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Modelled critical loads and dynamic data

Data sources

This report presents recent results of the team-work of the Bulgarian experts of Executive Environmental Agency and the Bulgarian scientific team as parts of the ICP Modelling and Mapping on the dynamic assessment of exceedances of critical loads for acidifying pollutants in Europe. Current critical loads data for acidification and eutrophication are described as well justifying methods and data applied.

Critical loads of acidifying sulphur and nitrogen are calculated for main forest tree species using the Steady State Mass Balance method in accordance with the latest recommendations provided in the last version of the Mapping Manual (UBA, 2004). The database involve maximum critical loads of sulphur (Manual, equation 5.22), maximum critical loads of nitrogen (Manual, equation 5.26), minimum critical loads of nitrogen (Manual, equation 5.25), nutrient nitrogen (Manual, equation 5.5) and all related data.

Critical loads are calculated using soil data base of the content of the organic mater (%), the clay content for the fraction 0,01 mm in the soil (%), soil bulk density, cation exchange capacity *CEC*, Base saturation, C:N ratio and the pH of the soil. in grid cells of 16 km×16 km (Ignatova et al., 2001). Data of base saturation have been obtained by means of 0.1 M $BaCl_2$ (ISO 11260 and ISO 14254). Runoff of water under root zone has been measured in grid cells of 10×10 km^2 for the entire country.

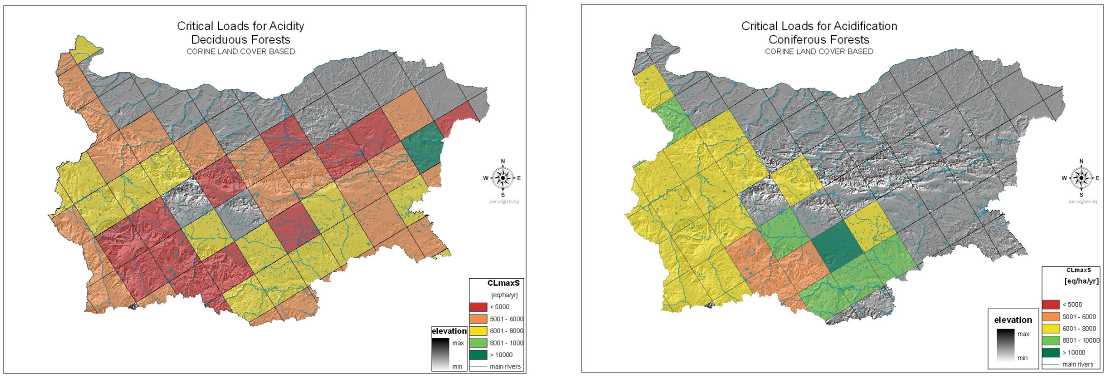

Figure BG-1. *CLmaxS for broadleaved (left) and coniferous (right) forests in Bulgaria.*

A network of 66 permanently opened collectors for atmospheric deposition by precipitation have been used for base cations, sulphur and nitrogen depositions.

Nitrogen and base cations net uptake rates are obtained by multiplying the element contents of the stems (N, Ca, K, Mg and Na) with annual harvesting rates. Data on biomass removal for forests have been derived from the National Forests Survey Agency. The content of base cations and nitrogen in the biomass has been taken from the literature for different harvested parts of the plants (stem and bark of forest trees) (Ignatova et al., 2000).

In the absence of more specific data on the production of basic cations through mineral weathering for most of study regions, weathering rates have been calculated according to the dominant parent material obtained from the lithology map of Bulgaria and the texture class taken from the FAO soil map for Europe, according to the clay contents of the Bulgarian forest soils (UBA, 1996).

