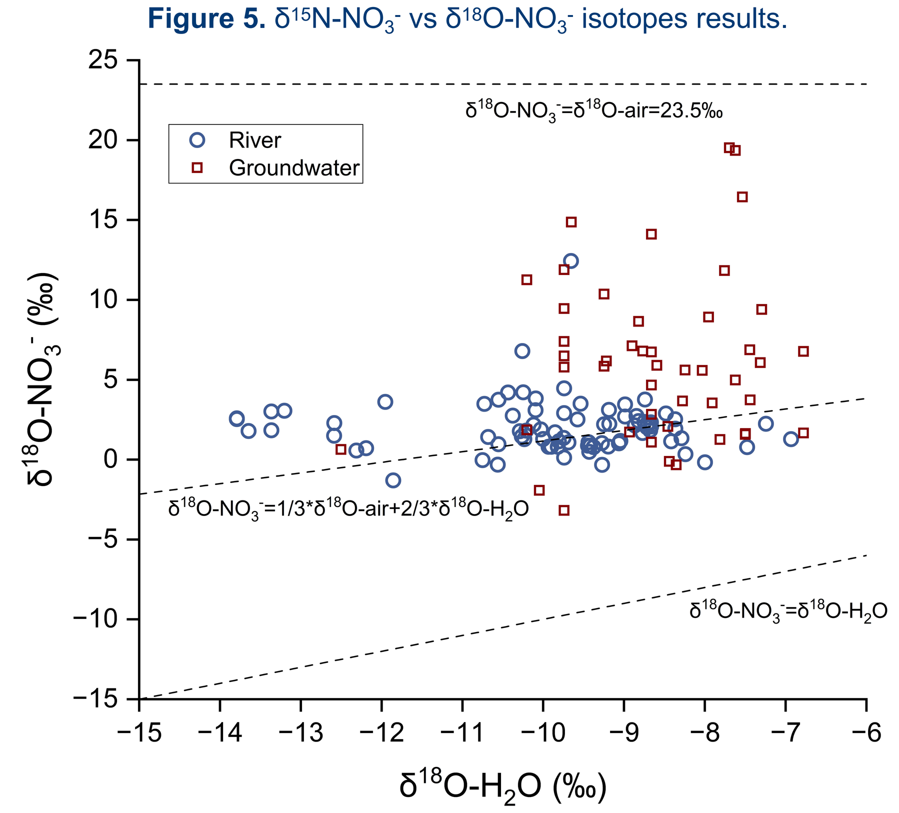
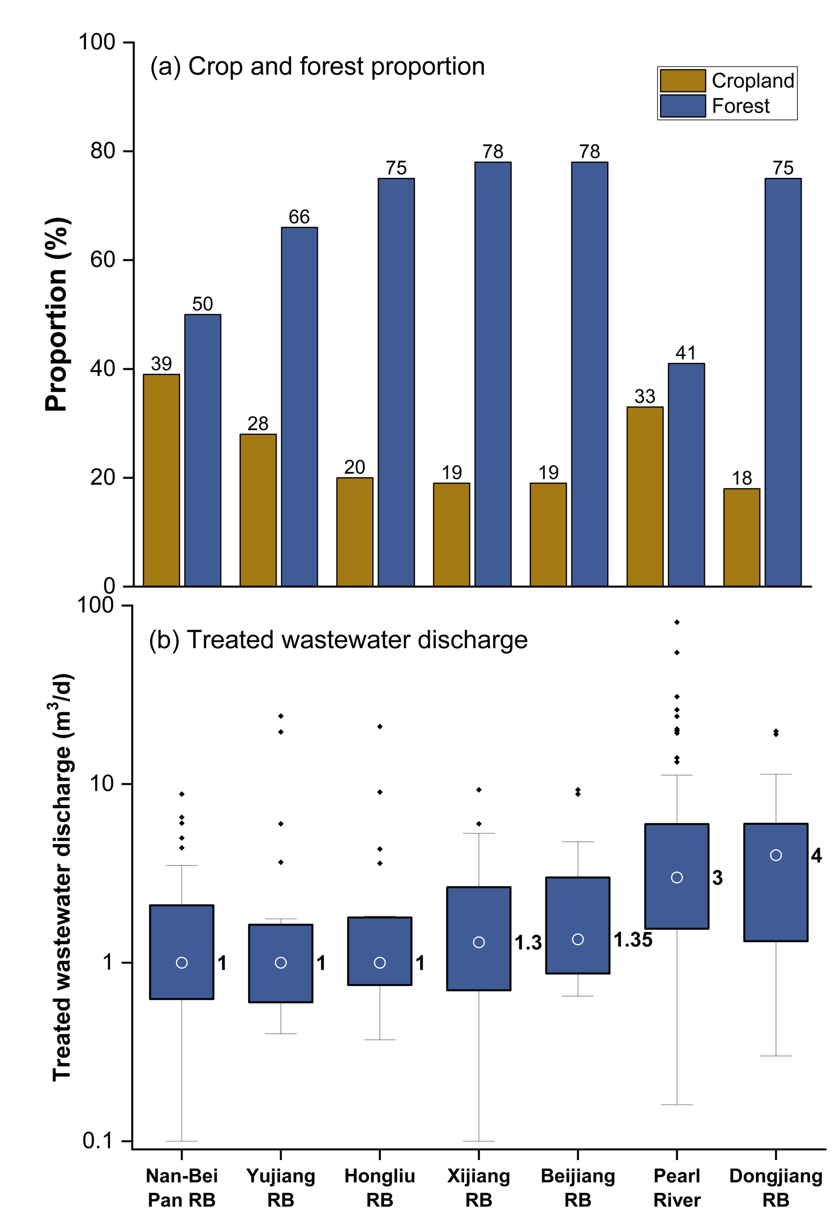


