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A comparison of models for the assessment of critical loads on different scales of observation

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ABSTRACT

Three simple models for the assessment of exceedances of critical loads for acidity, and eutrophication due to nitrogen, were applied in northeastern Bavaria on a mapscale of about 1:25.000. In order to get some rough ideas about their validity, the results were compared with three degrees of severe stand-level diebacks in spruce stands (Picea abies L.). The areal percentages show a similar pattern, and the most simple model seems to fit best. Hence it is concluded, that the accuracy and availability of data e.g. deposition and base saturation, soil depth, and lateral transports, are often more crucial than the quality of the models itself.

1. INTRODUCTION

In 1986 Nilsson & Grennfelt (see in 1) described the concept of critical loads for the first time; the definition itself: "The highest load that will not cause chemical changes leading to long-term harmful effects on the most sensitive ecological systems" was outlining the long term effects and was so far precise in its temporal scale. Ecological systems are somehow dimensionless and can be chosen according to the specific situation. Two years later the definition of critical loads was changed a little bit: "A quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified elements of the environment do not occur according to present knowledge". Now it is more open to all kind of temporal and spatial scales, which on the one hand has the advantage of a wider use of this evaluation concept; but on the other hand the applicants and modifier of this concept must define their own and relevant scales, also depending on the resolution of the data (2).

2. MATERIAL AND METHODS

Up to now a distinction was made among three types of critical loads calculations (see in 1): level O (= use of existing data to assign critical load classes to ecosystems based on ecosystem sensitivity); level 1 (= steady state modelling, divided into a water chemistry method and a mass balance method); and level 2 (= dynamic modelling). This classification only shows the degree of resolution in time and space. Their adequacy for specific loads, receptors, data bases and other purposes (e.g. specific locations, time horizons of prognosis) can not be recognised itself.

With the following examples three model conceptions (two level 1, one level 0) are applied and compared with severe stand level diebacks in a mountainous area in northeastern Bavaria. Unfortunately the maps cannot be printed in this paper, but could be recognized on the poster.

3. RESULTS

The simulation results are shown in Table 1.

Table 1
Frequencies of exceedance classes of critical loads in comparison to different degrees of severe stand-level dieback (%)

Exceedance class	1	2	3	4
Model 1				
Severe dieback	-	-	92	8
Medium dieback	-	11	72	17
No dieback	1	47	39	13
Model 2				
Severe dieback	40	44	16	-
Medium dieback	62	30	8	-
No dieback	92	7	1	-
Model 3				
Severe dieback	-	5	79	16
Medium dieback	-	18	73	9
No dieback	8	44	40	8

Model 1: The most simple modelling concept for the exceedance of critical loads substracts the weathering rate from the deposition rate. In this application the weathering rate was derived from geology and soil depth. The deposition rate was calculated by some open air measurements, multiplied with factors derived from surface roughness a.o. (level 1).
Model 2: In this example the N-deposition rate was compared with the empirical threshold (critical load) of 13 kg N ha^{-1} a^{-1} for vegetation changes in coniferous forests (level 0).
Model 3: Due to the fact that the pool of base cations in the soil buffers acidity there should be a delay of harmful effects proportionally to the size of the exchangeable pool of base cations. Hence reaction types were derived from soil estimates in combination with acid depositions (level 1).

3. FINAL REMARKS

In already longtermed heavily polluted areas the stand level dieback correlates with the exceedances of critical loads of acidity, nitrogen surplus causing eutrophication, and ecosystem reactions due to losses of base cations.

In general, for the calculation of exceedances with different resolution and parametrization the availability of data seems to be more limiting than the quality of models.

Lateral transports of material in the soils seem to be keyfactors at the landscape level in this area and should be implemented in the models in a next step.

4. REFERENCES

1 CCE (Coordination Centre for Effects), RIVM-report (1993) 163
2 R. Lenz and W. Haber, Vegetatio 89 (1990) 121-135