



PART II National Focal Centre Reports : France

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CCE STATUS REPORT 2008

**CRITICAL LOAD,
DYNAMIC MODELLING AND
IMPACT ASSESSMENT
IN EUROPE**

Netherlands Environmental Assessment Agency



**Critical Load, Dynamic Modelling and
Impact Assessment in Europe**

CCE Status Report 2008

Critical Load, Dynamic Modelling and Impact Assessment in Europe

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Convention on Long-range Transboundary Air Pollution

ICP M&M Coordination Centre for Effects

Critical Load, Dynamic Modelling and Impact Assessment in Europe

CCE Status Report 2008

Report 500090003

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Modelled critical loads and dynamic modelling data

The objectives of this call for data were to submit updated critical loads and to provide time series of modelled chemical variables for different deposition scenarios, i.e. dynamic modelling results. In 2005, the French National Focal Centre (NFC) provided updated critical load values for nitrogen (acid and nutrient) and sulphur as well as dynamic modelling results (Probst et al., 2005). In 2007, the French NFC: (1) tested the updated critical concentrations for the calculation of critical loads of nutrient nitrogen proposed by the Coordination Centre for Effects (CCE) and, (2) sent data for dynamic modelling (Probst and Legu  dois, 2007). In comparison with 2005, the only major change was the removal of coastal ecosystems (EUNIS code B1.4) from the dynamic modelling database as, for those ecosystems, the empirical critical loads were more consistent with observations (Probst et al., 2005).

For the 2008 call, the main differences concerned the structure of the database used for submission and the application of more conservative rules for the calibration of the dynamic model. To convert the 2007 data into the 2008 database structure we used the append queries provided by the CCE with VSD-Access version.

With the new calibration rules we had to change the values of the weathering rates (*Cawe*, *Mgwe*, *Kwe* and *Nawe*) and the base saturation (*bsat*) for calcareous soils in order to enable the dynamic model to calibrate. For these highly weatherable soils (weathering rates for base cations > 2,500 eq. ha⁻¹.a⁻¹), we had to increase the base saturation values to 0.9 and 0.99 for sites with weathering rates at 2,500 and 7,500 eq. ha⁻¹.a⁻¹ respectively. These adjustments were not sufficient for all the calcareous sites, so we also decreased the weathering rate down to 2,500 eq. ha⁻¹.a⁻¹. As we had no detailed information about the new calibration rules it was difficult to follow strict guideline for these number changes.

The 2008 results for dynamic modelling were significantly different from the 2007 results (Wilcoxon rank test performed on all the modelled variables *cAl*, *cBc*, *pH*, *ANC*, *bsat*, *CNrat* and *cN*, *n* = 244,290 and *p* < 3 %). Because of the way VSD-Access is built, it was not possible to assess the specific effect, on one side, of the value changes for base saturation and weathering rates, and, on the other side, of the modification of the deposition scenarios. However these changes shouldn't affect the target loads results as the concerned soils have a high buffering capacity.

Calculation method

The data were computed following the method used in 2005 by the French NFC (Probst et al., 2005) which is in accordance with the Mapping Manual (UBA, 2004). For steady state critical loads, the Simple Mass Balance (SMB) model (Sverdrup and de Vries, 1994) was applied on the soil top-layer (0–20 cm). VSD (Posch et al., 2003) was used for dynamic modelling. For soils with high buffering capacity, the results obtained with VSD show significant differences with more complex models (Probst et al., 2003; Probst et al., 2005). However VSD allows better consistency for impact assessment at large scale like across the European territory (Probst et al., 2005).

Data sources

Table FR-1: Sources for the parameters used in the critical load and dynamic modelling.