Figure 6. $\delta^{18}O$-H_2O vs $\delta^{18}O$-NO_3^- isotopes results.



- **River:**
  - Oxidation processes e.g. nitrification are apparent and dominate the N transforming process.
- **Groundwater:** • Denitrification

4. Discussion-subbasin RW NO_3^- sources

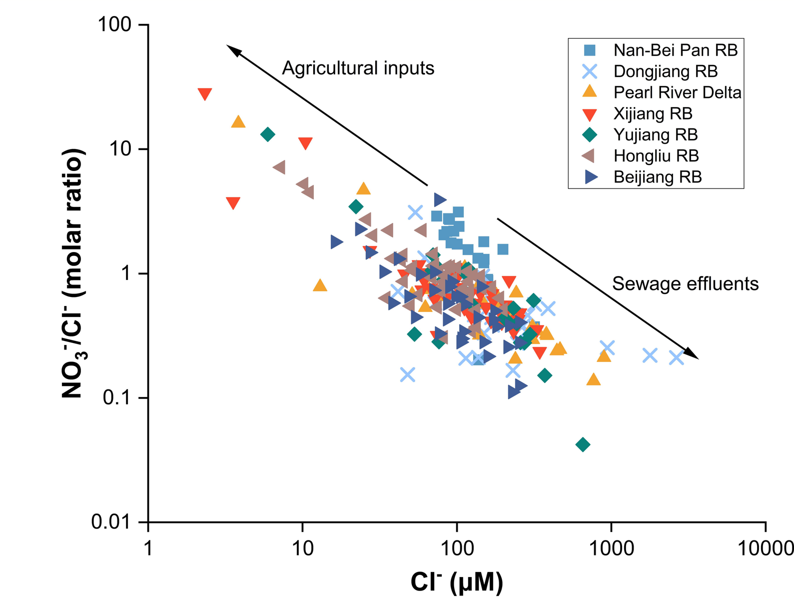


Figure 8. River water NO_3^-/Cl^- vs. Cl^-.

