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Introduction

The aim of the elaboration is to update critical loads of sulphur and nitrogen. The data incorporated in the elaboration were prepared for the last Call for Data 2015/2017 and processed with the use of the both measurement and modelled data in 957 forest localities. Some of them are results of the grant entitled "Forest soil state as a determining factor of health state development, biodiversity and filling productivity and outside productivity functions of forests" solved under the sponsorship of the Ministry of Agriculture of the Czech Republic (Novotný et al., 2014).

Updating the critical loads has been called out by two main reasons - for changes in meteorological situation from the previous elaboration of critical loads and changes in forest ground floor vegetation. Increase in temperatures and different precipitation amounts in forests are presented in Figures CZ-1 and CZ-2. The period involving long-term meteorological data (1960-90) was compared to the recent period (2011-14). The vegetation change is mainly realized by a gradual increase in nitrophilous species and decrease in oligotrophic species. The total number of species seems to increase with atmospheric deposition of nitrogen (Buriánek et al., 2013). The occurrence of nitrophilous vegetation species in the herbal floor of forests in the Czech Republic is shown in Figure CZ-3. Most data were compiled for the years of the phenological survey (1999 and 2014).

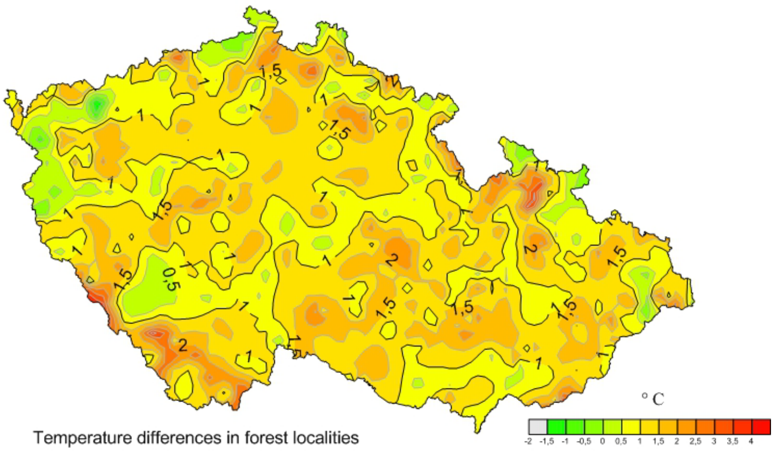

Figure CZ-1. Differences in temperatures in forests between the periods1960-90 and 2011-14.

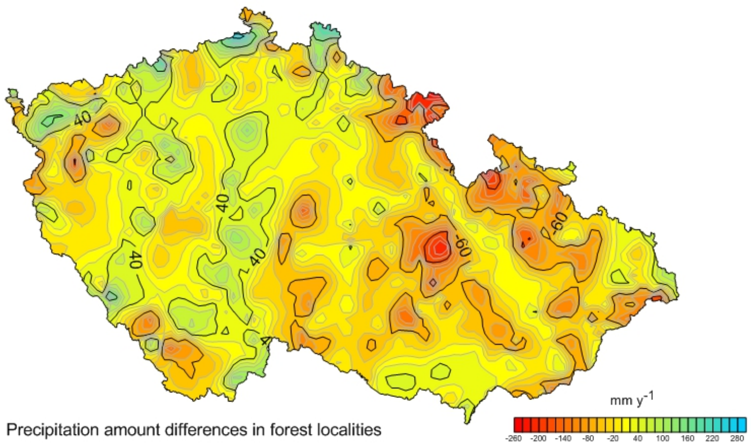

Figure CZ-2. Differences in precipitation amounts in forests between the periods1960-90 and 2011-14.

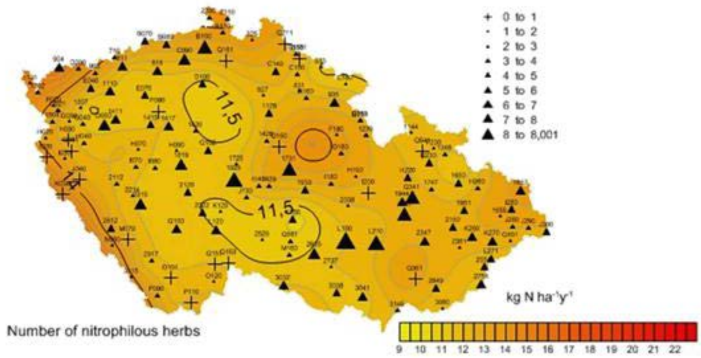

Figure CZ-3. Occurrence of nitrophilous vegetation species in the herbal floor of forests.

