

Environmental factors explaining the N and $\delta^{15}\text{N}$ values in the moss collected inside and outside canopy drip lines

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BACKGROUND

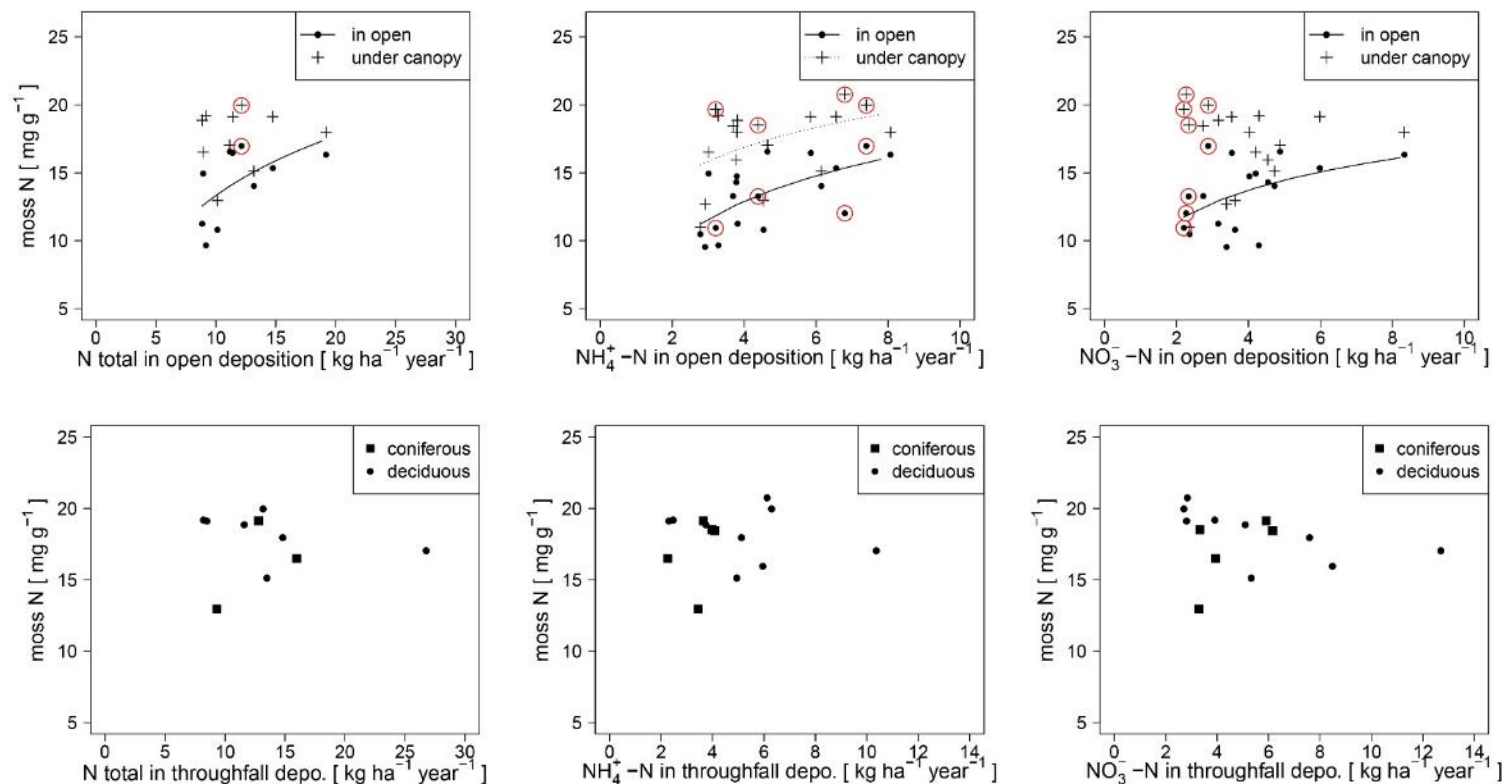
- Increased concentrations of nitrogen (N) compounds have in last decades been identified as a critical load for the environment on a global scale.
- To document current status and changes in the environment, monitoring of pollutants is essential.
- For this reason different infrastructure was established to monitor air and precipitation quality in Europe.
- To gain additional spatial information on deposited N, numerous biomonitoring methods were established, such as European moss biomonitoring survey, which is in last years developed inside the framework of ICP-Vegetation.