Variable	Explanation	Unit	Data sources or settings
<i>crittype</i> , <i>critvalue</i>	Chemical criterion used for critical loads - for acidity and corresponding critical value		See Table FR-3.
<i>CNacc</i>	Acceptable (critical) N concentration	meq.m ⁻³	Derived from the acceptable nitrogen leaching (0 for plain deciduous forest; 50 for plain coniferous forest; 100 for mountain forest ecosystems — Party and Thomas, 2000) and the amount of water percolating through the root zone.
<i>Cadep</i> , <i>Mgdep</i> , <i>Kdep</i> , <i>Nadep</i>	Total deposition of base cations	eq.ha ⁻¹ .a ⁻¹	RENECOFOR network measurements (ICP forest level I) extrapolated at the national scale (Ulrich et al., 1998; Croisé et al., 2002)
<i>Cawe</i> , <i>Mgwe</i> , <i>Kwe</i> , <i>Nawe</i>	Weathering rate of base cations	eq.ha ⁻¹ .a ⁻¹	PROFILE simulations (Party, 1999)
<i>Caup</i> , <i>Mgup</i> , <i>Kup</i> , <i>Naup</i>	Net growth uptake of base cations	eq.ha ⁻¹ .a ⁻¹	Calculated from base cation concentrations in vegetation (Party, 1999) and net uptake of biomass by harvesting (national survey, see IFN, 2002)
<i>Nupt</i>	Net growth uptake of nitrogen	eq.ha ⁻¹ .a ⁻¹	Calculated from nitrogen concentration in vegetation (Party and Thomas, 2000) and net uptake of biomass by harvesting (national survey, IFN, 2002)
<i>fde</i>	Denitrification fraction	eq.ha ⁻¹ .a ⁻¹	Adapted from the Mapping Manual data (UBA, 2004) for French soil conditions (see Table FR-2)
All soil parameters			From RENECOFOR network (ICP forest level I) data (Brêthes et al., 1997) and CCE network data (Badeau and Peiffer, 2001). See Table FR-4.

Table FR-2: Setting of the values for the denitrification fraction (adapted from UBA, 2004).

Soil type	f_{de}
Non hydromorphic soil	0.05 to 0.2
Hydromorphic silt or sandy soil	0.3
Hydromorphic clay	0.4
Peat soil and marshes	0.5

Table FR-3: Values for the chemical criterion and the critical limit used in the calculation of the critical loads for acidity.

Soil and bedrock type	Chemical criterion	<i>crittype</i>	<i>critvalue</i>
Soft calcareous sediments	Molar [Al]/[BC]	1	1,2
Hard calcareous sediments	Molar [Al]/[BC]	1	1,2
Soft acid sediments			
Sands	pH	4	4,6
<i>Sandy silex formations</i>	pH	4	4,6
<i>Others</i>	Molar [Al]/[BC]	1	1,2
Hard acid sediments			
Schists	pH	4	4,6
<i>Sandstones</i>	pH	4	4,6
<i>Others</i>	Molar [Al]/[BC]	1	1,2
Metamorphic rocks			
Acid granite	pH	4	4,6
Others	Molar [Al]/[BC]	1	1,2
Volcanic rocks	Molar [Al]/[BC]	1	1,2

Table FR-4: Value of the soil parameters (from Brêthes et al., 1997).

Variable	Explanation	Units	Min	Max	Median
<i>bulkdens</i>	Bulk density	g.cm ⁻³	0.732	1.400	0.915
<i>cOrgacids</i>	Total concentration of organic acids	eq.m ⁻³	0	0.02436	3.48 × 10 ⁻⁵
<i>CEC</i>	Cation exchange capacity	meq.kg ⁻¹	15	380	140
<i>bsat</i>	Base saturation	-	0.12	0.99	0.90
<i>Cpool</i>	Amount of carbon in the topsoil	g.m ⁻²	3920	13 800	9 878
<i>CNrat</i>	C/N ratio on the topsoil	g.g ⁻¹	12	28	15

The total concentration of organic acids in soil solution is calculated from DOC (Dissolved Organic Carbon) which is estimated from pH and clay content in soil layer. Due to the lack of data on partial CO₂-pressure in soil solution (*pCO₂fac*), only one value (5 at) was considered for the topsoil.

Results

Critical loads of nutrient nitrogen

The most sensitive areas for nitrogen eutrophication are located in Sologne (Centre part of France) and the Landes (SW), the northern part of Massif Central and the eastern Mediterranean area (Figure FR-1).

