Land cover controls the export of terminal electron acceptors from boreal catchments

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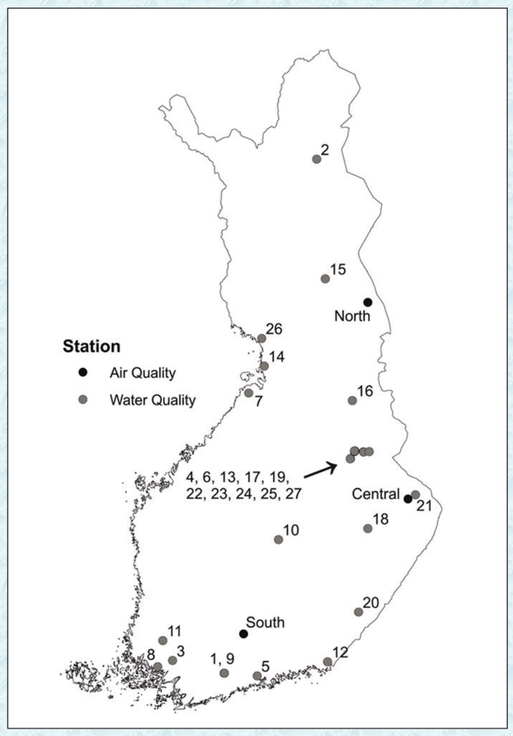
Background and objective

- Terminal electron acceptors (TEAs i.e. NO_3, Mn, Fe and SO_4) modify mineralization pathways and couple biogeochemical cycles, but yet the factors regulating their simultaneous fluxes are poorly elucidated.
- Our objective was to investigate how the land cover and atmospheric deposition control the annual export of TEAs.

Material and methods

- 27 boreal catchments (0.1–4283 km^2) (Fig. 1)
- Forest% 30–92 (average 62), Field% 0–42 (average 6.7) and Peat% 0–70 (average 28)
- Water% only 0–4 (average 1) and Built-up% 0–6.9 (average 1.3)
- The study period covered the years 2000–2011
- Daily runoff was determined by the rating curve method using continuous water level data, or in the case of some rivers, from data obtained from hydropower plants
- 9–41 water samples/year concentrating on spring and autumn high flow periods



Catchments
1 Yli-Knuuttila
2 Laanioja
3 Paimionjoki
4 Kangasvaara
5 Mustijoki
6 Kangaslampi
7 Siikajoki
8 Aurajoki
9 Teeressuonoja
10 Ruunapuro
11 Yläneenjoki
12 Virojoki
13 Porkkavaara
14 Kiiminkijoki
15 Vähä-Askanjoki
16 Myllypuro
17 Kivipuro
18 Kesselinpuro
19 Koivupuro
20 Huhtisuonoja
21 Kelopuro
22 Liuhapuro
23 Murtopuro
24 Korsukorpi
25 Välipuro
26 Kuivajoki
27 Suopuro

Atmospheric deposition stations
South (Kotinen)
Central (Hietajärvi)
North (Kuusamo)

Figure 1. Location of the catchments and atmospheric deposition stations.

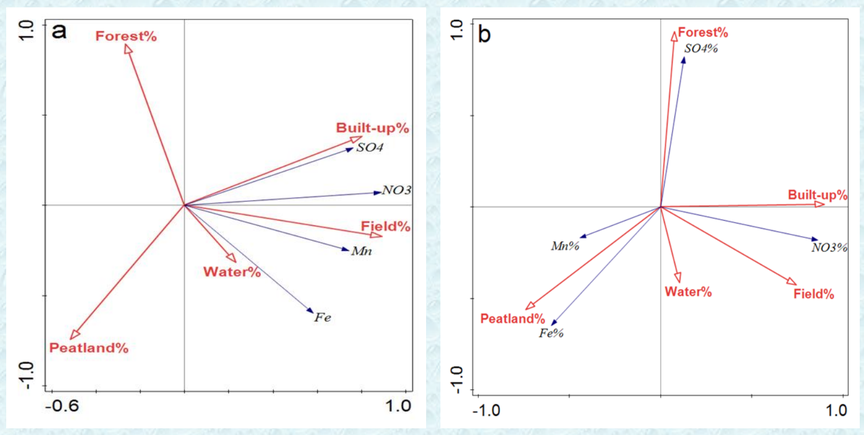


Figure 2. Principal component analysis ordination diagrams showing the main patterns of the variation of TEA exports (a) and molar ratios (b) in relation to the land use.