BACKGROUND

- ICP Vegetation report on N conc. in mosses across EU 2005/2006 (16 countries)
- General suitability for using mosses to identify area at risk of high N atmospheric deposition has been shown in numerous studies. Although to date some studies reported only weak dependence of N in deposition on N in moss tissue.
- Numerous reasons for those results were discussed like:
 1. moss regulate N tissue loads since N plays important role in moss metabolism,
 2. different moss species could have different abilities to bind atmospheric N,
 3. beside of the atmospheric N also other environmental variables could influence the N concentration in moss etc.
- Reduced and oxidized N compounds have different ^{15}N isotope signatures ($\delta^{15}\text{N}$). Based on the $\delta^{15}\text{N}$ values in mosses, the N emission sources can be hypothesized.

BACKGROUND



Skudnik, M. et al., 2014.
Influence of canopy drip on
the indicative N, S and $\delta^{15}\text{N}$
content in moss *Hypnum*
cupressiforme.
Environmental Pollution 190,
27-35.

AIM OF THE STUDY

- (1) Evaluate the influence of select site-specific environmental characteristics on the N concentrations and $\delta^{15}\text{N}$ values in moss sampled under canopies and in adjacent forest openings.
- (2) Identify to what extent the additional N inputs in the moss collected under canopies, compared with the N concentrations in mosses collected in forest openings and vice versa, could be explained by a statistical model by accounting for the select environmental characteristics.

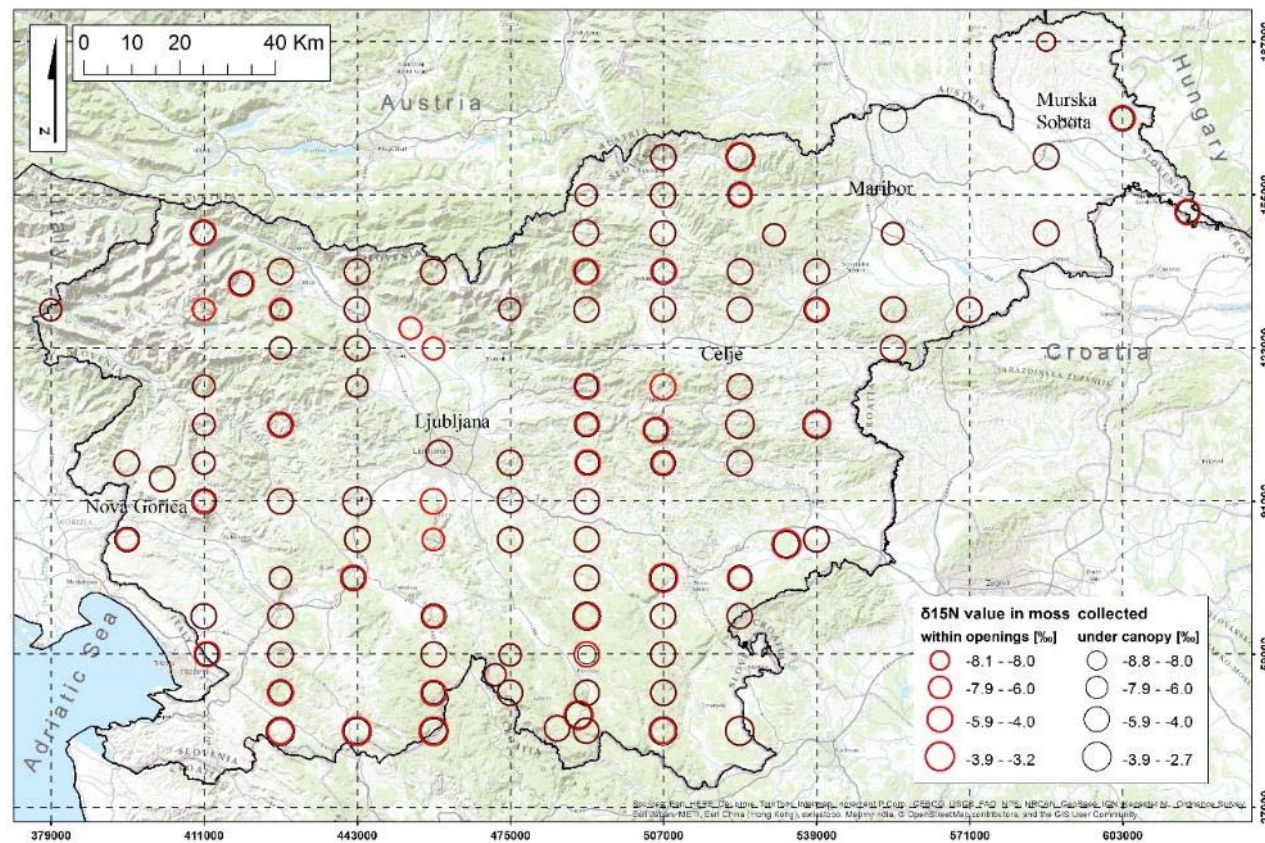
MOSS SAMPLING and ANALYSIS

- Moss *Hypnum cupressiforme* Hedw.
103 locations in Slovenia
Systematical sampling grid 16x8 km = FI plots, **ICP Forest Level I + Level II plots, EMEP**
- At each location, samples were taken at two types of sites: under tree canopies and in adjacent forest openings
- Moss collecting period: summer 2010
- Sample preparation (cleaning, composite sample from 5 subsamples ~ equal amount of each subsample), liophilization and homogenisation
- Chemical analysis LECO CNS-2000 + quality control – Standardized moss material M2, M3

