

# Accumulation of atmospheric nitrogen deposition in mosses

Winfried Schröder<sup>1</sup> and Stefan Nickel<sup>2</sup>

<sup>1</sup> Chair of Landscape Ecology, University of Vechta, P.O.B. 1553, 49364 Vechta

<sup>2</sup> Chair of Landscape Ecology, University of Vechta, P.O.B. 1553, 49364 Vechta

E-mail: Winfried.Schroeder@uni-vechta.de

## Abstract

Mosses are particularly suitable for recording the accumulation of atmospheric substance inputs in large areas at relatively many locations. In Europe, this has been done every five years since 1990 as part of the European Moss Survey. Mosses were collected at up to 7312 sites in up to 34 countries and chemically analysed for heavy metals (since 1990), nitrogen (since 2005) and organic substances (since 2010). In Germany, in addition to the measurement data from chemical analysis for each moss collection site, data of site and environmental characteristics that could have an influence on the accumulation of atmospheric deposition in mosses were collected. These potential predictors were included in the statistical analyses so that their significance could be identified and ordained according to their influence. For the 1990-2010 measurement campaigns, the corresponding investigations showed that atmospheric deposition, vegetation structure, crown deposition and land use are particularly closely linked to the variability of element accumulations in mosses. The calculations also show that, unlike most heavy metals, there is no decrease in nitrogen bioaccumulation.

Keywords: European Moss Survey, chemical transport models (EMEP, LOTOS EUROS), open field deposition, throughfall deposition.

## Acknowledgement

This work was supported by the German Environment Agency (Umweltbundesamt, Dessau, Germany).

## References

- Dreyer A, Nickel S, Schröder W 2018 (Persistent) Organic pollutants in Germany: results from a pilot study within the 2015 moss survey. *Environ. Sci. Eur.* **30**(43): 1-14 <<https://doi.org/10.1186/s12302-018-0172-y>>
- Nickel S, Schröder W 2018 Modelling spatial patterns of correlations between concentrations of heavy metals in mosses and atmospheric deposition across Europe in 2010, link to research data and scientific software (Version v1) [Data set]. ZENODO, <https://doi.org/10.5281/zenodo.1401131>, Supplement to: Nickel S, Schröder W, Schmalfluss R, Saathoff M, Harmens H, Mills G, Frontasyeva MV, Barandovski L, Blum O, Carballeira A, de Temmermann L, Dunaev A, Ene A, Fagerli H, Godzik B, Ilyin I, Jonkers S, Jeran Z, Lazo P, Leblond S, Liiv S, Mankovska B, Núñez-Olivera E, Piispanen J, Poikolainen J, Popescu IV, Qarri F, Santamaria JM, Schaap M, Skudnik M, Špiric Z, Stafilov T, Steinnes E, Stihl C, Suchara I, Uggerud HT, Zechmeister HG 2018. Modelling spatial patterns of correlations between concentrations of heavy metals in mosses and atmospheric deposition in 2010 across Europe. *Environ. Sci. Eur.* **30**(53):1-17
- Schröder W Nickel S 2018 Mapping percentile statistics of element concentrations in moss specimens collected from 1990 to 2015 in forests throughout Germany. *Atmosph. Environ.* **190**:161-168
- Schröder, W, Nickel S 2018 Site-specific investigation and spatial modelling of canopy drip effect on element concentrations in moss. *Environ. Sci. Pollut. Res.* **25**(27):27173-27186

Schröder W, Nickel S 2019 Spatial structures of heavy metals and nitrogen accumulation in moss specimens sampled between 1990 and 2015 throughout Germany. *Environ. Sci. Eur.* **31**(33):1-15+ Suppl:1-8 [<https://doi.org/10.1186/s12302-019-0216-y>] (ID: 642)

Schröder W, Nickel S, Völksen B, Dreyer A 2019 Nutzung von Bioindikationsmethoden zur Bestimmung und Regionalisierung von Schadstoffeinträgen für eine Abschätzung des atmosphärischen Beitrags zu aktuellen Belastungen von Ökosystemen. Abschlussbericht. *UBA-Texte 91/2019* (Bd.1:1-189 , Bd. 2:1-296)

Wosniok W, Nickel S, Schröder W 2019. R software tool for calculating minimum sample sizes for arbitrary distributions (SSAD). Link to scientific software (Version v1). ZENODO, <https://doi.org/10.5281/zenodo.2583010>