Methods

Updated critical loads for acidification and eutrophication are involved in tables 'CLacid' and 'CLeut'. Critical loads of sulphur CLmaxS and critical loads of nitrogen CLminN, CLmaxN in the table 'CLacid' are based on the SMB method (CLRTAP, 2015). The table 'CLeut' contains CLeutN values - the minimum values between CLnutN (computed by the SMB method) and CLempN. Only forest areas are taken into account. Data on critical loads are in eq ha^{-1} a^{-1}.

Maximum critical load of sulphur, CLmaxS:

$CLmaxS = BC_{dep} - Cl_{dep} + BC_{we} - Bc_{upt} - (-ANC_{lecrit})$

BC_w weathering rate

BC_{dep} base cation deposition

Cl_{dep} chloride deposition

Bc_{upt} base cation uptake

ANC_{lecrit} alkalinity leaching (Al criterion)

Atmospheric deposition of base cations was revised. The data of wet and bulk depositions in 2009-13 (www.chmi.cz) were processed in maps with the help of Surfer 12. Depositions of base cations including chlorides into coniferous and mixed forest localities were multiplied by factors 1.7 and 1.3, respectively (based on the analysis of bulk and throughfall data). Weathering rates were obtained from texture and parent material classes and computed with use so-called weathering rate classes WRc and average annual temperature (CLRTAP, 2015). Uptake fluxes equal average annual removal of Ca^{2+}, Mg^{2+}, K^+ and N in 2003-10 (from databases presented on the web site of UHUL in 2011, www.uhul.cz). Uptake of these elements involves the removal of stems including branches (CLRTAP, 2015). The aluminium criterion [Al]=0.02 eq m^{-3}, especially useful for drinking water protection, was considered in the calculation of critical alkalinity leaching values.

Minimum critical load of nitrogen, CLminN:

$CLminN = N_{upt} + N_{imacc}$

N_{upt} nitrogen uptake

N_{imacc} acceptable immobilization of N in the soil

Temperature-dependent immobilisation rate of nitrogen proposed by the NFC of Germany was applied to the calculation of acceptable immobilisation of nitrogen in the soil given in the table 'SiteInfo'. The calculation includes the soils of C/N ratios higher than 21. Soils of lower C/N ratios were supplied by the value of 0.5 kg N ha^{-1} a^{-1} (background value).

Maximum critical load of nitrogen, CLmaxN:

$CLmaxN = CLminN + CLmaxS/(1-f_{de})$

f_{de} denitrification fraction ($0 \leq f_{de} < 1$)

Critical load of nutrient nitrogen, CLnutN:

$CLnutN = N_{upt} + N_{imacc} + N_{leacc}/(1-f_{de})$

N_{leacc} acceptable leaching of N (1 mg 1^{-1})

Empirical critical load of nitrogen, CLempN:
Forests of the Czech Republic, characterized by selected plots according to forest typological classification, fall into the following main types of forest habitats. They are Alder carrs (short cut in Czech L1), Alluvial forests (L2), Oak-hornbeam forests (L3), Ravine forests (L4), Beech forests (L5), Thermophilous oak forests (L6), Acidophilous oak forests (L7), Dry pine forests (L8), Spruce forests (L9) and Bog forests (L10). These types of habitats can be classified by the EUNIS as Riverine ash-alder woodland and Mixed oak-elm-ash woodland of great revers (G1.4), Alder swamp woods and Sphagnum birch woods (G1.6), Medio-European acidophilous and neutrophile beech forests and Medio-European subalpine beech woods (G1.7), Medio-European acidophilous oak forests and Sub-continental oak-hornbeam forests (G1.8), Euro-Siberian steppe oak woods (G1.9), Hercynian slope forests (G1.H), Mire spruce woods and Hercynian subalpine spruce forests (G3.2), Scots pine mire woods and Middle European Scots pine forests (G3.5). Classification to the EUNIS is based on the transfer of typology of forests carried out according to the Catalogue (Chytrý et al., 2001).

Empirical critical loads of N range from 5 kg ha^{-1} a^{-1} for habitats with coniferous tree species (including Sphagnum birch woods – only one locality) to 10 kg ha^{-1} a^{-1} for habitats covered by deciduous tree species. Values of nitrogen empirical critical loads agree with critical loads for eutrophication CLeutN in 87.5 % of localities.