SAMPLING SITE CHARACTERISTICS - EXPLANATORY VARIABLES

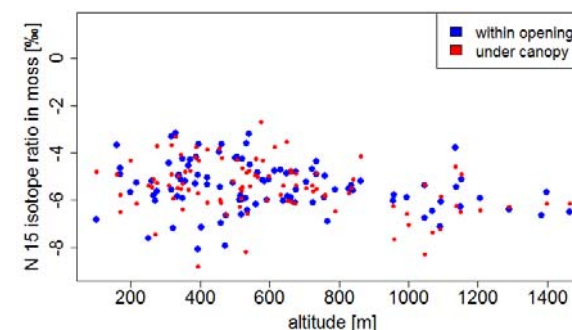
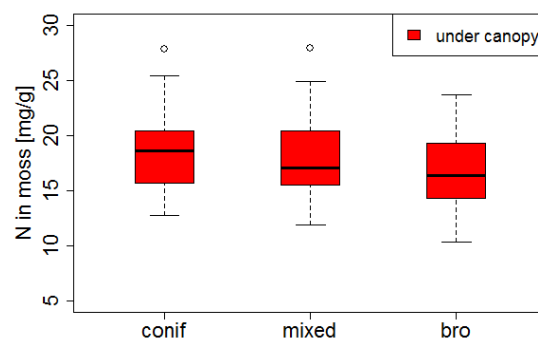
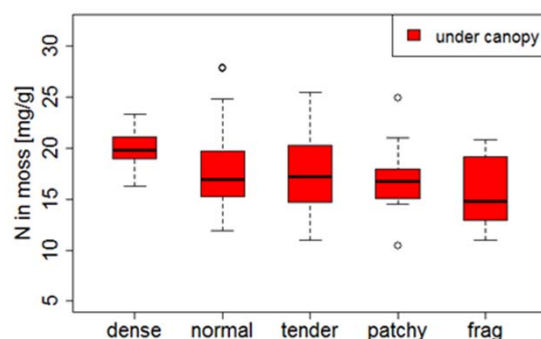
Regressor group	Regressor	Data type	Data provider
Location of moss sampling	Distance from each moss subsample at each sampling site to nearest tree crown, distance to nearest shrub, growth substrate, topography, slope, exposition, altitude	Site-specific	Field assessment
Characteristics of surrounding forest	Basal area, canopy closure, tree species mixture, top tree height, age of the stand, development phase, number of trees per hectare, type of bedrock	Site-specific	Slovenian Forestry Institute
Climate data	Average yearly precipitation (1971-2000), number of days with more than 30 mm of rain (1971-2000), average air temperatures (1971-2000), average air humidity (1971-2000), sunshine duration (1971-2000), average snow cover duration (1971-2000), average wind speed 50 m above ground (1994-2001)	Raster map – resolution 100x100 m	Slovenian Environmental Agency
Precipitation data	Yearly precipitation (average for period 2008-2010), sum of monthly precipitation, number of days with snow cover (average for period 2008-2010)	Raster map – resolution 100x100 m	Slovenian Environmental Agency
Land use – local scale	Forest land use, agricultural land use, urban land, water land (0.5, 1, 5, 8 km radius)	Shape map	Ministry of Agriculture and the Environment
Land use – regional scale	Forest land use, agricultural land use, urban land, water land (40, 80, 100 km radius)	Raster map – resolution 100x100 m	European Environment Agency

MOSS COLLECTING LOCATIONS AND MEASURED VALUES



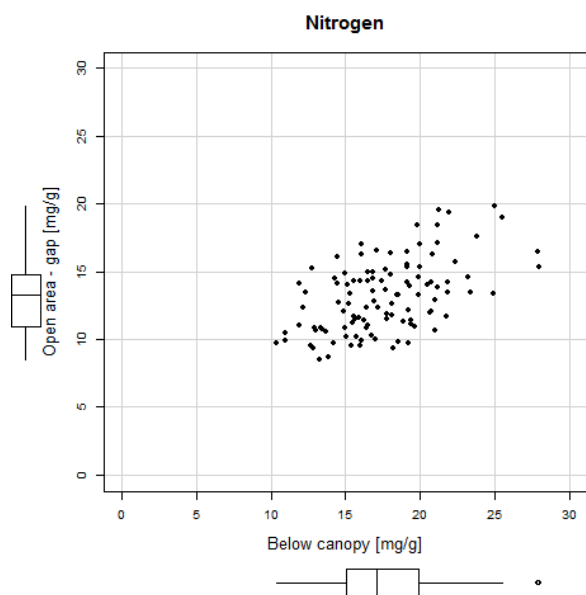
Environmental factors explaining the N and $\delta^{15}\text{N}$ values in the moss