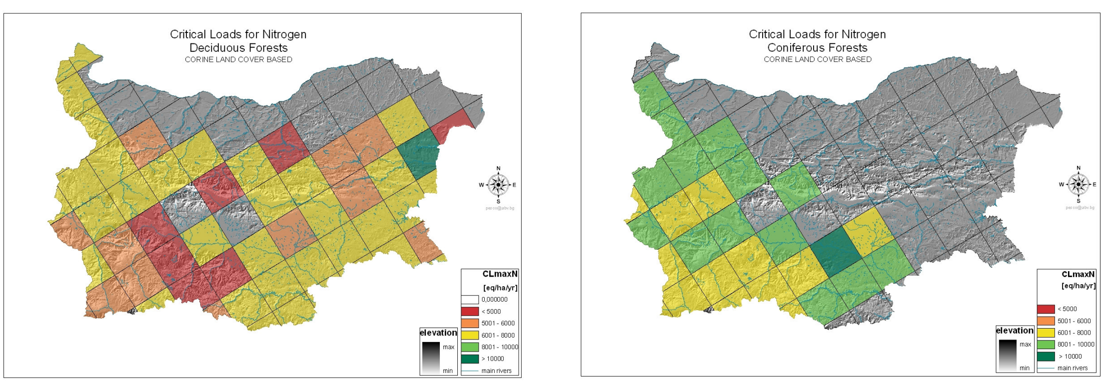

Figure BG-2. *$CL_{max}N$ for broadleaved (left) and coniferous (right) forests in Bulgaria.*

Chemical criterion used is a molar ratio [Al]:[Bc]=1 (Manual, equation 5.31). Identifiers of the site for critical loads calculation of acidifying nitrogen and sulphur, and the integers in the submission of the empirical critical loads of nitrogen are not identical because of different number of sites under consideration in two submissions but they correlate each to other by the EMEP-grid cells indices and geographical coordinates.

Calculated values for *CLmaxS* vary between 5234 and 10044 eq ha^{-1} a^{-1} for coniferous, and between 3266 and 10774 eq $ha^{-1}a^{-1}$ for broadleaved forests (Figure BG-1). *CLmaxN* are similar but a little higher than *CLmaxS* (Figure BG-2). On the contrary, critical load values for nutrient nitrogen are lower and ranged between 584 and 950 eq $ha^{-1}a^{-1}$ for coniferous, and between 400 and 781 eq $ha^{-1}a^{-1}$ for deciduous forests. The lowest critical loads are calculated for *CLminN* (between 573 and 926 eq $ha^{-1}a^{-1}$ for coniferous, and between 394 and 768 eq ha^{-1} a^{-1} for deciduous forests).

In general, all calculated critical loads values for all over the country are higher for coniferous forests than for brood leaved ones, due to the lower mean values of critical loads parameters used for the computing (base cations weathering, deposition and uptake).

Table BG-1. *Average, maximum and minimum values of critical loads of sulphur, nitrogen as well as alkalinity for broadleaved and coniferous forests in Bulgaria (in eq ha^{-1} a^{-1}).*

	Coniferous			*Broadleaved*		
	Min	*Max*	*Average*	*Min*	*Max*	*Average*
CLmaxS	*5234*	*10044*	*7273*	*3266*	*10774*	*5560*
CLminN	*573*	*926*	*789*	*394*	*768*	*534*
CLmaxN	*5985*	*10621*	*8062*	*3778*	*11230*	*6094*
CLnutN	*584*	*950*	*801*	*400*	*781*	*550*
nANCcrit	*3154*	*6060*	*4384*	*1989*	*6473*	*3353*

For the minimum critical loads of nitrogen as well as the critical loads of nutrient nitrogen the variability of computed individual data is much smaller, which reflects on the average values (789 eq $ha^{-1}a^{-1}$ for coniferous ecosystems for minimum critical loads of nitrogen with 534 eq ha^{-1} a^{-1} for broadleaved ones, and 801 eq $ha^{-1}a^{-1}$ for coniferous for nutrient nitrogen against 550 eq $ha^{-1}a^{-1}$ for broad leaved forests) (Table BG-1).

