Using CORINE Land Cover classification to assess and map the sensitivity of forest ecosystems in Bulgaria

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Abstract

In order to protect surface waters and soils in deciduous and coniferous forests, the central aim of the study was to compare critical loads of acidity and heavy metals (lead and cadmium) using a steady state mass balance approach taking into account the environment quality objectives. Coniferous and brood leaved forest species have been selected from the CORINE Land Cover classification as receptors in view of the different effects of acidity and heavy metals on forests. Calculated critical loads of acidity, Pb and Cd for brood leaved and coniferous forested geographical units 50/50 km have been mapped using GIS Arc view software. Critical loads of acidity, heavy metals and their compartments were computed for both brood leaved and coniferous forests in separate records for each grid cells. It was concluded that the critical loads of acidity are very high and the Bulgarian forested areas are well protected against the acid pollutants, whereas the critical loads of Pb and Cd are very low. The critical loads for both acidity and heavy metals for brood leaved forested catchments are lower than for the coniferous at similar ecological and climatic conditions due mainly to the lower leaching by the runoff and lower growth uptake by the biomass of deciduous forest species, which demonstrates the higher sensitivity of brood leaved forest ecosystems to the acidity and heavy metals pollution than the coniferous ones.

1 Introduction

CORINE Land Cover classification has been applied to define the main ecosystems in Bulgaria as Forests (mainly brood leaved and coniferous species which types vary depending on ecological conditions of the habitat (dry and humid as well as poor and rich habitats), Temporate heath and scrub, Alpine and sub alpine grasslands and Bogs and marshes (CEC, 1991). Coniferous and brood leaved forest species have been selected from the CORINE Land Cover classification as receptors of air pollutants. Critical loads of acidity, heavy metals and their compartments were computed for both brood leaved and coniferous forests in separate records for each grid cells in the aim to compare their sensitivity.

2 Materials and Methods

CORINE Land Cover maps have been used to assess the sensitivity of Forest Ecosystems by modelling critical loads and levels for acidifying pollutants and heavy metals. Steady State Mass Balance method (UBA, 1996) has been selected for calculating and modelling of critical loads of acidity, sulfur, nitrogen, cadmium and lead for forest ecosystems in Bulgaria.
(Ignatova et al., 2001, 2002). Values for each parameter and the resulting critical loads have been stored for each forest type (coniferous and deciduous forests) in separate records for each EMEP 50 x 50 km² grid cells. The spatial distribution of the abovementioned ecosystems has been shown by means of the CORINE Land Cover Information, EMEP grid network and Arc-view Program.

3 Results and comments

The frequency distribution of the values of critical loads for both deciduous and coniferous is shown in Table 1. All values of critical loads of acidity, as well as maximum critical loads of sulfur and nitrogen are much more higher than 2000 eq.ha⁻¹.yr⁻¹.

![Spatial distribution of critical loads of sulfur for deciduous and coniferous forests in Bulgaria](image1)

**Fig. 1. CLmax(S) for deciduous (top) and coniferous (bottom) forests in Bulgaria**

![Spatial distribution of critical loads of sulfur for deciduous and coniferous forests in Bulgaria](image2)

**Fig. 1:** Spatial distribution of critical loads of sulfur for deciduous (top) and coniferous (bottom) forest ecosystems in Bulgaria
### Tab.1: Distribution of critical load values in Bulgaria for deciduous and coniferous (2001), %

<table>
<thead>
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<th>eq.ha⁻¹.yr⁻¹</th>
<th>CL(A)</th>
<th>CLmax(S)</th>
<th>CLmin(N)</th>
<th>CLmax(N)</th>
<th>CLnut(N)</th>
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<tr>
<td></td>
<td>Dec</td>
<td>Con</td>
<td>Dec</td>
<td>Con</td>
<td>Dec</td>
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<tr>
<td>&lt; 200</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>200-500</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>32.73</td>
<td>0</td>
</tr>
<tr>
<td>500-1000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>67.27</td>
<td>100</td>
</tr>
<tr>
<td>1000-2000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>&gt; 2000</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

In general, all calculated critical loads values for all over the country are higher for coniferous forests than for deciduous ones, due to the lower mean values of critical loads parameters used for the computing (base cations weathering rate, deposition and uptake) (fig. 1). Despite the same geographical parameters the mean value of maximum critical loads of sulfur for coniferous ecosystems has been calculated as 7096 eqha⁻¹.yr⁻¹, whereas the value of only 6241 eqha⁻¹.yr⁻¹ has been averaged for deciduous forests in the same cells.

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**Fig. 2**: Spatial distribution of both critical loads of sulfur and areas covered by deciduous and coniferous forest ecosystems in Bulgaria

Using CORINE Land Cover Information Critical loads of acidifying pollutants for both coniferous and broad leaved forests with their corresponding areas for every EMEP grid cells could be shown on only one map, which gives the possibility to compare them easily (fig. 2). All values of critical loads of sulfur from fig. 1 have been included in fig. 2, but there were an additional information about the area covered by each forest ecosystem in every EMEP grid cells.
For the Bulgarian country the mapped forest ecosystems involve 55 EMEP 50x50 km² grid cells, of which 26 are covered by brood leaved forests only, but in other 29 cells, the forest is a composite of both brood leaved and coniferous. Sometimes, there are more than 20 species in one grid cell. Values for most of parameters and resulting critical loads, stored in separate records, show a great variability. In this case some of tree species will not be protected by calculated average critical loads when their individual critical loads are lower.

**Fig. 3:** Distribution of critical loads values of Pb (left) and Cd (right) for brood leaved (red) and coniferous (green) forest ecosystems in Bulgaria, in percent

Concerning the distribution of critical loads of Pb and Cd, for 44 % of the grid cells covered by brood leaved forests, critical loads of Pb were situated between 2,5 and 5,0 gha⁻¹yr⁻¹ for Pb and between 0,025 and 0,050 gha⁻¹yr⁻¹ for Cd, when the maximum of the grid cells with coniferous forested catchments (50 %) were included in the class of 7,5 – 10,0 gha⁻¹yr⁻¹ for Pb and between 0,75 and 1,00 gha⁻¹yr⁻¹ (fig. 3). The picture was similar for Cd. This kind of distribution of the critical loads confirms that brood leaved forest ecosystems are more sensitive to the both Cd and Pb deposition than coniferous ones.

### 4 Conclusion

It could be concluded that using the CORINE Land Cover information the calculated values for acidity and heavy metals give a good initial indication of the spatial variability of ecosystem sensitivity to acidification and heavy metals pollution in Bulgaria. By combining the CORINE Land Cover map with EMEP grid cells network, critical loads of acidifying pollutants for both coniferous and brood leaved forests together with their corresponding areas for every EMEP grid cells could be shown on only one map, which gives the possibility to compare them easily.

Although the high buffering capacity of the Bulgarian forested area, brood leaved forests are more sensitive to the acid deposition and heavy metals than the coniferous ones. Taking into consideration that the deciduous forest ecosystems occupy two and a half times more of the area in the country, than the coniferous ones and that the critical loads for the deciduous forests are much lower than those for the coniferous ones, at similar geographical and climatic parameters, the deciduous ecosystems could be used as a biological monitor for atmospheric pollutants concentrations reduction.
References