Modelled critical loads of nutrient N

eq.ha⁻¹.a⁻¹

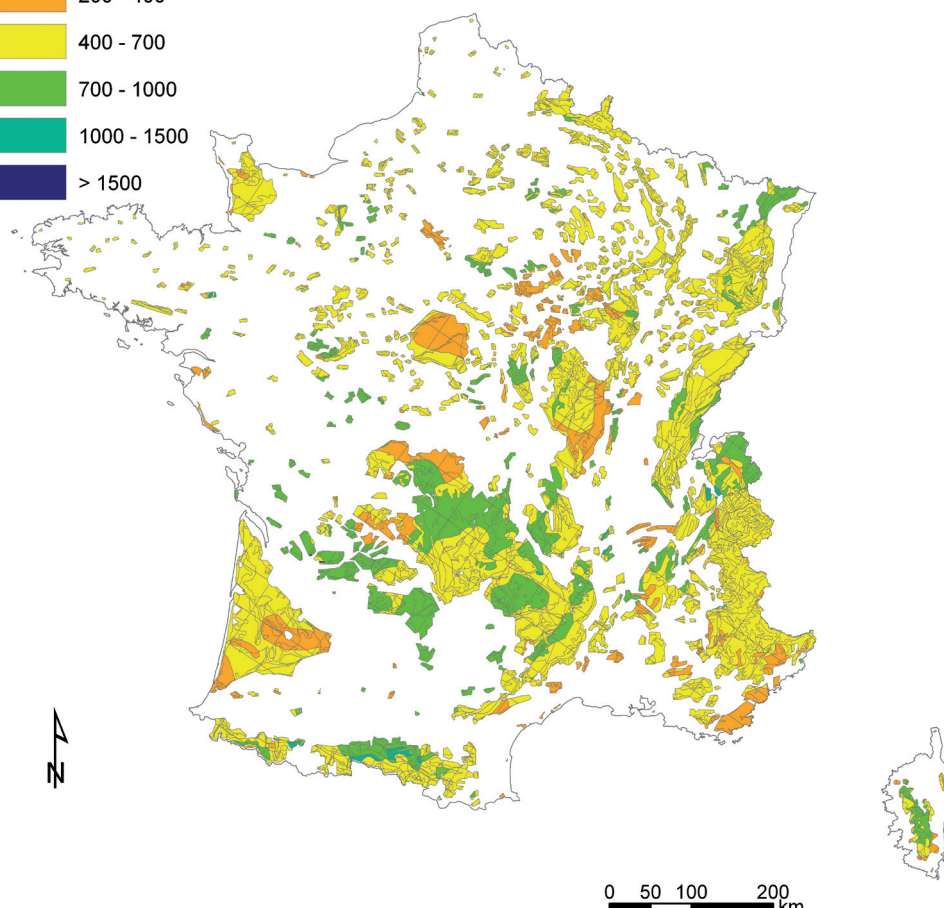
200 - 400

400 - 700

700 - 1000

1000 - 1500

> 1500

**Figure FR-1: Map of modelled critical loads of nutrient nitrogen.**

The critical loads of nutrient nitrogen show a global sensitivity of the French ecosystems. The lowest critical load values ($< 400 \text{ eq.ha}^{-1}.\text{a}^{-1}$ or $< 5.6 \text{ kgN.ha}^{-1}.\text{a}^{-1}$) represent $22,185 \text{ km}^2$ (12.5 % of the studied area). Critical load values $< 700 \text{ eq.ha}^{-1}.\text{a}^{-1}$ ($< 9.8 \text{ kgN.ha}^{-1}.\text{a}^{-1}$) represent $140,375 \text{ km}^2$ (79.2% of the studied area, i.e. forests and natural grasslands).

Critical loads of sulphur

Critical loads of sulphur were updated in 2005 (Figure FR-2) with a new computation of cations throughfall deposition, taking into account the cycle between biomass uptake and redeposition. Globally, the French ecosystems are not very sensitive to acidification by sulphur. The most sensitive areas are the Landes (SW), Sologne, some parts of the Massif Central as well as the Vosges mountains.