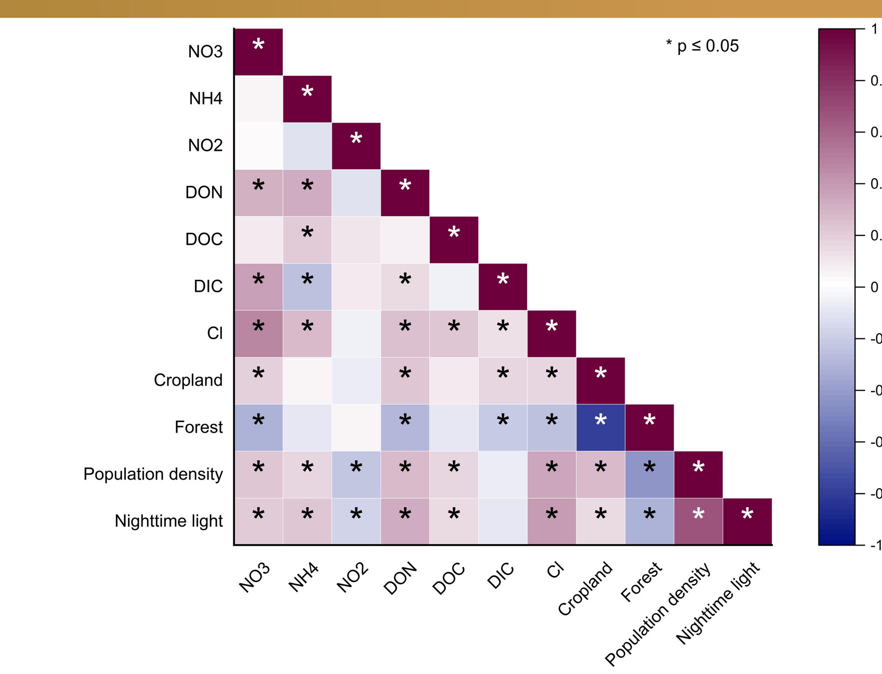
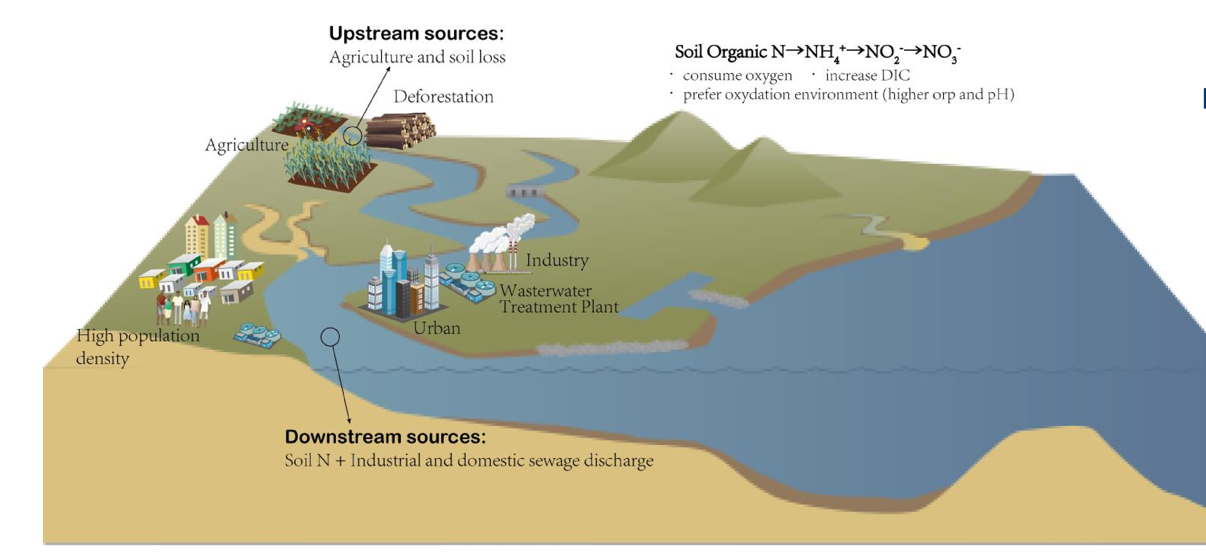


Figure 9. River water variables corelation analysis (Spearman test)



MixSIAR model for river:

- **Soil Organic N:** 53.6% ± 25%
- **Sewage and manure:** 24.0% ± 14%
- **Synthetic NH_4^+ fertilizer:** 21.4% ± 18%
- **Precipitation:** 0.9% ± 0.8%

Figure 10. Schematic diagram of the major sources and distribution at basin scale for river.

5. Conclusions

- The large basin-scale N dynamics is examined in this study.
- TN in GW is almost double that of RW, where NO_3^- is the main species in both waters.
- In GW, denitrification dominates N dynamics, while in RW, nitrification controls the N distribution throughout the basin.
- Overall, the biggest NO_3^- source for RW is soil organic N (53.6 ± 25%), followed by sewage and manure (24.0% ± 14%).
- In the upstream river NO_3^- could be more sourced from agriculture and soil loss, while in the downstream the influence of sewage effluent increases.
- Further exploration under other climate seasons should be taken to figure out and verify the N controlling mechanisms.

References

[1] Yang, J.Huang, X., 2021. The 30 m annual land cover dataset and its dynamics in China from 1990 to 2019. Earth system science data. 13(8), 3907-3925. https://doi.org/10.5194/essd-13-3907-2021.

[2] Ehalt Macedo, H., Lehner, B., Nicell, J., Grill, G., Li, J., Limtong, A., Shakya, R. (2022). Distribution and characteristics of wastewater treatment plants within the global river network. Earth System Science Data, 14(2): 559–577. https://doi.org/10.5194/essd-14-559-2022.