Empirical critical loads of nutrient nitrogen

Data sources

The empirical critical loads of nitrogen for habitats groups treated have been determined in accordance with the Mapping Manual chapter 5.2.1 (UBA, 2004) using suggested empirical critical loads for nitrogen deposition as follow (Bobbink et al., 2003):

Forest habitats (G): 10-15 kg N $ha^{-1}a^{-1}$;

Heathland, scrub and tundra habitats (F): 5-15 kg N $ha^{-1}a^{-1}$ for alpine and subalpine scrub habitats (F2) and 10-20 kg N $ha^{-1}a^{-1}$ for dry heaths (F4.2)

Grasslands and tall forb habitats (E): 10-20 kg N $ha^{-1}a^{-1}$ for Inland dune pioneer grassland (E1.94), inland dune siliceous grasslands (E1.95) and mountain hay meadows,

10-15 kg N $ha^{-1}a^{-1}$ for alpine and subalpine grassland (E4), 20-30 kg N $ha^{-1}a^{-1}$ for low and medium altitude hay meadows (E2.2);

Mire, bog and fen habitats (D): 5-10 kg N $ha^{-1}a^{-1}$ for raised and blanket bogs (D1);

Inland surface water habitats (C): 10-20 kg N $ha^{-1}a^{-1}$ for dune slack pools (C1.16);

Coastal habitats (B)- 10-20 kg N ha^{-1} a^{-1} for shifting coastal dunes (B1.3), coastal stable dune grasslands (B1.4) and coastal dune heaths (B1.5);

Because of insufficient national data of empirically derived Nitrogen critical loads for ecosystems of concern, the lower, middle or upper part of the Ranges of the Nitrogen critical loads for natural and (semi-)natural ecosystem groups have been used according to the general relationships between abiotic factors like mean annual temperature, soil wetness, base cation availability, management intensity etc. on the one hand and critical loads for Nitrogen, on the other, as given in Table BG-2 (UBA, 2004). The empirical critical loads of nitrogen in eq $ha^{-1}a^{-1}$ have been derived by multiplying the values in kg N $ha^{-1}a^{-1}$ with 71.4286 (1000/14).

Table BG-2. *Suggested values for using lower, middle or upper part of the set critical loads of nitrogen for the selected habitats groups (in eq* $ha^{-1}a^{-1}$*).*

Habitats group	Temperature	Soil wetness	Base cation availability	Management intensity	Empirical N CLs
	Cold	Dry	Low	Low	357.14
D1	Intermediate	Normal	Intermediate	Usual	535.71
	Hot	Wet	High	High	714.28
	Cold	Dry	Low	Low	357.14
F2	Intermediate	Normal	Intermediate	Usual	714.28
	Hot	Wet	High	High	1071.42
	Cold	Dry	Low	Low	714.28
G1, G3, E4	Intermediate	Normal	Intermediate	Usual	892.81
	Hot	Wet	High	High	1071.42
F4.2, E1.94,	Cold	Dry	Low	Low	714.28
E1.95, C1.16,	Intermediate	Normal	Intermediate	Usual	1071.42
B1.3,B1.4, B1.5	Hot	Wet	High	High	1428.56
	Cold	Dry	Low	Low	1428.56
E2.2	Intermediate	Normal	Intermediate	Usual	1785.70
	Hot	Wet	High	High	2142.84
	Cold	Dry	Low	Low	2142.84
A2	Intermediate	Normal	Intermediate	Usual	2499.98
	Hot	Wet	High	High	2857.12

To facilitate and harmonize the mapping procedure with respect to empirical nitrogen critical loads, the receptor groups were classified according to the EUNIS habitats classification for Europe (Davies and Moss, 2002; Hall et al., 2003). Woodland and forests habitats (G code in accordance with the EUNIS system), heathland, scrub and tundra habitats (F), grasslands and tall forb habitats (E), mire, bog and fen habitats (D), Inland surface water habitats (C), Costal habitats (B) and Marine habitats (A) have been selected as receptors.