Modelled critical loads of sulphur

$\text{eq.ha}^{-1}.\text{a}^{-1}$

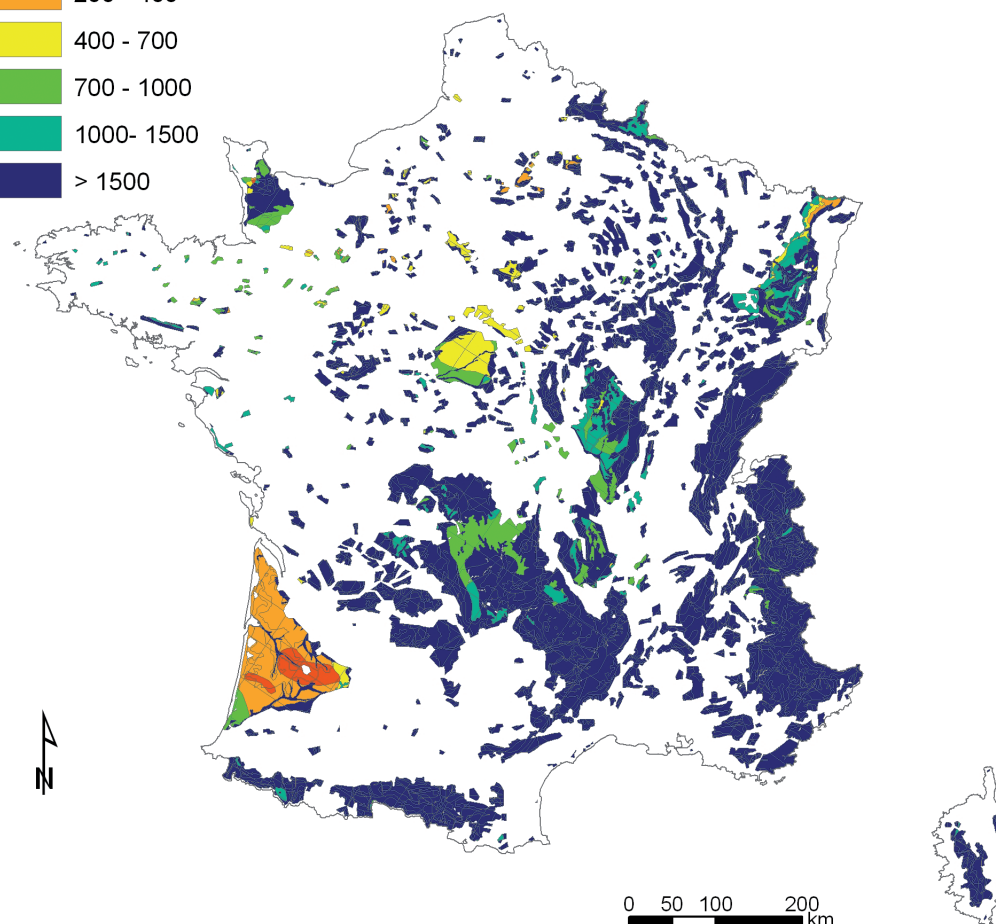


Figure FR-2: Map of the modelled critical loads of sulphur

Empirical critical loads of nutrient nitrogen

Method

The determination of empirical critical loads of nitrogen for French ecosystems was based on the method described in chapter 5.2 of the Mapping Manual (UBA, 2004). The values given in table 5.1 of the Mapping Manual (UBA, 2004) were adapted to the French terrestrial ecosystems (Party et al., 2001). The adaptation was based on: (1) the information available on the potential vegetation and the land use for each ecosystem and, (2) the adaptation rules given in table 5.2 of UBA (2004) using temperature, frost period and base cation availability estimated by expert judgement. The subsequent empirical critical loads are given in Table FR-5.

Table FR-5: Empirical critical loads, in eq.ha-1.a-1, derived for the French ecosystems (adapted from Party et al., 2001).

Potential vegetation	Land use			
	Coastal dune	Grassland	Upland meadow	Forest
Coastal dunes and heathlands	1786			
Swamps, bogs and wet heathlands	1786	714		714
<i>Quercus robur</i> dominated woodlands		1214		714
<i>Quercus-Carpinus</i> or <i>Ulmus</i> woodlands with <i>Quercus petraea</i>	1214	1214	500	857
<i>Quercus petraea</i> and <i>Q. pubescens</i> woodlands	1429	1429		1214
<i>Quercus petraea</i> , <i>Q. robur</i> or <i>pubescens</i> and <i>Q. pyrenaica</i> woodlands		1214		Per. + Bord.: 1214 SW + Nantes: 714
Mixed <i>Fagus-Quercus</i> and <i>Fagus</i> woodlands	1214	1214	500	1071
<i>Quercus pubescens</i> woodlands		K: 1789 A: 714		Corsica: 1071 Out Cors.: 1429
<i>Quercus ilex</i> woodlands	K: 1789 A: 714	K: 1789 A: 714		Corsica: 1071 Out Cors.: 1429
<i>Quercus suber</i> woodlands		714		Corsica: 1071 Out Cors.: 1429
<i>Pinus halepensis</i> and <i>P. nigra laricio corsicana</i> Mediterranean woodlands		857		1071
<i>Pinus pinaster</i> woodlands		714		500
<i>Abies</i> and mixed <i>Abies-Fagus</i> woodlands		714	714	857
<i>Picea</i> woodlands		714		714
<i>Pinus sylvestris</i> woodlands		714		500
<i>Pinus uncinata</i> and <i>P. cembra</i> woodlands		500		500
<i>Larix</i> woodlands		714		714
Alpine and subalpine grasslands			500	

K: calcareous ecosystem; A: acidic ecosystem; Out Cors.: outside Corsica; Per.+Bord.: Perigord and Bordeaux regions; SW+Nantes: South-West and Nantes regions.

