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CRITICAL LOADS AND EXCEEDANCES FOR EUTROPHICATION AND ACIDIFICATION FOR FLEMISH FORESTS

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Abstract

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Critical loads were estimated for over more than 1400 receptors supporting forest vegetation in northern Belgium using simple mass balance method. Necessary data were derived from old historical soil database, recent data from forest surveys, meteo data, level I and II plots and regional studies concerning elemental sequestration in woody biomass. Deposition estimates were performed with the OPS–model, which had been validated with deposition measurements of N and S in 6 level II plots over the period 1994–1998. In addition, an edge enhancement factor was calculated to account for enhanced deposition in plots, situated in forest edges.

Magnitude of the critical loads depended on the criteria used for acceptable leaching of acidity and nitrogen. For eutrophying nitrogen, critical loads were related to protection of shallow groundwater for nitrate leaching or to conservation of floral composition. For acidifying nitrogen and sulphur, critical loads were related to criteria preventing root damage from Al toxicity (mol Ca/Al = 1) and further acidification of the soil profile (ANC = 0).

The study revealed that demands to conserve species composition and prevent further soil acidification are the sternest, followed by requirements to prevent nitrate leaching to contaminating groundwater and impairing root systems. Deciduous forest ecosystems were less vulnerable to nitrate leaching than coniferous sites. Emission reduction strategies must especially be aimed towards reducing ammonia emissions being the main cause of acidification and eutrophication in Flemish forests.

Aims

Critical loads were estimated for over more than 1400 receptive points supporting forest vegetation in Flanders using simple mass balance method. For eutrophying nitrogen, critical loads were related to protection of shallow groundwater for nitrate leaching or to conservation of floral composition. For acidifying nitrogen and sulphur, critical loads were related to criteria preventing root damage from Al toxicity and further acidification of the soil profile.

Material and methods

Necessary data were derived from an old historical soil database, recent data from forest surveys, meteo data, level I and II plots and regional studies concerning elemental sequestration in woody biomass. The acceptable leaching of acidity ($ANC_{le(crit)}$) was determined by (1) a critical Bc/Al ratio of 1 for all tree species and (2) avoiding further decrease of the acid neutralising capacity (ANC = 0). The acceptable leaching loss of nitrate was calculated from (1) threshold values preventing shifts in vegetation composition (100 mol_c N (De Vries, 1996) and 6 kg N (Hall, 2001)) and (2) EU quality target values (25 ppm NO_3) or drinking–water standards (50 ppm NO_3) preventing nitrate contamination of shallow ground water.

Deposition estimates were performed using the Operational Priority Substances (OPS) model (Van Jaarsveld, 1995), which had been validated by deposition measurements of N and S in 6 level II plots over the period 1993–1998. In addition, an edge enhancement factor was calculated to account for enhanced deposition in plots, situated in forest edges.

Results and conclusions

Magnitude of the critical loads depended on the considered effects induced by eutrophication and acidification. The study revealed that demands to conserve species composition and to prevent further soil acidification were the most stringent, with critical loads being exceeded in all receptive points (Table 1). Meeting deposition targets for preventing dam-

T a b l e 1. Overview of median critical loads and exceedances for deciduous and coniferous forest according to applied criterion (non–calcareous soils)

Effect	Criterion	Critical load [eq ha^{-1} jaar^{-1}]		Exceedance [eq ha^{-1} jaar^{-1}]		% exceedance (for 1425 receptive points)	
		deciduous	*coniferous*	*deciduous*	*coniferous*	*deciduous*	*coniferous*
–acidification							
Root damage	–BC/Al = 1	2700	3100	830	1100	86	95
Base status	–ANC = 0	1500	1500	2100	2700	100	100
–eutropying nitrogen							
Floral composition	1.4 kg N	1100	710	1800	2600	100	100
	6 kg N	1700	1200	1200	2100	99	100
Nitrate infiltration	25 ppm NO_3	2900	1800	60	1600	53	99
Shallow ground water	50 ppm NO_3	4900	2900	–2000	510	12	69

age to root systems will be not sufficient for preventing changes in floral composition and counteracting further soil acidification.

Exceedances were the highest in western and northern parts of Flanders with lowest CL (sandy soils) and with excessive ammonia deposition.

It was concluded that critical loads related to nitrate contamination of shallow ground water were less exceeded at deciduous sites. Calculations indicated that 53% of the deciduous plots received atmospheric nitrogen deposition in excess of their CL compared to 99% at coniferous sites. This difference was attributable to:

- Higher critical loads at deciduous sites due to 1. better dilution of nitrates in the soil water because of lower canopy evaporation 2. higher immobilisation of N in woody biomass and 3. higher denitrification rates due to location on richer and wetter soils.
- Higher depositions at coniferous sites due to more efficient canopy scavenging (> 20%) and location nearby animal farms.

Emission reduction strategies must especially be aimed towards reducing ammonia emissions being the main cause of acidification and eutrophication in Flemish forests.

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