TEXTE

58/2012

Deutsches National Focal Centre des ICP Modelling & Mapping (CLRTAP)

Berichterstattung an das Coordination Centre for Effects (CCE)

Anlage 3

Umwelt
Bundes
Amt
Für Mensch und Umwelt

| TEXTE | 58/2012

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Deutsches National Focal Centre des ICP Modelling & Mapping (CLRTAP)

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Im Auftrag des Umweltbundesamtes

UMWELTBUNDESAMT

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GERMANY

Anlage 3

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The respond of the German NFC to the Call for Contributions (CCE 2012) focus on (i) an overview of biological endpoints and (ii) application of biodiversity indices, (iv) comparison of simulation results using different sites, (v) include nature protection areas (such as NATURA 2000 areas) in model testing, (vi) review the possibilities to use EUNIS classes, habitat classes and eco-regions as a basis for regionalisation, and (viii) submit an update of the critical load database in the format of the 2011 Call for Data (in brackets are the items of the letter with the call for contributions).

Critical loads of sulphur and nitrogen for terrestrial ecosystems

Critical loads are calculated following the methods described in the Mapping Manual (ICP Modelling & Mapping 2010). New data of long-term annual means of temperature and precipitation (1980 – 2010) were available and a new approach for critical (acceptable) nitrogen concentrations could be derived. About 35 % of German territory is covered by forests and other (semi-) natural vegetation for which critical loads of acidity and nutrient nitrogen are computed (see Tab. DE-1). The German critical load database consists of 124,439 grid cells of 1*1 km^2.

Table DE-1: Selected receptors for critical load computation in Germany (“Others” are EUNIS classes with a proportion of the receptor area less than 1%)

EUNIS Code	Proportion of the receptor area [%]	Proportion of German territory [%]	EUNIS Code	Proportion of the receptor area [%]	Proportion of German territory [%]
G4.6	14,7	5,15	G4.8	3,6	1,26
G3.1C	10,2	3,57	G3.1D	3,1	1,09
G1.91	10,0	3,48	G4.71	2,0	0,71
G1.63	9,6	3,34	G1.41	2,0	0,70
G1A.16	8,8	3,08	G1.65	1,4	0,50
G1.61	8,7	3,05	G4.4	1,1	0,39
G3.42	7,8	2,74	G1.221	1,0	0,35
G1.87	5,4	1,87	Others	5,4	1,86
G1.66	5,2	1,81			

Critical Loads of Acidity, $CL_{max}(S)$ and $CL_{max}(N)$

The calculation of critical loads of sulphur and nitrogen for forest soils and other (semi-) natural vegetation was conducted according to the simple mass balance equations (equations 5.22 and 5.26) of the Mapping Manual. For base cation and chloride deposition the 3-year means (2005 – 2007) were included in order to smoothen large variations of this parameter due to meteorological influences.

The critical load calculation for each grid cell of the dataset was done by using 3 different chemical criteria (Fig. DE-1, Y-axis): the critical aluminium concentration (Al, equation 5.29), the critical base cation to aluminium ratio (Bc/Al, equation 5.31) and the critical pH-value (pH, equation 5.35). The minimum value determines the $CL_{max}(S)$ for a grid cell. In Figure DE-1 “Forellenbach” for the example the critical aluminium concentration was the most sensitive criteria.

In comparison with the 2011 data submission (CCE 2011) only small changes can be observed concerning the critical loads of acidity in terms of sulphur (Fig. DE-3) and nitrogen (Fig. DE-4). This is mainly caused by the updated long-term annual mean (1980 – 2010) of temperature and precipitation. Ecosystems with high risk for acidification (sensitivity below 1 keq ha^{-1} a^{-1}) were identified for about 20 % of receptor area.