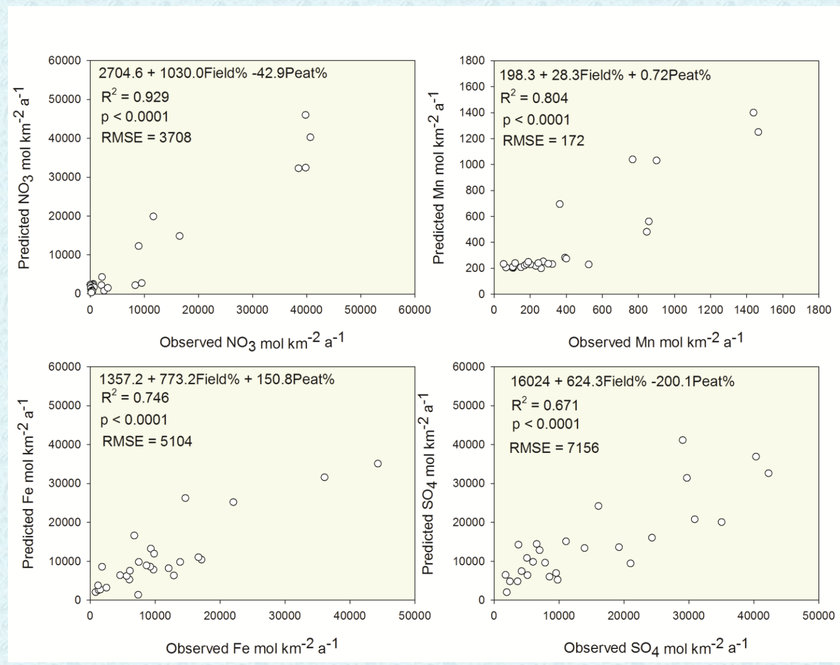


Figure 3. Regression models for estimating TEA export and the observed and predicted NO_3, Mn, Fe and SO_4 exports.

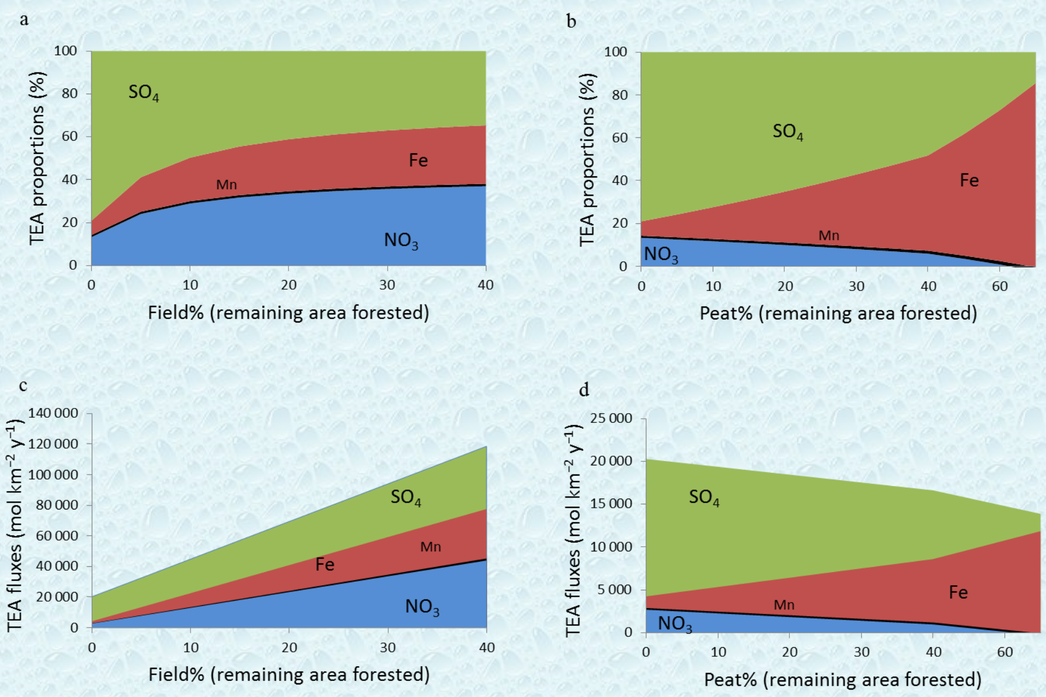


Figure 4. Proportions and exports of TEAs as estimated from regression models in Figure 3. Proportions of TEAs as a function of field percentage (a) and peat percentage (b); export of TEAs as a function of field percentage (c) and peat percentage (d).

TEA exports and molar ratios are strongly controlled by land cover

- Atmospheric deposition was a poor predictor for export of TEAs explaining at its best 24-27% ($p < 0.01$) of the variation in NO_3 and Mn exports.
- Fields produced the highest export of TEAs, particularly NO_3 (Figs. 2 and 4).
- Peatland was linked to low NO_3 and SO_4 but high Fe exports.
- NO_3, Mn and Fe exports from forests were low, SO_4 having proportionally the highest export.
- The land cover classes explained well the variation in the export of NO_3, Mn, Fe and SO_4 (Fig. 3).
- The variable export of TEAs having different availability and physical behavior may create different premises for anaerobic mineralization in downstream systems, which adds a new dimension to the link between terrestrial system, land use and environmental problems such as eutrophication and climate change.

Acknowledgements: This study is a part of the TEAQUILA project supported by the AKVA programme of the Academy of Finland.

Palviainen, M., Lehtoranta, J., Ekholm, P., Ruoho-Airola, T., & Kortelainen, P. 2015. Land cover controls the export of terminal electron acceptors from boreal catchments. Ecosystems (accepted).