

CRITICAL LOAD MAPPING OF HEAVY METALS AND OTHER LONG RANGE TRANSBOUNDARY AIR POLLUTANTS IN EUROPE: A CASE STUDY OF HUNGARY

Zsuzsanna FLACHNER¹ – László BOZÓ²

¹Research Institute for soil and Agrochmistry, Hungarian Academy of Sciences, Budapest, Herman O. 15. flachner@rissac.hu

²Hungarian Meteorological Service, H-1675 Budapest, P.O.B. 39. bozo.l@met.hu

Introduction

One of the longest research cooperation in Europe is linked to pollution prevention and pollution assessment of long-range transboundary air pollutants (Convention on Long Range Transboundary Air Pollution – LRTAP) due to their very complex effects on natural, semi-natural and man-made environment. The most well-known effects ranges from acidification and eutrophication of ecosystem to multi-effects of different pollutants on food production, food chain – such as GHG gases, SO_x, NO_x and heavy metals (Flachner, Zs.–Németh, T.–Tóth, R., 2002). Recently more attention is paid on health effects of particulate matters and heavy metal pollution effects on food production, which problems are a mixture of long range and regional, local pollution.

Under the supervision of the UN ECE Secretariat the Working Group on Effects, the Task Force of the International Co-operative programme on the Modelling and Mapping of Critical levels (CL) implement the programme of the UNECE on providing assistance for decision makers on abatement strategies since 1980, coordinated by the CCE (Coordination Centre for Effects, RIVM, Bilthoven, the Netherlands) (M.Posch-J.P.Hettelingh, 2005). The programme offered for all participating parties of the convention a harmonised, jointly developed methodology the so called critical load calculating, modelling and mapping. The method is used in the integrated assessment (IA) modelling since the 2nd Sulphur Protocol (Oslo, 1994) very successfully almost for 1.2 million different ecosystem types at a scale of 50km x 50km EMEP grid. The present work of the WG contributes to the Clean Air for Europe (CAFE) EU programme successful implementation.

The ICP M&M has updated CL for several transboundary HM (Cd, Pb, Hg) air pollutants as well, which can be applied by National Focal Centres (NFC) in member states, comparing them with the actual deposition of HM.

The last two years the responsible Ministry for Environment and Water did not have sufficient resources to continue subsidizing the work of the Hungarian NFC, so the results presented are building on the existing data and on the results of the Hungarian Meteorological Service.

Methodology of CL calculation and mapping

The methodology is broadly described in many different international literatures (Nilson J., Grennfelt, 1988). There are 48 variables in the calculation, which can be done on two different ways: applying the simple mass balance method or using different dynamic models (VSD, Safe, MakeDep) for calculation of present critical loads and expected future changes. In Hungary the soil information and monitoring system (TIM) is applied, the biomass data are derived from the ICP Forest sites (Dombos, Szabó, Pásztor, in CCE report, 2005).

New variable has been introduced by the process of dynamic modelling – beside the calculation of the critical load, the difference the target load and actual deposition, the recovery delay time (RDT) can be calculated as well, which describes the possibility of the recovery of the ecosystem in case of the implementation of the current legislation base line (BL/CL) (CCE report, 2005).

Model computations were performed based on the application of a Lagrangian-type long-range transport model (Bozó, 2000) on the total deposition of lead and cadmium. Even relatively low fluxes across the Earth's surface can result in accumulation of toxic trace metals in various soils. From the soils they can be taken up by the plants and may be leached out into the ground water, which level have been assessed by different other research groups. CL calculation methodology was developed and first applied in the frame of WG on effects (UBA, 2004), which comparative results are published recently.

European results

The EU level assessment shows the very high sensitivity of ecosystems in northern countries and in southern France. Low values of critical loads of eutrophication (below 400 eq/ha*year) occur particularly for forest soils in most of Europe. All maps are available at homepage of CCE (www.mnp.nl).

Concerning the results of HM (namely Pb, Hg, Cd) the European results draw the attention on the importance of more detailed assessment of CL of HM. The highest CL occurred in the Scandinavia, the Carpathian Mountains as well as the border area of Slovakia and Hungary.