Critical Loads of Nutrient Nitrogen, $CL_{nut}(N)$

The calculation of critical loads of nutrient nitrogen is described in detail in the Mapping Manual (equation 5.5). Different criteria and, consequently, different protection targets were used for acceptable N concentrations in soil solution for the critical load computation (Fig. DE-1, X-axis). Following the Manual (Chapter 5.3.1.2 and Table 5.7) the limit can be set by the EC target to avoid pollution of ground water (EC target). Ranges describe the sensitivity to frost and fungal diseases (Sensitivity min, Sensitivity max) or the impact on fine root biomass or length (Fine root min, Fine root max). The elevated nitrogen leaching / N saturation is given by a constant value (N le). To protect in total ecosystem functions and services named as “ecosystem integrity” (ESI) a national approach was derived. Using all available information on vegetation, soil units, and impact sensitivity a matrix was formed combining this with values for acceptable N concentrations (Fig. DE-2). Applying this approach the $CL_{nut}(N)$ reflects always the most sensitive compartment of the ecosystem (see Fig. DE-1, ESI value). The regional distribution of resulting critical loads of nutrient nitrogen is shown in Figure DE-5.

In addition to the calculation of critical loads with the steady-state mass balance approach empirical critical loads of nitrogen, $CL_{emp}(N)$, were assessed for the national dataset following the updated and reviewed values (Bobbink & Hettelingh 2011, Fig. DE-6).

