C, N, P export regimes in rivers from headwater to downstream catchments

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INTRODUCTION

Excessive amounts of nutrients and dissolved organic matter in freshwater bodies affect aquatic ecosystems. The objective of this study is to characterize the spatial and temporal variability in NO_3, DOC and SRP export regimes from archetypal headwater catchments to downstream reaches, and to analyze the resulting nutrient stoichiometric ratios. Export regimes in headwater catchments are used for interpretation of land-to-stream C, N, P transfer processes and compared with those in downstream reaches to infer in-stream processes and point-source contributions. The potential ecological impacts of the observed export regimes are assessed with nutrient stoichiometric ratios.

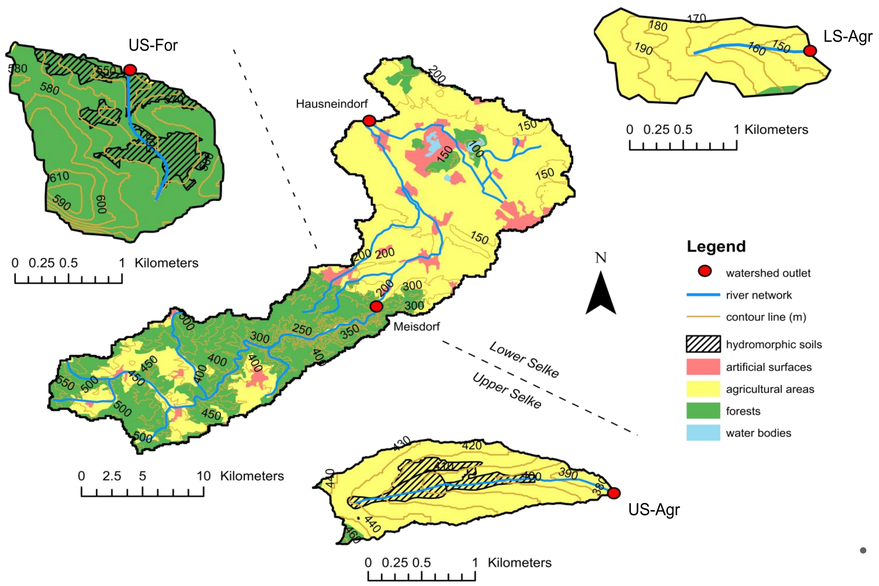
STUDY AREA

Selke river, tributary of Elbe, part of the hydrological TERENO Harz/Central German Lowland Observatory. Three archetypal headwater catchments (1 – 3 km²) monitored:

- US-Agr: Upstream x agriculture; presence of riparian wetland
- US-For: Upstream x forest; presence of riparian wetland
- LS-Agr: Lowland x agriculture; absence of riparian wetland

Two downstream reaches (184 – 456 km²) monitored:

