Simple Mass Balance (SMB) Critical Loads – UK status and application

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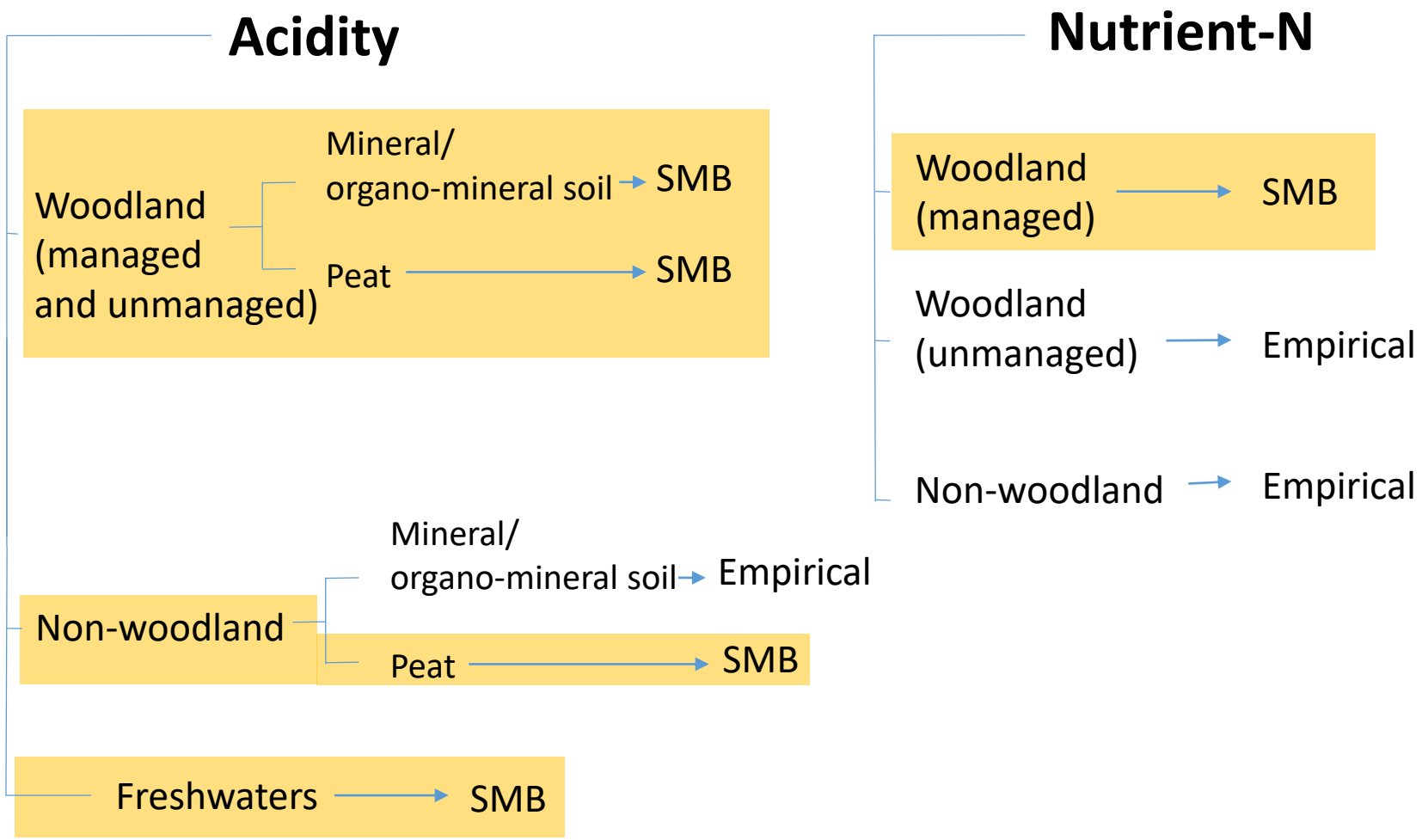
CL mapping methods in the UK



Acidity CL for woodland habitats

$$CLA = ANC_w - ANC_{le(crit)}$$

where:

ANC_w = acid neutralising capacity (ANC) generated by base cation weathering

$ANC_{le(crit)}$ = critical leaching of ANC

	Mineral/organo-mineral soil	Organic soils
Chemical criteria	Ca:Al=1	Critical pH 4.4
Gibbsite constant (m^6 eq^{-2})	950 – mineral soil 100 - organo-mineral	-
Calcium deposition	CBED 1998-2000	-
Calcium weathering	ANC_w * calcium correction factor	zero
Base cation contribution from fertilizer (keq ha^{-1} $year^{-1}$)	Conifer - 0.08 Broadleaf - 0.177 (organo-mineral soil only)	0.417
Calcium uptake values (keq ha^{-1} $year^{-1}$) for managed woodland during harvesting/removal	Conifer – 0.16 Broadleaf Ca-rich soil – 0.29 Broadleaf Ca-poor soil – 0.195	-