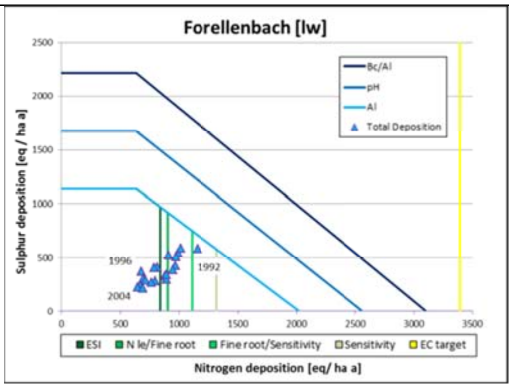


Figure DE-1: Example of Critical Load Function

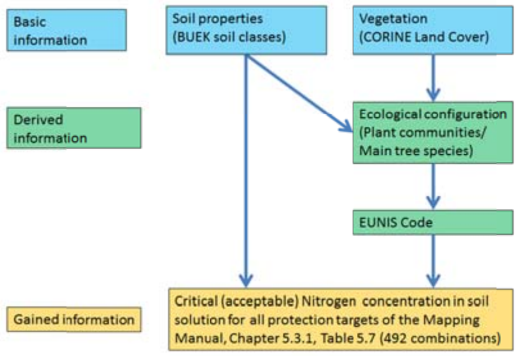


Figure DE-2: Deriving critical N concentrations

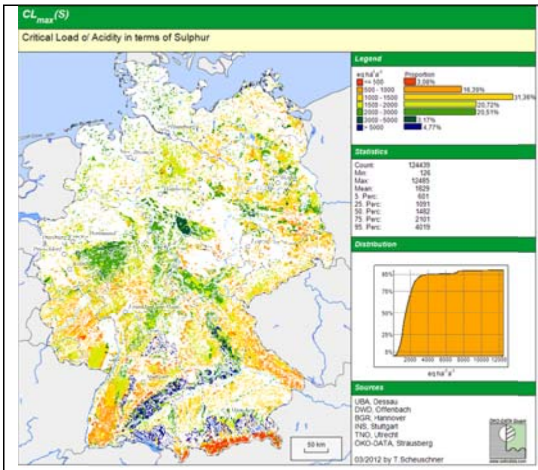


Figure DE-3: $CL_{max}(S)$

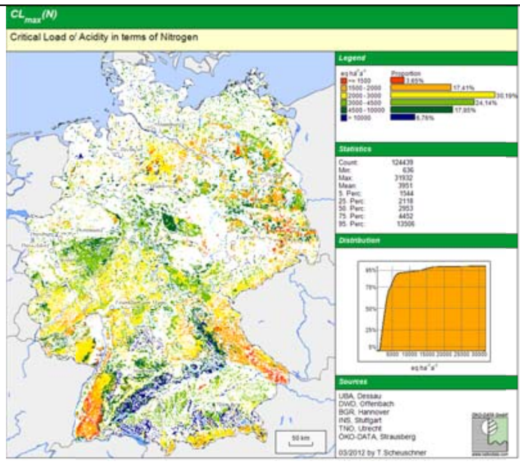


Figure DE-4: $CL_{max}(N)$

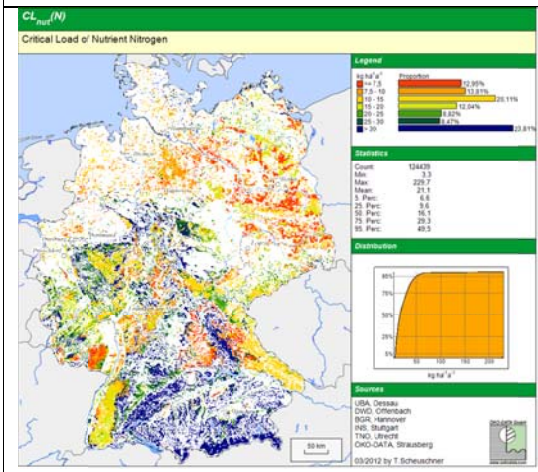


Figure DE-5: $CL_{nut}(N)$

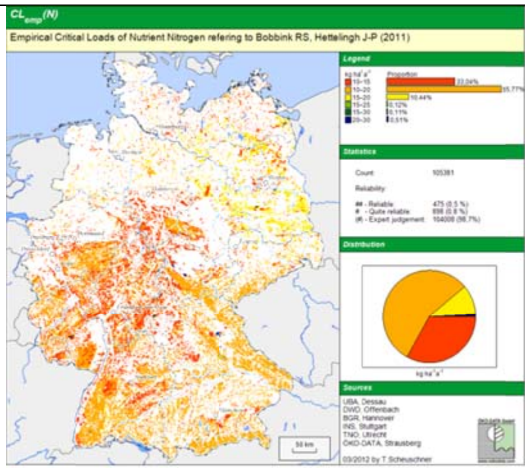


Figure DE-6: $CL_{emp}(N)$

Site-specific soil and vegetation model runs to selected plots

Description of Selected VSD+ Sites in Germany

The German NFC participates in the test run of the latest version of the VSD+ model (http://www.rivm.nl/en/themasites/cce/methods_and_models/vsd-model/index.html). The version 3.6.1.2 features a more sophisticated approach to include the matter fluxes of the litterfall. The VSD+ model was applied to 4 selected sites in Germany. Two plots are sites of the ICP Integrated Monitoring and two are managed by the ICP Forests Level II project. The 4 chosen sites represent different combinations of vegetation types and soil classes. They are also located in quite different landscapes and climate regions (see Fig. DE-7). The German sites for the VSD+ model application represent not only different ecosystems but also different environmental and soil chemical conditions. The selected plots are also located in regions with different levels of air pollution.

Input parameters

The data set for deposition was derived by data from the MAPESI project (MAPESI 2011) and measurements on the plot (ICP IM Plot Forellenbach). Even though the MAPESI project provides several time steps only the values for 2007 were chosen. These values were used to create modeled nitrogen deposition time series, where the originally given times series of the VSD+ model was the reference. The same was done for the sulphur deposition. The uptake parameters were estimated assuming only extensive land use. The values for litterfall (dry mass, C + N content) were derived from measurements but the input time series was adapted to reflect a lower litterfall flux during the forest maturing period (first 40 years).

The water content of the soil, the percolation and reduction factors of the nitrification, denitrification and mineralization was derived, applying the “MetHyd” (v1.3) tool proposed by the CCE.