Data Sources

The French ecosystem classification and map was updated in 2003 for calculation and mapping of the critical loads of acidity and nutrient nitrogen (Probst et al., 2003 ; Moncoulon et al., 2004). The map of potential vegetation was synthesised for the French territory by Party (1999) from various vegetation maps (Dupias and Rey, 1985; Houzard, 1986; Ozenda and Lucas, 1987). Land use was derived from the map of forested and grassland areas in de Monza (1989) as well as the Digital Elevation Model GTOPO30 (USGS, 1996).

Results

The most sensitive areas to nitrogen deposition are located in the Landes (SW), the eastern part of the Paris basin, the eastern part of the Massif Central as well as in the Alps (Figure FR-3). Empirical critical loads of nitrogen are higher than critical loads for nutrient nitrogen determined with the Steady State Mass Balance (SMB) model (see Figure FR-1 as well as Party and Thomas, 2000). Consequently, the sensitivity of the ecosystems is lower when derived from the empirical method. Comparatively to the SMB model, most of the ecosystems shifted to a higher critical load class with the empirical method (+ 1 class for 49 % of the ecosystems and + 2 classes for 35 % of the ecosystems).

Empirical critical loads of N

eq.ha⁻¹.a⁻¹

500 - 700

700 - 1000

1000 - 1500

> 1500

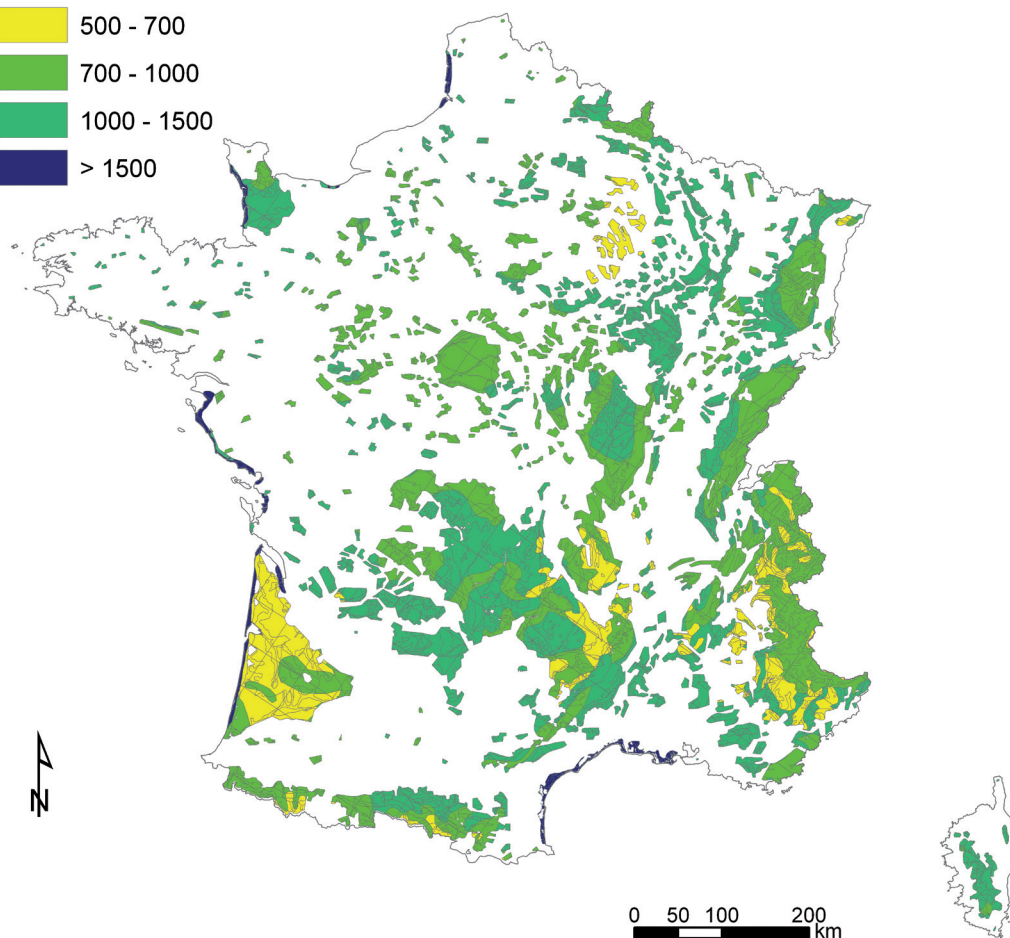


Figure FR-3: Map of the empirical critical loads of nutrient nitrogen.

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