Acidity CL for peat soils

Since 2003:

$CLA = Q * [H^+]$

where:

Q = runoff in metres (mean 1km values for 1941-1970)

$[H^+]$ = critical hydrogen ion concentration equivalent to pH 4.4

- Applicable to upland and lowland acid peat soils, but not to the lowland, arable fen peats
- CL for the lowland arable fen areas are 4.0 keq ha^{-1} $year^{-1}$ (the top of CL empirical range for soils) and applied to all arable areas in LCM2000

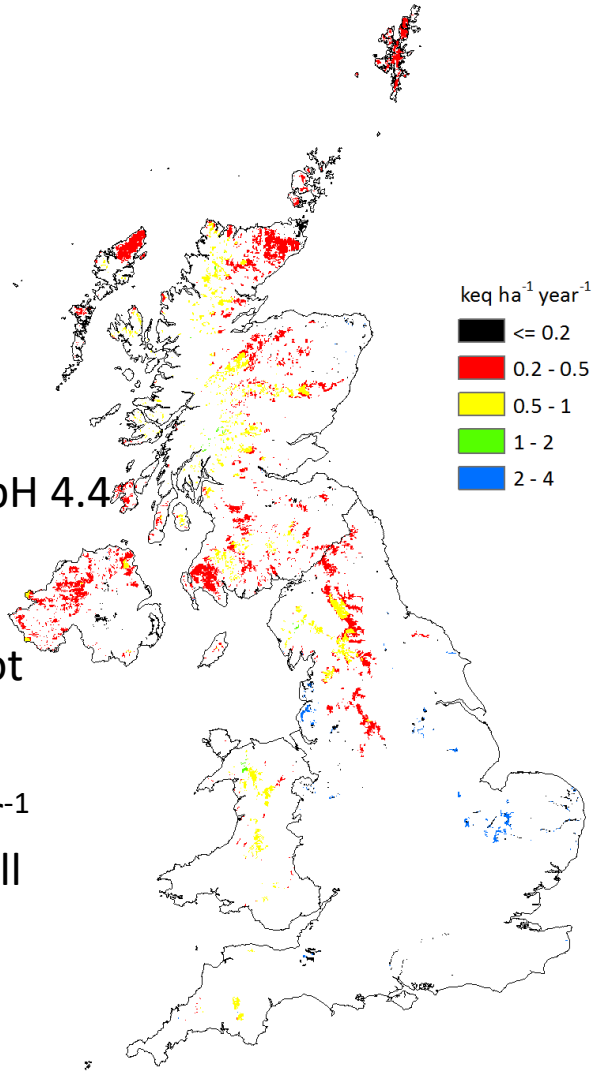


Figure 1 Acidity critical loads for 1km squares dominated by peat soils.

Acidity CL for freshwaters

Since 1994:

The catchment-based First-Order Acidity Balance model (Henriksen & Posch, 2001)

- UK version assumes N sink average over the whole catchment.
    - No terrestrial nitrate leaching (Ndep <= CLminN)
    - Terrestrial nitrate leaching occurs (Ndep > CLminN)
- Currently applied to 1752 sites across the UK
- Seasalts screening - all sites with non-marine base cation conc. < 20 µeq l^{-1} were removed from the mapping data set
- Nested catchments - a “net” or “unique” catchment area for each site to avoid any double-counting of habitat area
- ANC_{crit} - value of 20 µeq l^{-1}

Nutrient-N CL for managed woodland

$$\mathbf{CLnutN = N_u + N_i + N_{de} + N_{le(acc)}}$$

where:

N_u = nitrogen uptake (removal by harvesting of trees)

N_i = nitrogen immobilisation

N_{de} = denitrification

$N_{le(acc)}$ = acceptable level of nitrogen leaching

- Data for N_u, N_i and N_{de} are the same as those used in the derivation of CLminN for managed woodlands
- Fixed values for $N_{le(acc)}$ have been defined for application to managed conifers and managed broadleaved woodland separately:
  - Managed conifers: 4 kg N ha^{-1} $year^{-1,}$ (Emmett et al., 1993; and Emmett & Reynolds, 1996)
  - Managed broadleaf: 3 kg N ha^{-1} $year^{-1}$ (Williams et al., 2000)

Uncertainties associated with SMB approaches in the UK

- N leaching

$$N_{le(acc)} = Q * [N]_{acc}$$

where:

Q = precipitation surplus (m^3 ha^{-1} $year^{-1}$)

$[N]_{acc}$ = acceptable N concentration (eq m^{-3})

- Denitrification

  - spatiotemporal variability and the difficulty of measuring the denitrification flux to N_2 (dinitrogen)

- N fixation

  - not generally considered as part of the steady-state mass balance for woodlands, but N fixation by alder (*Alnus* spp.) may be significant in some types of wet woodland

- Weathering rates

  - Measurement methods on different soil types and uncertain soil maps

THANK YOU