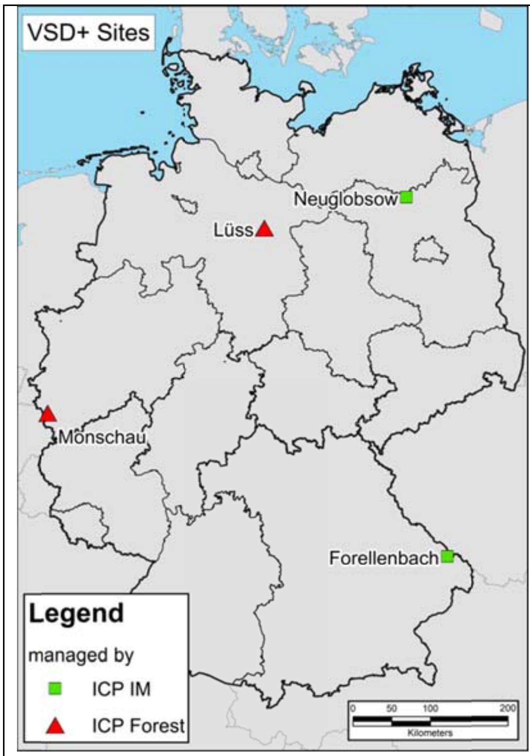


Figure DE-7: Selected sites for the VSD+ model in Germany

Decision on biological endpoints for modelling

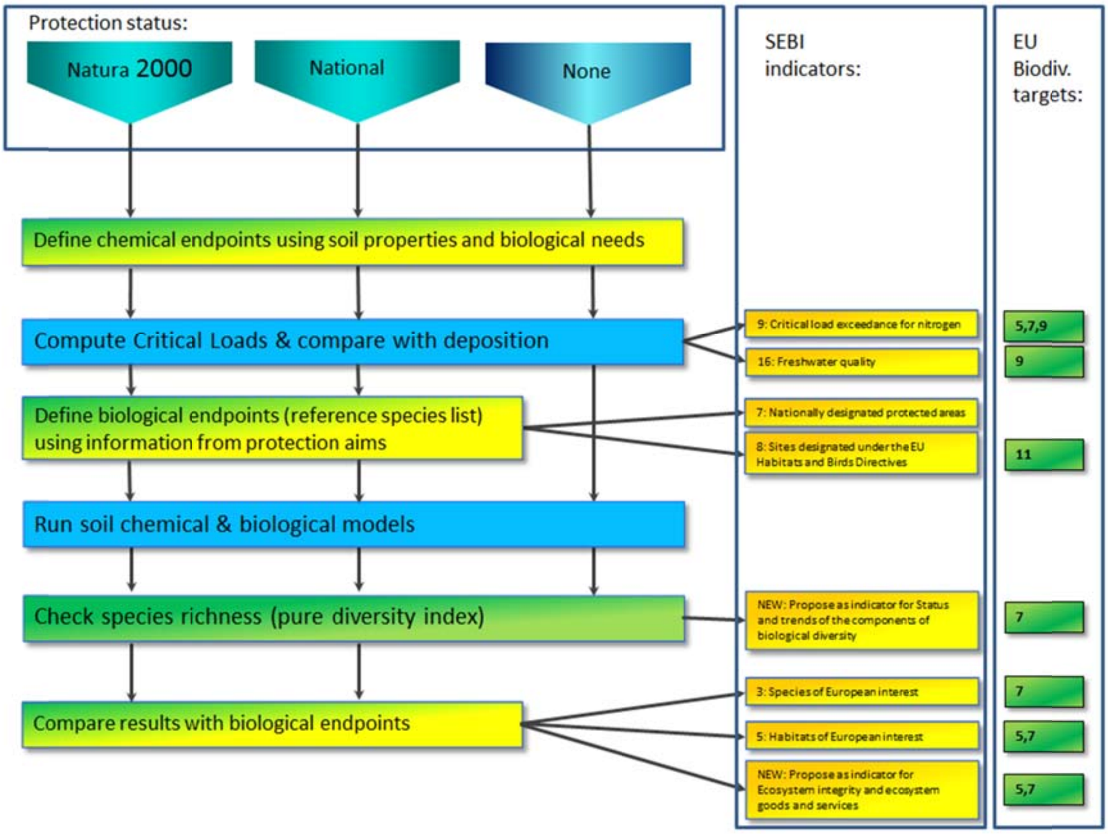


Figure DE-8: Flowchart for endpoint discussion

The way of receiving different endpoints and relating the results of soil chemical and plant response modelling to SEBI indicators and EU biodiversity targets is illustrated in Figure DE-8 and will be discussed in the following. The starting point is always the information about the occurring vegetation and the protection status of the area (or the plot that represents an area). By adding information about soil properties the first endpoints can be defined. These chemical endpoints are the well documented Critical Limits for the different chemical criterions and accepted nitrogen leaching (see chapter above). The next step (Critical Load and Exceedances) produces the first direct links to SEBI and EU biodiversity indicators.
The definition of biological endpoints depends on the protection status. The NATURA 2000 areas already define habitat types and these habitat types can be linked to plant species and/ or plant communities. Usually national approaches for nature conservation also follow the concept of defining an area and aims (biological endpoints) for the protection. If no protection is implemented the biological endpoint is vague and probably subjective so only the occurring plant species composition can be examined.
After running the soil chemical and biological models (in this case VSD+ and BERN) the results can be analyzed regarding the expected occurrence, vitality or possibility of plant species. By counting the numbers of species which occur or have a certain level of possibility a first impression of biological diversity can be shown. This result might be proposed to be a indicator for “Status and trends of the components of biological diversity”.
Much more important is the integration of the previous defined biological endpoints. These endpoints are supposed to be deterministic and an analysis regarding the similarity of these two sets of plant species should produce results for several SEBI indicators. The information about the development of the vitality of specified members of habitat type might be proposed as indicator for “Ecosystem integrity and ecosystem goods and services” (ESI).