Concerning the type of management of the studied areas the proposed classification in the instructions for submitting empirical critical loads of nitrogen has been applied as follow:

0: No specific nature protection applies
1: Special Protection Area (SPA), Birds Directive applies
2: Special Area of Conservation (SAC), Habitats Directive applies
9: A national nature protection program applies

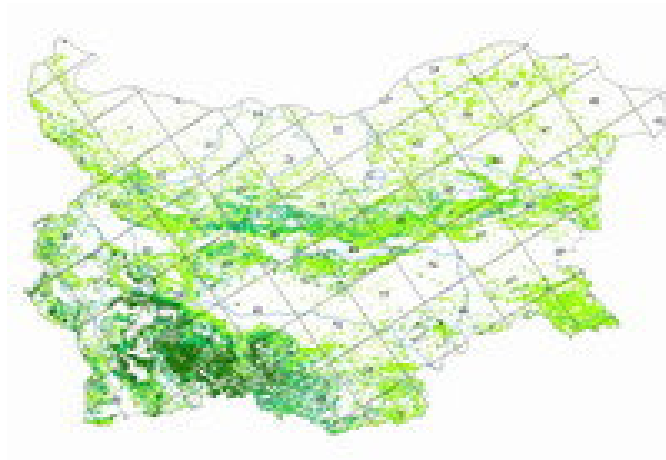

Figure BG-3. Distribution of forested areas in Bulgarian part of the 50 km×50 km EMEP grid cells.

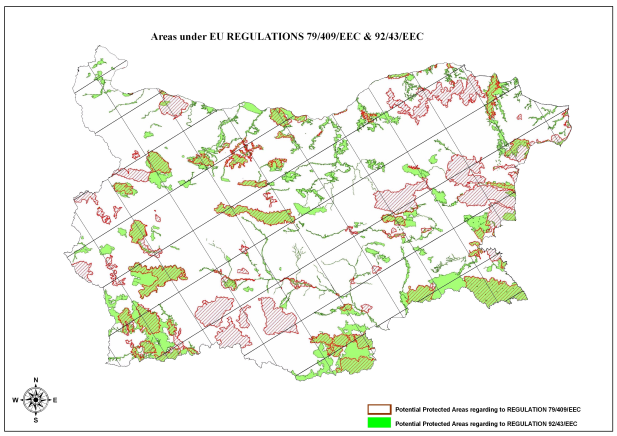

***Figure BG-4.** Distribution of areas under EU Regulations 79/409/EEC and 92/43/EEC in Bulgarian part of the 50 km×50 km EMEP grid cells.*

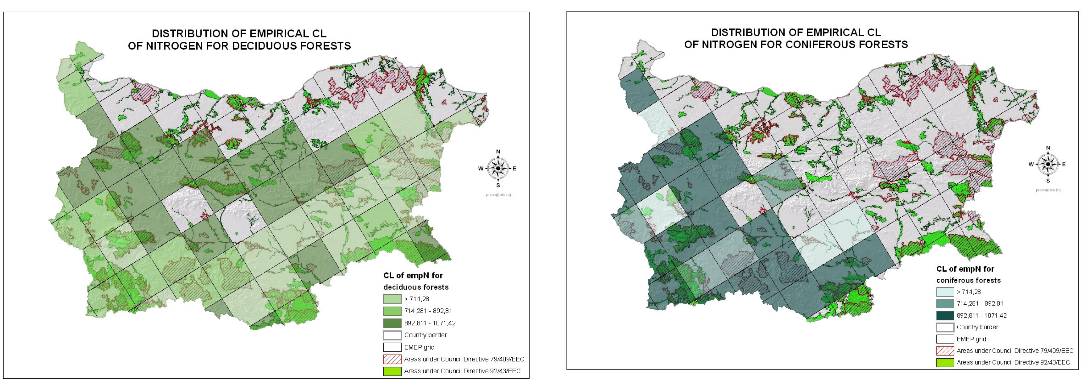

***Figure BG-5.** Distribution of the empirical critical loads of Nitrogen for broad leaved (left) and coniferous (right) forests in Bulgaria, eq ha^{-1} a^{-1}.*

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