In general the results of the European assessment are the following (CCE report, 2005):

8.5% of the ecosystem area in pan- Europe and 17.8% in the EU25 are still at risk of acidification in 2000;

28.5% and 65.2% are at risk of eutrophication in 2000;

atmospheric deposition of cadmium does not cause risk in 2000, while the risk of lead deposition decreases since 1990, but still widespread in 2000;

the risk of mercury remains important without large changes in the last decades in almost all of the reporting countries.

Actual mapping of HM in Hungary

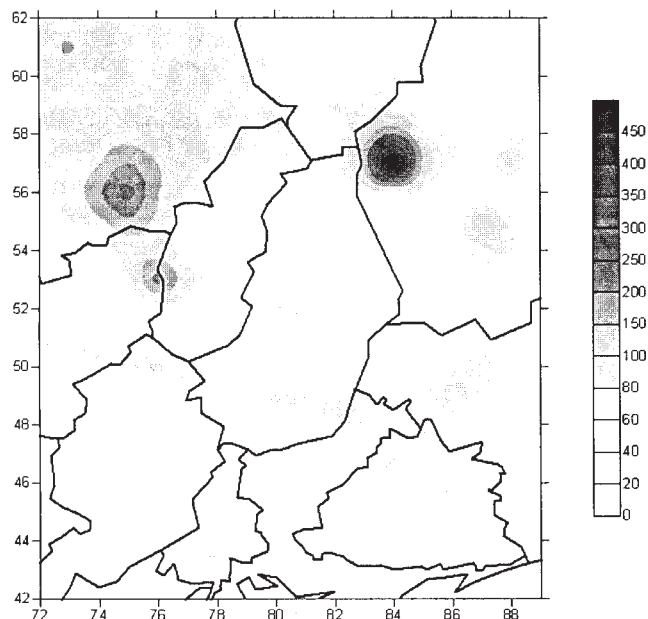
The rate of annual lead deposition in 2002 over Hungary was in the range of 1000-4000 g km⁻² yr⁻¹ (Fig.1.) much below the ecological threshold in Europe (250,000 g km⁻² yr⁻¹). It was also estimated by model computations that ecological threshold of 5,000 g km⁻² yr⁻¹ for Cd was not exceeded in any parts of the region: it varies in the range of 20-300 g km⁻² yr⁻¹. Based on the comparisons with regional background measurements, it was found that our model simulations underestimate the rate of annual deposition by 10-20%. The reason for this could be the underestimations in emission data of trace elements and the uncertainty in the parameterization of deposition processes in the atmosphere. The rate of lead deposition varied significantly during the past decades.

Due to the cumulative characteristics of lead in our environment, it is advisable to estimate the cumulative lead deposition in Hungary for the past 50 years and to provide some quantitative estimates for the next decade. This type of simulation was also done by means of TRACE model computations. Historical emission data were taken from Olendrzynski et al., while future scenarios are based on the calculations of Berdowski et al. For comparisons, the target of model simulations was not only Hungary but a few other countries in different regions of Europe – United Kingdom, The Netherlands, Spain, Austria, Romania and Poland. It is not surprising that cumulative lead deposition was much higher during the 30 years of the period 1955-1985 than that of 1985-2015.

Regarding Hungary, the rate of total lead deposition was 320 mg m⁻² during 1955-1985, while on the basis of model computations it is expected that it will not exceed 95 mg m⁻² during the consecutive 30 years period (1985-2015). It can also be stated that in some selected countries (e.g. The Netherlands or Austria) the cumulative lead deposition rate was higher than in Hungary, while in the case of Romania and Spain lower cumulative lead deposition rates were estimated.

The CL for HM calculation for Hungary has not completed yet due to the already mentioned reasons – but the European results and the actual deposition modelling draw the attention on the importance of these type of assessment work, fulfilling our international data submission obligations.

Fig.1. Rate of Pb deposition in Hungary in 2002 computed by TRACE model ($\text{g m}^{-2} \text{a}^{-1}$)



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