Application soil chemical and vegetation response model

The focuses in this study was the modelling of the soil chemistry (using VSD+) and link the results to a vegetation response model (BERN). The model output for pH and the C:N was chosen to model trends of possibility for plant species and/or plant communities. Figure DE-9 show the typical results for pH and C:N ratio for the ICP IM plot “Forellenbach”. This plot has measured pH values (in soil solution) for almost 2 decades (blue X, with standard deviation bars) and various measurements of soil carbon and nitrogen. These measured values are needed for the calibration and affect the model results directly (see the increasing oscillation were the pH measurements happen).

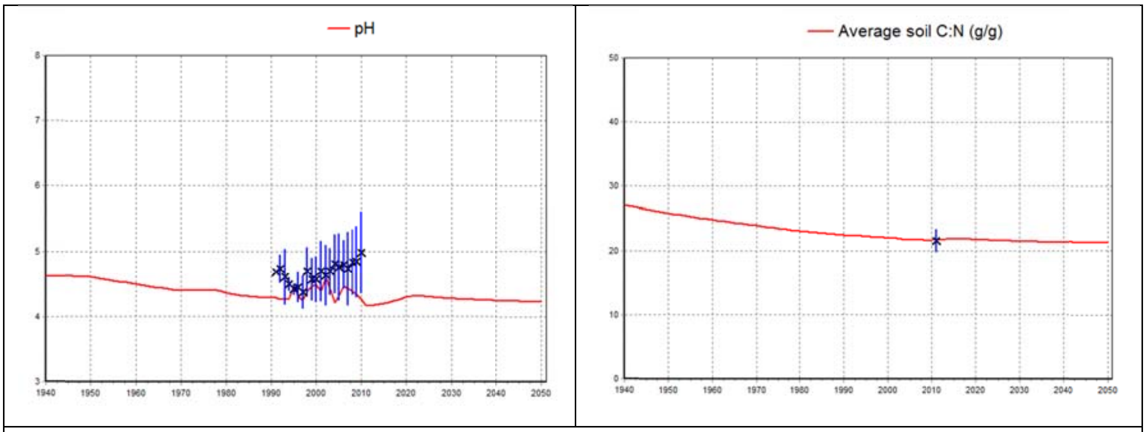


Figure DE-9: pH value (left) and C:N ratio (right) modelled with the VSD+ model on the ICP IM plot “Forellenbach”

The BERN model calculates the possibilities of plant species and communities by using fuzzy functions for 7 different site factors (soil water content, base saturation or pH, C:N ratio, climatic water balance, vegetation period, solar radiation and temperature). These functions represent the realized ecological niche under pristine or semi-natural conditions. In this study only the pH and C:N ratio was used since the focus was on highlighting the reaction of the vegetation model to the soil chemical model. The other site factors were considered as fixed on the best fitting value. Figure DE-10 shows the pure number of species with different possibility thresholds in time. A possibility below 0.1 marks a high level of plant physiological stress and great risk of damage to the plant or dysfunctions for a plant community. Values above 0.5 indicate full regeneration capabilities for plant species or plant communities. The decreasing trend of pH (4.6 to 4.4) and C:N ratio (28 to 22) till 1990 is reflected by a decreasing number of species with high possibility (650 to 480). The VSD+ modelled pH reacts quite strong in the years between 1990 and 2010 while the C:N shows only little altering. The modelled possibility of plant species reacts to this alteration (the plants with high possibilities stronger than the plants with lower values).