Element	Explanatory variables	R ²
N _{open}	% of urban land within 80 km radius (19%), sum of 120 days of precipitation (11%), distance to the nearest tree (9%) , altitude (4%), % of agricultural land within 5 km radius (3%)	0.46 p < 0.001
N _{canopy}	canopy closure (11%) , tree mixture (9%) , average wind speed 50m above ground (7%), <u>% of forestland within 0.5 km radius (6%)</u> , % of urban land within 40 km radius (6%), sum of 120 days of precipitation (2%)	0.41 p < 0.001
$\delta^{15}\text{N}_{\text{open}}$	tree mixture (10%) , <u>altitude (7%)</u> , <u>% of agricultural land within 0.5 km radius (6%)</u> , distance to the nearest tree (5%)	0.28 p < 0.001
$\delta^{15}\text{N}_{\text{canopy}}$	<u>altitude (12%)</u> , tree mixture (6%) , <u>% of agricultural land within 5 km radius (3%)</u>	0.21 p < 0.001

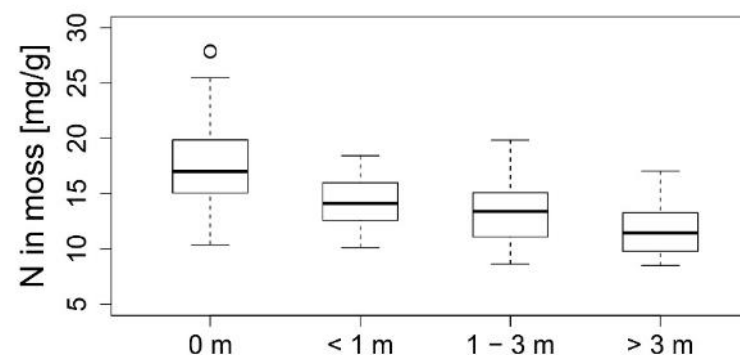


Additional inputs in the moss explained by a statistical model

Element	Explanatory variables	R ²
N _{open}	N conc. in mosses collected within forest stand (18%), % of urban land in radius 80 km (16%), sum of 120 day precipitation (9%), distance to nearest tree (7%) , Altitude (3%), % of crop land in radius 5 km (2%)	0.54 (N=103) p < 0.001
N _{canopy}	N conc. in mosses collected within forest openings (26%), canopy closure (9%) , % of forestland in radius 0.5 km (8%), tree mixture (7%) , average wind speed 50 m above ground (5%)	0.55 (N=103) p < 0.001
(N _{canopy}) [*]	N conc. in mosses collected within forest openings (26%), canopy closure (11%) , % of forestland in radius 0.5 km (9%), tree mixture (8%) , average wind speed 50 m above ground (8%)	0.62 (N=90) p < 0.001



* Only locations where mosses in open were collected > 1m from the nearest tree



INTRODUCTION

METHODS

RESULTS

CONCLUSIONS

- Moss collected in the forest openings reflects the surrounding land-use characteristics and, consequently, the main N emission sources.
- For moss sampled under canopies, the characteristics of the forest at the moss-sampling locations are more important than the main emission sources outside the forest.
- To some level it is possible to predict N content in moss collected below canopy on the basis of N value in moss collected in the open area taking into account specific site characteristics.
- Would similar analysis be interesting also using the ICP-Forest throughfall and bulk deposition data?

References:

- Skudnik, M. et al., 2014. Influence of canopy drip on the indicative N, S and $\delta^{15}\text{N}$ content in moss *Hypnum cupressiforme*. *Environmental Pollution* 190, 27-35.
- Skudnik, M. et al., 2015. Potential environmental factors that influence the nitrogen concentration and $\delta^{15}\text{N}$ values in the moss *Hypnum cupressiforme* collected inside and outside canopy drip lines. *Environmental Pollution* 198, 78-85.



Acknowledgment:

Slovenian Environmental Agency for the meteorological data

D. Žlindra from the SFI for all CNS analysis

S. Lojen and S. Žigon from the IJS for the $\delta^{15}\text{N}$ value analysis.



Thank you for your attention!

