BELGIUM (Wallonia)

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Mapping procedure Wallonia

Digitized maps with a total of 1900 ecosystems were overlaid by a 5×5 km^2 grid to produce the resulting maps for coniferous, deciduous and mixed forests in Wallonia.

In Wallonia, the critical value given for a grid cell represents the average of the critical values weighted by their respective ecosystem area (coniferous, deciduous or mixed forests).

Calculation methods and results Wallonia

Forest soils

Calculation methods

Critical loads for forest soils were calculated according to the method as described in UBA (1996) and Manual for Dynamic Modelling of Soil Response to Atmospheric Deposition (2003):

$CL_{max}(S) = BC_{we} + BC_{dep} - BC_u - ANC_{le(crit)}$
$CL_{max}(N) = N_i + N_u + CL_{max}(S)$
$CL_{nut}(N) = N_i + N_u + N_{le} + N_{de}$
$ANC_{le(crit)} = -Q_{le}\ ([Al^{3+}] + [H^+] - [RCOO^-])$

where:

$[Al^{3+}] = 0.2$ eq/m^3
$[H^+]$ = concentration of $[H^+]$ at critical pH (see Table BE-2).
$[RCOO^-]$= 0.044 mol$_c$/molC × DOC$_{measured}$ (see Table BE-2)

The equilibrium K = [Al^{3+}]/[H$^+$]^3 criterion

The Al^{3+} concentration was estimated by 1) experimental speciation of soil solutions to measure rapidly reacting aluminium, *Alqr* (Clarke et al., 1992) ; 2) calculation of Al^{3+} concentration from *Alqr* using the SPECIES speciation software. The K values established for 10 representative Walloon forest soils (table BE-3) were more relevant than the gibbsite equilibrium constant recommended in the manual (UBA, 1996). The difference between the estimated Al^{3+} concentrations and concentration that causes damage to root system (0.2 eq Al^{3+}/m^3 ; De Vries et al., 1994) gives the remaining capacity of the soil to neutralise the acidity.

The Tables BE-1 and BE-2 summarise the values given to some of the parameters.

Table BE-1. *Aluminium equilibrium and weathering rates calculated for Walloon soils.*

Sites	Soil types	K	BCwe eq ha^{-1} a^{-1}
Bande (1-2)	Podzol	140	610
Chimay (1)	Cambisol	414	1443
Eupen (1)	Cambisol	2438	2057
Eupen (2)	Cambisol	25	852
Hotton (1)	Cambisol	2736	4366
Louvain-la-Neuve (1)	Luvisol	656	638
Meix-dvt-Virton (1)	Cambisol	2329	467
Ruette (1)	Cambisol	5335	3531
Transinne (1)	Cambisol	3525	560
Willerzie (2)	Cambisol	2553	596

(1) deciduous or (2) coniferous forest

Table BE-2. *Constants used in critical loads calculations in Wallonia*

Parameter	Value
N_i	5.6 kg N ha^{-1} a^{-1} coniferous forest
	7.7 kg N ha^{-1} a^{-1} deciduous forest
	6.65 kg N ha^{-1} a^{-1} mixed forest
$N_{le\ (acc)}$	4 mg N L^{-1} for coniferous forest
	6,5 mg N L^{-1} for deciduous forest
	5,25 mg N L^{-1} for mixed forest
N_{de}	Fraction of ($N_{dep} - N_i - N_u$)

Soils

In Wallonia, 47 soil types were distinguished according to the soil associations map of the Walloon territory, established by Maréchal and Tavernier (1970). Each ecosystem is characterised by a soil type and a forest type.

Weathering rate

In *Wallonia*, the base cation weathering rates (BC_{we}) were estimated for 10 different representative soil types (table BE-1) through leaching experiments. Increasing inputs of acid were added to soil columns and the cumulated outputs of lixiviated base cations (Ca, Mg, K, Na) were measured. Polynomial functions were used to describe the input-output relationship. To estimate BC_{we}, an acid input was fixed at 900 eqH$^+$ ha^{-1} a^{-1} in order to keep a long term balance of base content in soils.

$N_{le} = Q_{le} \cdot cN_{(acc)}$

The flux of drainage water leaching, Q_{le}, from the soil layer (entire rooting depth) was estimated from lysimetric measurement on 10 different representative soil types (Table BE-3) (Catholic University of Louvain, 2005).

Table BE-3. *Flux of drainage water through entire root layer Qle, concentration of organic acids ($RCOO^-$) and pH critique in Walloon soils.*

Sites	Soil types	$RCOO^-$ eq/m^3	pH crit	Q_{le} m a^{-1} (at 0.5m)
Bande (1-2)	Podzol	0.103	3.95	0.138
Chimay (1)	Cambisol	0.038	4.10	0.046
Eupen (1)	Cambisol	0.105	4.36	0.045
Eupen (2)	Cambisol	0.094	3.70	0.045
Hotton (1)	Cambisol	0.031	4.38	0.108
Louvain-la-Neuve (1)	Luvisol	0.099	4.17	0.039
Meix-dvt-Virton (1)	Cambisol	0.037	4.35	0.049
Ruette (1)	Cambisol	0.007	4.47	0.045
Transinne (1)	Cambisol	0.078	4.41	0.053
Willerzie (2)	Cambisol	0.038	4.37	0.044

(1) deciduous; (2) coniferous forest

Precipitation surplus

The actual methodology can not be compared with the previous methodology because the definition of the precipitation surplus is modified. In the previous methodology the surplus was defined as the total amount of water leaving the root zone (total run off). In the present methodology the precipitation surplus doesn’t take into account of the horizontal flux but considers only the amount of water percolating through the root zone (mm a^{-1}). In forest growing on abrupt locations, a non negligible fraction of the precipitation runs off on the top soil.

Net growth uptake of base cations and nitrogen

In Wallonia, the net nutrient uptake (equal to the removal in harvested biomass) was calculated using the average growth rates measured in 25 Walloon ecological territories and the chemical composition of coniferous and deciduous trees. The chemical composition of the trees (*Picea abies, fagus sylvatica, Quercus robus*, *Carpinus betulus*) appears to be linked to the soil type (acidic or calcareous) (Duvigneaud et al., 1969; Bosman et al., 2001; Unité des Eaux et Forêts, May 2001).

The net growth uptake of nitrogen ranges between 266 and 822 eq ha^{-1} a^{-1}, while base cations uptake values vary between 545 and 1224 eq ha^{-1} a^{-1} depending on trees species and location in Belgium.

Base cations deposition

In *Wallonia*, actual throughfall data collected in 8 sites, between 1997 and 2002, were used to estimate BC_{dep} parameters. The marine contribution to Ca^{2+}, Mg^{2+} and K^+ depositions was estimated using sodium deposition according to the method described in UBA (1996). The BC_{dep} data of the 8 sites was extrapolated to all Walloon ecosystems as a function of the location and the tree species.

Results

In Wallonia, The highest CL values were found in calcareous soils under deciduous or coniferous forests. The measured release rate of base cations from soil weathering processes is high in these areas, and thus provides a high long-term buffering capacity against soil acidification.

More sensitive forest ecosystems are met on sandy-loamy or loamy gravelly soils. The lowest *CLnutN* values were found in Ardennes. In this zone, *Picea abies L.Karts.* frequently show magnesium deficiency symptoms, which have been exacerbated by atmospheric pollution (Weissen et al., 1990).

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