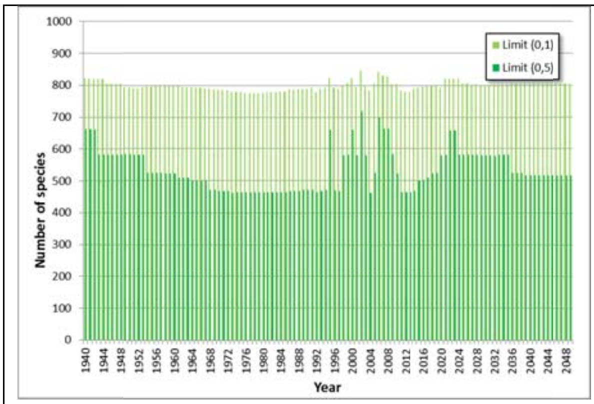
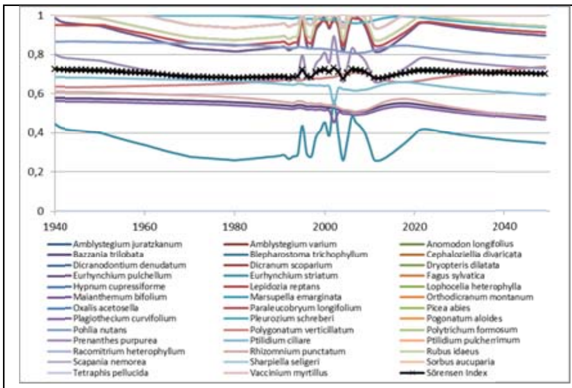


Figure DE-10: Number of plant species with possibility of 0.1 and 0.5 on the ICP IM plot “Forellenbach”

Different sets of plant species and plant communities were analysed regarding their site potential. The setup of these sets represents also different levels of information which can be provided by such study (Fig. DE-11). The first set is the combination of all plants found in different years of plant surveys at the observed area. Since this selection represents some kind of conservation aim it will be called “conservative selection”. The members of the second set of plant species are plant species which can be expected in the plant community which is directly linked to the NATURA 2000 habitat type. Such plant collection can be derived if the analysed plot is located in a nature protection area. Since this plant collection doesn’t necessarily represent the currently occurring plant species it will be called “deterministic selection”. The last set is the collection of all plant communities which are expected to be in the recent NATURA 2000 habitat type 9110.

Figure 12 shows the assemblage of the results for the other modelled plots. The ICP IM Site “Neuglobsow” was modelled twice, assuming deciduous forest and coniferous forest. Due to limitation in space only the results for “Number of species” and the “conservative selection” are documented in this report.

Figure 11 and 12 includes the Sørensen index as described in CCE Status Report, Annex 4A p53 (CCC 2011). The calculation was done by using the BERN modelled possibility and the chosen list (“conservative” or “deterministic selection”) of plant species. By including the possibility of the plant species not only the presence and absence alter the Sørensen index, but also the condition of the occurring species will affect the results.



