POLEN

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Calculation methods

Critical loads

Basically critical loads were calculated in accordance with the methodology presented in the latest version of the Mapping Manual and implemented in the SONOX software (Mill, 2000).

Broadleaved (EUNIS class G1) and coniferous (EUNIS class G3) forest ecosystems were the receptors mapped. The Polish critical loads database consists of 88,383 records representing grid cells of 1×1 km^2 size covering about 30% of the country's area.

Target loads

The target loads for protection of forest soils were computed with the Access version of the VSD model (Posch and Reinds, 2005). For the cation exchange the Gapon model was used.

Revisions made to input data

The following changes to critical loads input data have been made since the last update:

Chemical criterion

A test has been performed to compare the effect of different chemical criteria on critical loads for Polish forest soils. The Al criterion produced the lowest $CL_{max}(S)$ values and was accepted for critical and target loads calculations instead of previously used Bc/Al criterion.

Base cation deposition data

The bulk deposition data for base cations produced by the Institute of Meteorology and Water Management – the Wrocław Branch under the State Monitoring of Environment authority were compared with the recently distributed EMEP base cations maps. Taking into account some model uncertainties, difference in spatial replication (50×50 km^2 EMEP grids vs determined spatial points), contribution of local sources in monitored values basically not considered by EMEP model (the monitored depositions are systematically higher than modelled) a conclusion may be drawn that in general the correspondence of the monitored and modelled depositions might be considered satisfactory.

To calculate critical loads for Polish forest ecosystems national base cation deposition data monitored for 2003 were applied.

Denitrification fraction

Denitrification fraction values f_{de} were assigned to soil clay content according to empirical relationship given in German NFC Report in Posch et al. (2001).

Sea salt correction

Within this critical loads update the base cations deposition was corrected for sea salt contribution. No significant changes to critical load values have been observed.

No changes to additional soil data needed for target loads calculations have been made within this update.

Summary of Polish critical loads data

Summary of $CL_{max}(S)$, $CL_{min}(N)$, $CL_{max}(N)$ and $CL_{nut}(N)$ as well as corresponding input data is given in Table PL-1

Maps submitted

Based on the results of critical load calculations updated maps of $CL_{max}(S)$, $CL_{min}(N)$, $CL_{max}(N)$ and $CL_{nut}(N)$ for Polish forests were submitted - Figures PL 1-2.

Dynamic modelling results

The dynamic model VSD (Very Simple Dynamic model) has been used to generate target load functions for 88,383 forest sites. Target load functions are submitted for the target years 2030, 2050 and 2100. A summary of the results is presented in Table PL-2.

Table PL-1. Summary of Polish critical load data.

Parameter	EUNIS code	Min value	Mean value	Max value	Methods used	Description
$Cl_{max}(S)$ [eq $ha^{-1}yr^{-1}$]	G1	409	1574	4970	$CL_{max}(S)=BC_{dep}+BC_w-BC_u-ANC_{le(crit)}$	Calculated by SONOX
	G3	530	1577	5039		
$Cl_{min}(N)$ [eq $ha^{-1}yr^{-1}$]	G1	219	743	1321	$Cl_{min}(N)=N_i+N_u$	Calculated by SONOX
	G3	219	421	896		
$CL_{max}(N)$ [eq $ha^{-1}yr^{-1}$]	G1	990	2994	>9,999	$CL_{max}(N)=CL_{min}(N)+CL_{max}(S)/(1-f_{de})$	Calculated by SONOX
	G3	990	2357			
$CL_{nut}(N)$ [eq $ha^{-1}yr^{-1}$]	G1	257	800	1501	$CL_{nut}(N)=N_i+N_u+N_{le}(acc)/(1-f_{de})$	Calculated by SONOX
	G3	257	491	1566		
Bc_{dep} [eq $ha^{-1}yr^{-1}$]	G1	208	438	694	The bulk deposition values of base cations were estimated from the reported wet deposition data multiplied by dry deposition factors derived from throughfall data provided by the integrated monitoring surveys	Monitoring network operated by the Institute of Meteorology and Water Management – Wroclaw Branch under the authority of Main Inspectorate of Environment Protection
	G3	208	441	840		
BC_u [eq $ha^{-1}yr^{-1}$]	G1	72	344	572	Uptake of base cations related to deciduous and coniferous trees was calculated as the minimum of growth limited uptake and nutrient limited uptake.	Elements content in stems and branches was provided by the Polish Academy of Science – Institute of Dendrology (Fober, 1986). The forest growth rates were obtained from the Forest Management and Geodesy Office.
	G3	72	186	409		
BC_w [eq $ha^{-1}yr^{-1}$]	G1	218	566	2558	Calculated according to Mapping Manual. Also PROFILE model has been applied for limited number of sites.	Soil samples delivered by the Forest Research Institute (Wawrzoniak et al., 2000) Mineral composition analysis (Stępniewski, 1998)
	G3	218	466	2558		
Q_{le} [mm yr^{-1}]	G1	5	167	1366	According to Mapping Manual, calculated as the difference between 30- year mean atmospheric precipitation and evapotranspiration	Hydrological Atlas of Poland (Stachy et al., 1986)
	G3	5	152	1360		
K_{gibb} [m^6eq^{-2}]	G1		300		Following the Mapping Manual recommendation the value 300 for mineral soils was chosen.	Mapping Manual
	G3		300			
$ANC_{le(crit)}$ [eq $ha^{-1}yr^{-1}$]	G1	14.2	479	3897	Calculated via SMB equation with Bc:Al ratios differentiated due to 6 tree species.	Mapping Manual
	G3	14.2	432	3865		
N_i [eq $ha^{-1}yr^{-1}$]	G1	71	157	356	A temperature dependent long-term immobilization factor was applied, ranging from 71 to 356 eq $ha^{-1}yr^{-1}$	CCE Status Report 2001
	G3	71	138	356		
N_u [eq $ha^{-1}yr^{-1}$]	G1	112	587	965	Uptake of nitrogen related to six major tree species was calculated as the minimum of growth limited uptake and nutrient limited uptake.	Elements content in stems and branches was provided by the Polish Academy of Science – Institute of Dendrology (Fober, 1986). The forest growth rates were obtained from data bank of the Forest Management and Geodesy Office.
	G3	112	283	540		
f_{de}	G1	0.1	0.17	0.8	Depending on soil clay content values from 0.1 to 0.8 were applied	CCE Status Report 2001
	G3	0.1	0.13	0.8		
$N_{le}(acc)$ [eq $ha^{-1}yr^{-1}$]	G1	1.1	35.1	286	For coniferous: 0.0143 eq/m3· Qle for deciduous: 0.02 eq/m3 ·Qle	Mapping Manual
	G3	1.8	53.9	480		