The table 'SiteInfo' gives partial results for calculation of critical loads for acidification and eutrophication such as base cation depositions, weathering rates, uptake, denitrification rates and so on. The important values are for example the flux of drainage water leaching from the soil layer Q_{le} (or precipitation surplus), equilibrium constant K_{Alox} and exponent, concentration of organic acids Corgacids (or m*DOC). The flux of drainage water was computed according to the relationship described in De Vries et al. (2004). The values of equilibrium constants K_{Alox} (in the form of decadic log) were taken from the Mapping Manual (CLRTAP, 2015). The values of K_{Alox} and exponent were derived from analyses of the soil solution of Dutch forests. Data presented in $log_{10}K_{Alox}$ also involve values for loess and clay soils. Values for loess soils, especially, are important for the territory of the Czech Republic for a large number of forest localities covered by leached loess soils relatively.

Concentrations of DOC in the soil solution are measured only in a small number of forest localities. Measurements proceed only in forest plots including intensive monitoring (level II) performed by the Forestry and Game Management Research Inst5tute in Prague – Zbraslav and included in the International Cooperative Programme for Forests. Data on the soil solution concentration of DOC were used for the assessment of the content of DOC in all considered localities. Relationships of DOC and soil C/N ratios, pH, altitudes, average annual temperatures and content of organic C in soils were investigated.

Conclusion
The data incorporated in the elaboration were processed with the use of the both measurement and modelled data in 957 forest localities. The main aim was to update critical loads of sulphur and nitrogen. The

results cover the forest area of 6396.25 km^2 altogether. Maximum critical loads of sulphur range from 122.68 eq $ha^{-1}a^{-1}$ to 2680.7 eq $ha^{-1}a^{-1}$. Minimum critical loads of nitrogen are in the range of 35.71–893.21 eq $ha^{-1}a^{-1}$. Results of maximum critical loads of nitrogen fall in the range of 420.77–4064.87 eq $ha^{-1}a^{-1}$. The lower values reached out in the case of critical loads of nutrient nitrogen CLeutN. Their values range from 357.14 to 714.29 eq $ha^{-1}a^{-1}$. This range corresponds to the values of empirical critical loads of nitrogen.

References

Buriánek V., Novotný R., Hellebrandová K., Šrámek V., 2013. Ground vegetation as an important factor in the biodiversity of forest ecosystems and its evaluation in regard to nitrogen deposition. *Journal of Forest Science* 59(6): 238-252

Chytrý M., Kučera T., Kočí M. (eds), 2001. Katalog biotopů České republiky. Interpretační příručka k evropským programům Natura2000 a Smaragd. AOPK, Praha ve spolupráci s PřFMU, Brno a BÚ AVČR. ISBN 80-86064-55-7, 1. vydání, Praha, 307 pp

CLRTAP, 2015. Mapping critical loads for ecosystems, Chapter V of Manual on methodologies and kriteria for modelling and mapping critical loads and levels and air pollution effects, risks and trends. UNECE Convention on Long-range Transboundary Air Pollution; www.icpmapping.org

De Vries W., Schütze G., Lofts S., Tipping E., Meili M., Römkens P.F.A.M., Groenenberg J.E., 2004. Calculation of critical loads for cadmium, lead and mercury. Background document to a Mapping Manual on Critical Loads of cadmium, lead and mercury. Alterra Report 1104, Alterra, Wageningen, 26 pp

Novotný R., Hůnová I., Skořepová I., Zapletal M., Seidl V., Buriánek V., Fadrhonsová V., Jurkovská L., Neudertová Hellebrandová K., Kurfűrst P., Lachmanová Z., Schovánková J., Stoklasová P., Stráník V., Šrámek V., Vlček O., 2014. Stav lesních půd jako určující faktor vývoje zdravotního stavu, biodiverzity a naplňování produkčních i mimoprodukčních funkcí lesa Závěrečná zpráva grantu NAZV QI112A168, Výzkumný ústav lesního hospodářství a myslivosti, Zbraslav - Strnady. 65 pp. (Forest soil state as a determining factor of health state development, biodiversity and filling productivity and outside productivity functions of forests. Final Report of the NAZV grant, Forestry and Game Management Research Institute, Zbraslav – Strnady. 93 pp)