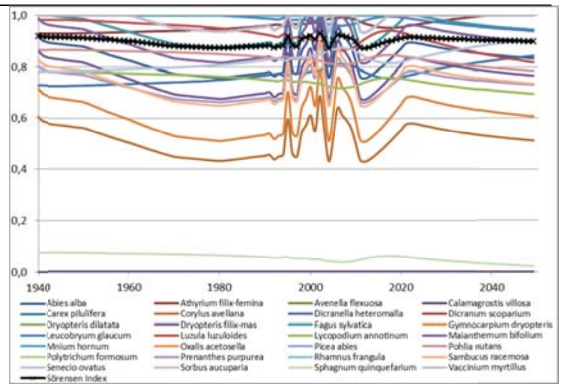
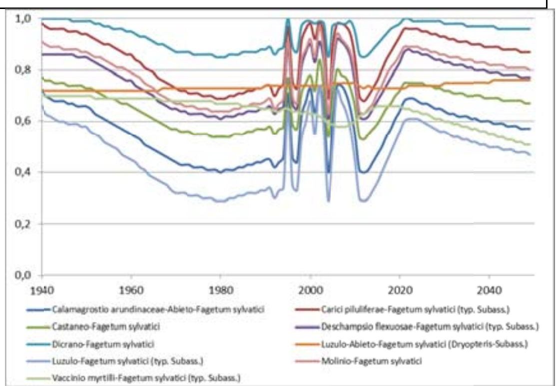
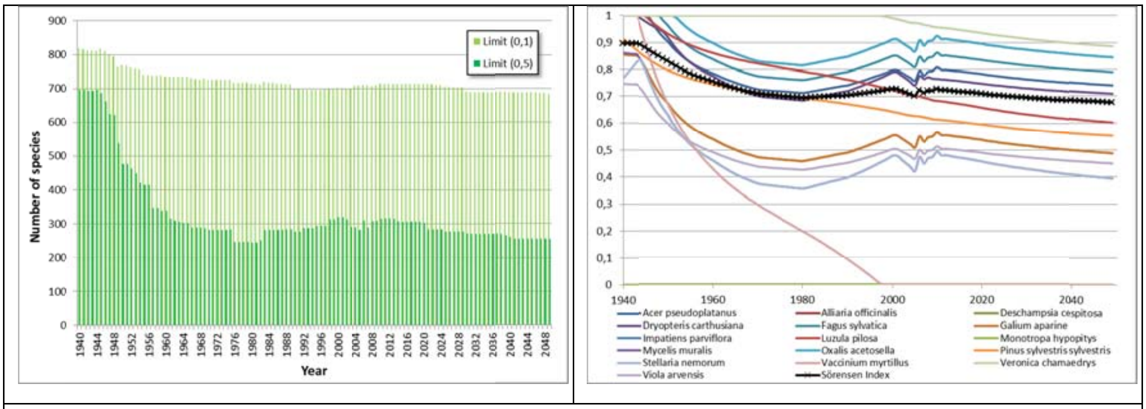
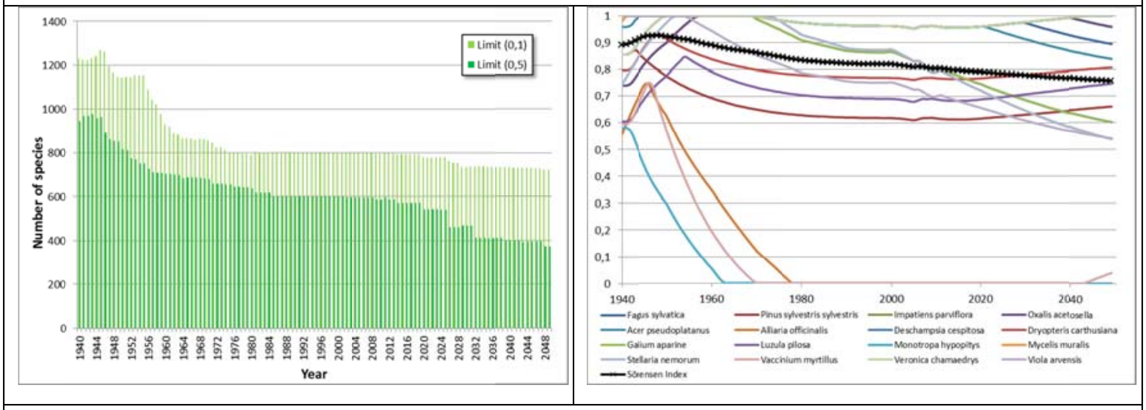


Figure DE-11: Conservative (top left), deterministic (top right)selection and plant communities of NATURA 2000 habitat 9110 for ICP IM plot Forellenbach