Table PL-2. Summary of target loads calculations for Polish forest ecosystems.

Status	Target Year	Number of sites	%
TLF present	2030	38767	43.86
	2050	39175	44.32
	2100	39107	44.25
TL not feasible	2030	604	0.68
	2050	83	0.09
	2100	0	0.00
Not exceeded in 2010	2030	9368	10.60
	2050	9481	10.73
	2100	9632	10.90
Exceeded at present		48739	55.15

Heavy Metals

Since the 15th CCE workshop in Berlin the following two changes have been made to the Polish heavy metals database:

- Soil pH values measured in KCl extract were corrected to soil solution pH according to the regression function given in Table 5.23 in the Manual on Methodologies and Criteria for Modelling and mapping Critical loads & Levels and Air Pollution Effects, Risks and Trends.
- Annual mean precipitation surplus values were determined by empirical relationship combining long-term mean annual values of temperature, precipitation and potential evapotranspiration. This relationship is given in the Manual as equation 5.91b.

The two corrected input parameters were entered into the heavy metals database and calculations of critical loads of cadmium, lead and mercury were repeated. The corrections done resulted in a further improvement of the accordance of the Polish critical loads of the all considered metals with relevant critical loads in neighboring countries.

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Figure PL-1. Critical loads.

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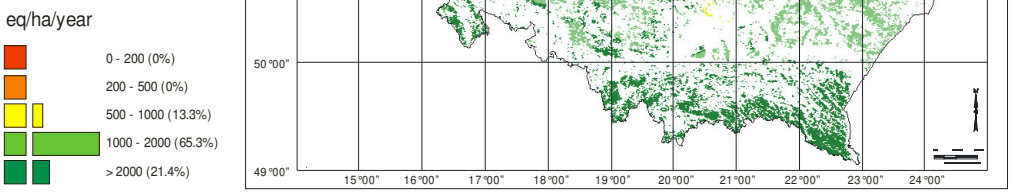
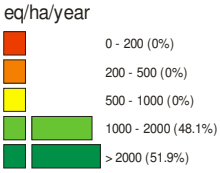
Maximum critical loads of sulphur

