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Runoff has a land cover specific effect on the terminal electron acceptors in the boreal streams

Climate change modifies the hydrological patterns, which influence runoff in the northern regions, but there is little knowledge how the changes in runoff affect the export of redox-sensitive substances from terrestrial to aquatic systems. Here we show how runoff alters the mobility of terminal electron acceptors (TEAs: NO_3, Mn, Fe and SO_4) in different catchments.

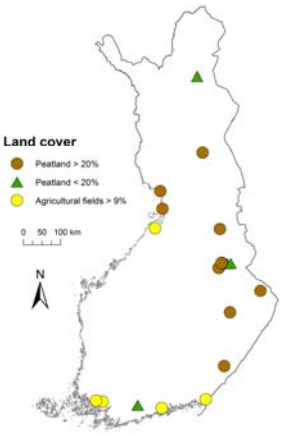

Figure 1. Location of the catchments.

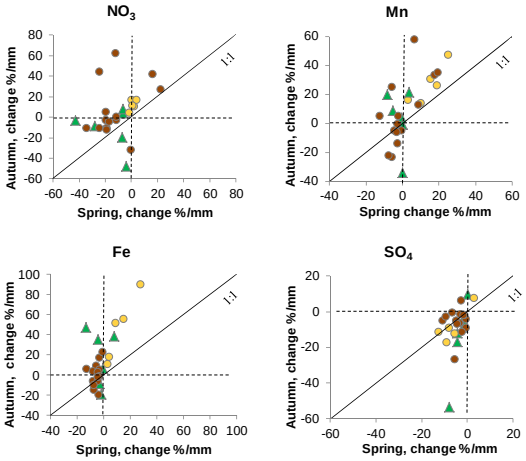

Figure 2. The change in concentrations of NO_3, Mn, Fe and SO_4 (%) per changing runoff (mm day^{-1}) in spring and autumn in 25 catchments. Symbols cf. Fig. 1

Material and methods

- 25 boreal catchments, 0.1–4283 km^2 (Fig. 1)
- Land cover:
  - Upland forests 30–92% (mean 62%)
  - Agricultural fields 0–42% (mean 5.4%)
  - Peatlands 0–70% (mean 29%)
  - Water 0–4% (mean 1%)
  - Built-up areas 0–6.9% (mean 1.2%)
- Daily runoff for years 2000–2011 was determined by the rating curve method using continuous water level data, or for some rivers from hydropower plants.
- 9–41 water samples/year concentrating on spring (January-May) and autumn (September-December)
- The TEA export scenarios were made by using a moderate climate change scenario (IPCC, B2) (www.climateguide.fi)

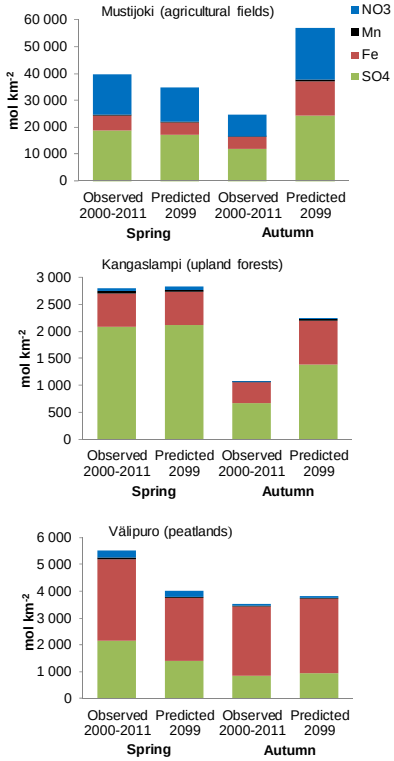

Figure 3. Observed (2000-2011) and predicted (2099) TEA exports in spring and autumn in three catchments with different land cover.

The effect of runoff on TEAs varies among the substances, land cover classes and seasons

- NO_3, Mn and Fe increased with increasing runoff in agricultural catchments (Fig. 2).
- Increasing runoff had a stronger influence on concentrations in autumn than in spring.
- In upland forest/peatland catchments, the dilution effect of the increasing runoff on NO_3, Mn and Fe concentrations was more frequent in spring compared to autumn.
- Most of the catchments had a negative correlation between SO_4 concentrations and runoff implying dilution behaviour (Fig. 2).
- The relative importance of the spring snowmelt decreased in wet and warm years.
- The results suggest that climate change increases TEA exports in autumn especially in agricultural catchments (Fig. 3)

Conclusions

Our study shows that climate change and runoff regime are likely to alter the variability in TEA concentrations and the timing of the TEA exports, which are land cover specific.

The variation in the timing, (i.e. does the export of TEAs take place before or after the growing season), may affect the processing of TEAs and the subsequent feedbacks in the cycling of carbon and nutrients in aquatic ecosystems.

Acknowledgements

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