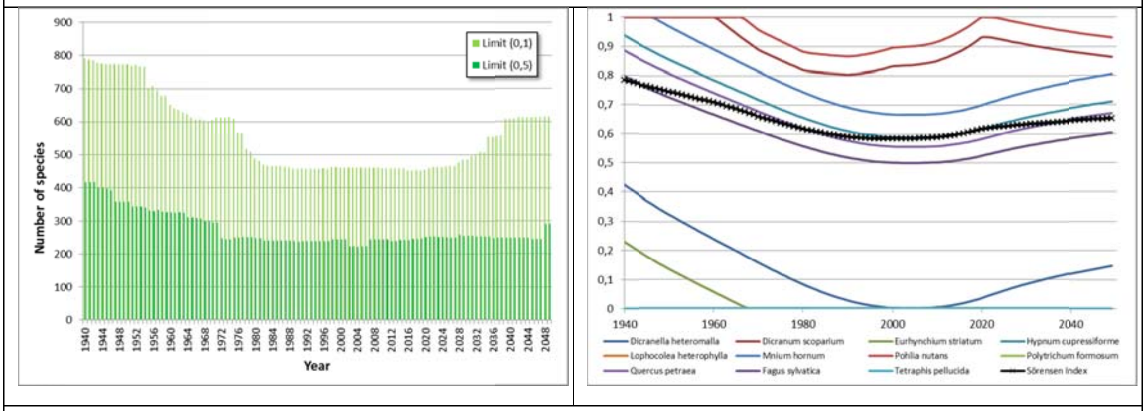




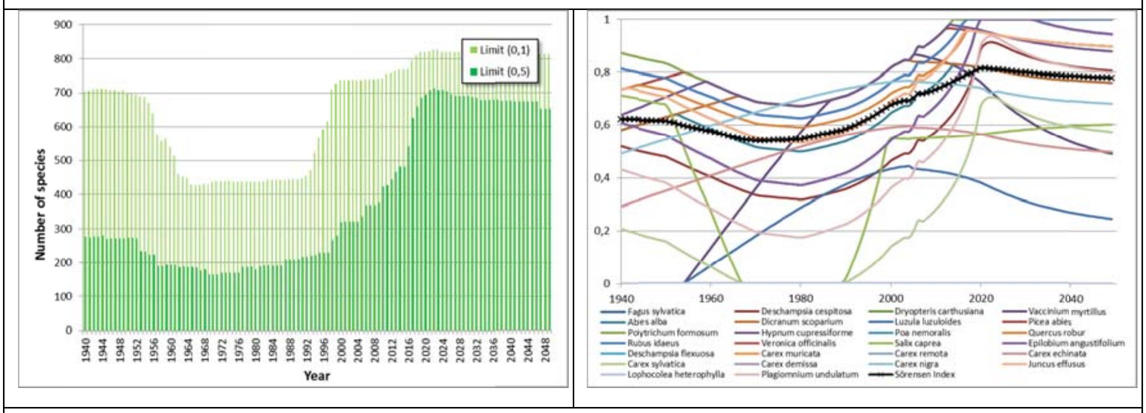
ICP Integrated Monitoring plot Neuglobsow (deciduous forest)



ICP Integrated Monitoring plot Neuglobsow (coniferous forest)



ICP Forest Level II plot Lüss



ICP Forest Level II plot Monschau

Figure 12: Number of plant species (left) and conservative selection (right) for Neuglobsow (deciduous forest), Neuglobsow (coniferous forest), Lüss and Monschau

Conclusions and recommendations

The Critical Load approach already offers a number of tools to parameterize SEBI and EU biodiversity targets. As shown in the first chapter the breakdown back to the original approach already increases the level of information for the acidity term. The adaptation of the original critical nitrogen concentration (proposed by the ICP Modelling & Mapping) by adding information of soil properties might be a useful guideline to create a harmonized approach for the Critical Load computation which automatically fit to SEBI and EU biodiversity targets.
As described in Figure DE-8 dynamic modelling of soil chemistry and plant response might be very useful to describe biodiversity targets. Obviously, the determination of the biological endpoint is the most crucial part. This report proposes a method including the information of the European wide protection approach and is focused on the distinction between protection (NATURA 2000 or National) and no protection. It follows the concept that a deterministic goal can only be defined when a target (plant species list/ plant community/ habitat type) is set. An area that is under no specific protection simply doesn't have a deterministic goal and any definition of a biological endpoint tends to be subjective, thus only a conservative analysis appears to be meaningful.

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