2005



Maximum critical loads of nitrogen

2005



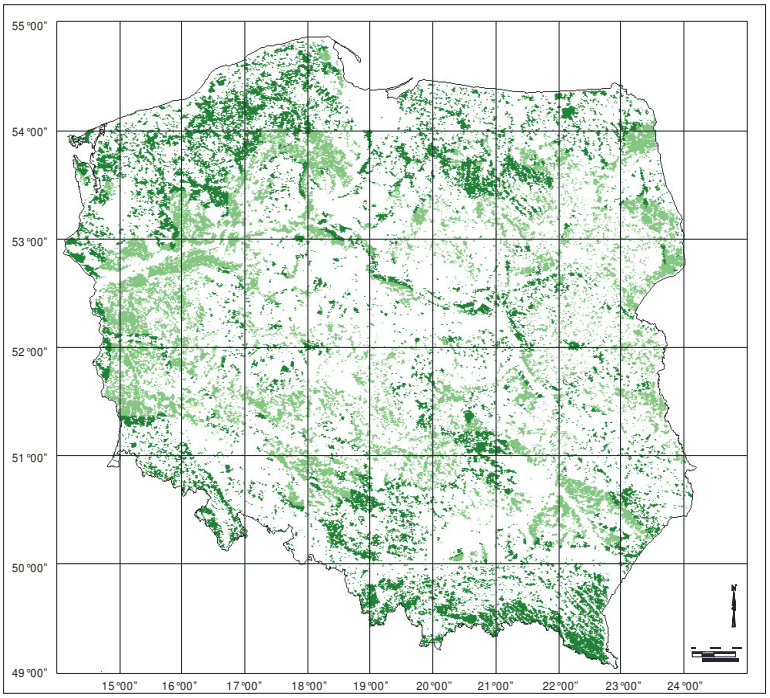


Figure PL-2. Critical loads.

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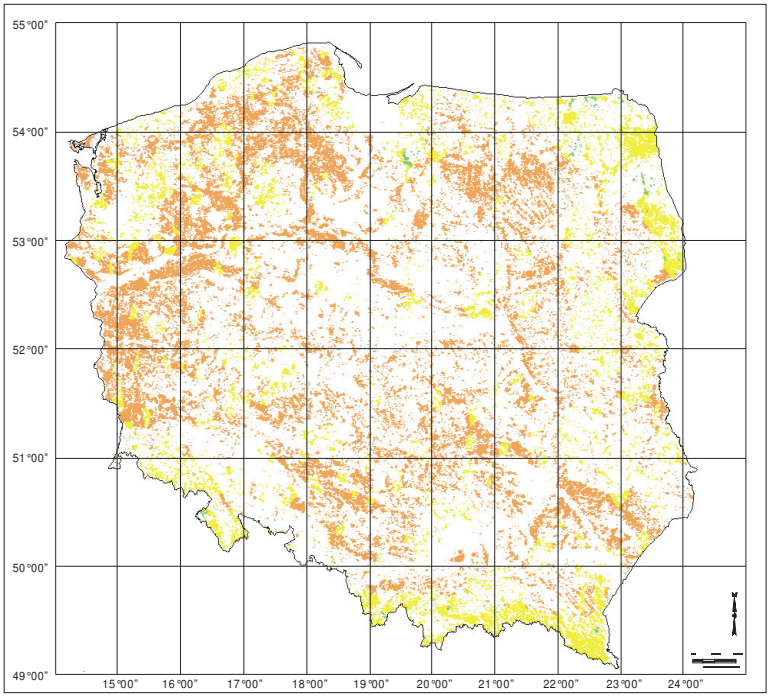
Minimum critical loads of nitrogen

2005

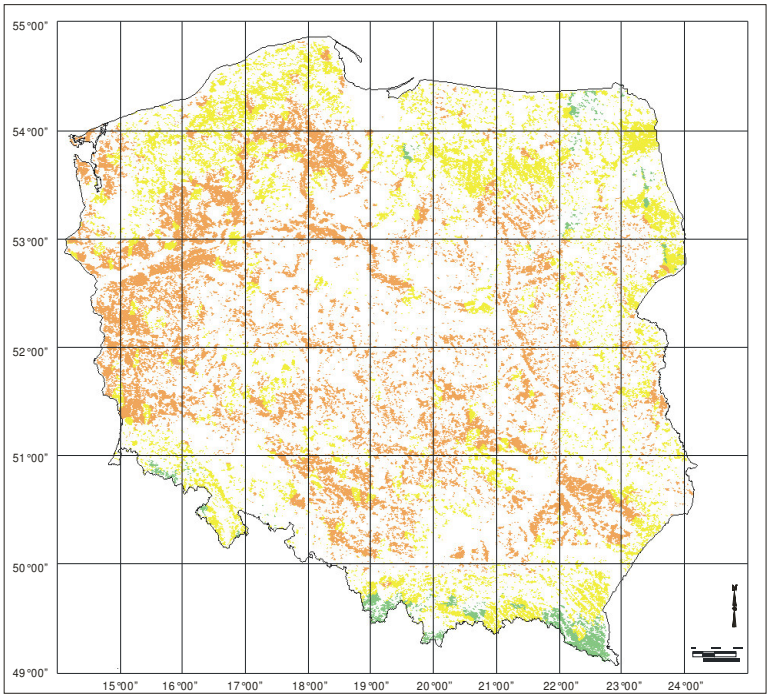


eq/ha/year

- 0 - 200 (0%)
- 200 - 500 (69.7%)
- 500 - 1000 (29.7%)
- 1000 - 2000 (0.5%)
- > 2000 (0%)

Critical loads of nutrient nitrogen

2005



eq/ha/year

- 0 - 200 (0%)
- 200 - 500 (55.1%)
- 500 - 1000 (40.8%)
- 1000 - 2000 (4.1%)
- > 2000 (0%)