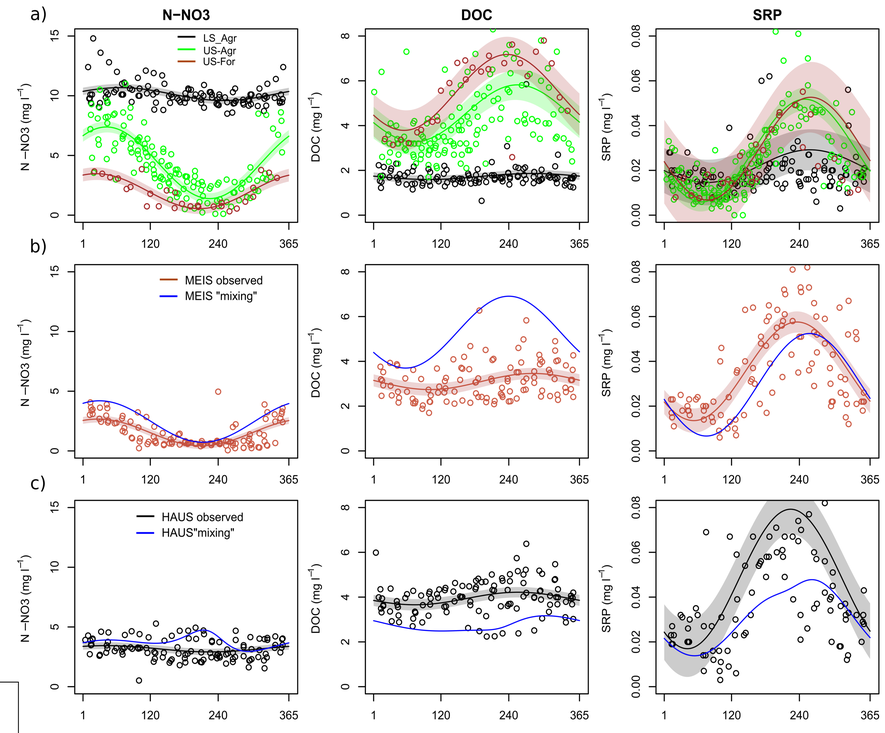
- Meisdorf (MEIS): Upper Selke; integrate US-For and US-Agr
- Hausneindorf (HAUS): Lower Selke; integrates MEIS and LS-Agr



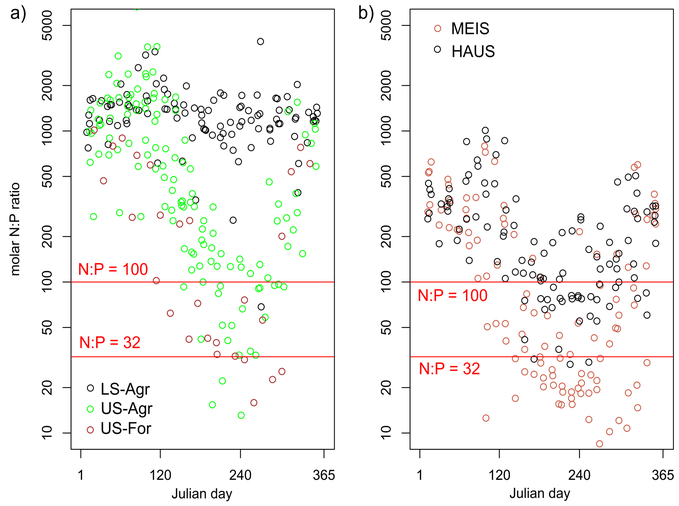
SEASONAL EXPORT REGIMES

(a) in each headwater catchment, same seasonal dynamics for each element: NO3 maxima in winter and SRP – DOC maxima in summer. Higher seasonal amplitude in US-Agr and US-For: presence of riparian wetland causes NO3 decrease (denitrification) and SRP – DOC increase (solubilisation) in summer.

(b) and (c) in downstream reaches alteration of export regimes (decrease or increase in variance). Near conservative transport of NO3; apparent consumption of DOC in upper Selke and apparent production of DOC in lower Selke; summer SRP maxima augmented by point sources contribution.



SEASONAL N:P RATIOS



Opposite dynamics for NO3 and SRP lead to variability in N:P ratio > variability in NO3 or SRP. Two threshold for N – P colimitation considered: N:P = 100 and N:P = 32. P is the limiting nutrient for a majority of the time but N – P colimitation occurs during the summer growing season (eutrophication risk). Higher probability of N – P colimitation in catchments with presence of riparian wetlands and/or presence of point sources.

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CONCLUSIONS

- Land use and lithology determine C, N, P land-to-stream transport mechanisms in headwater catchments
- Presence of riparian wetlands creates seasonal variability in C, N, P export regimes
- In-stream processes and point source contributions alter C, N, P export regimes in downstream reaches
- Opposite N and P dynamics lead to large variability in N:P ratios and possible N – P colimitation

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