EVALUATING STRATEGIES FOR CONTROLLING ACIDIFICATION IN EUROPE WITH A REGIONAL SCALE AIR QUALITY MODEL

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This paper reviews some practical aspects of using results from a long range transport model of sulfur in Europe in a policy analysis context. This context is provided by the IIASA RAINS (Regional Acidification Information and Simulation) model which is used for analyzing international strategies to control acidification in Europe over a 1980-2030 time horizon (Alcamo et al. 1984; Hordijk et al. 1985). The RAINS model consists of several linked submodels (Figure 1), one which is a source-receptor matrix based on the so-called EMEP model of long range transport of sulfur in Europe* (Eliassen and Saltbones, 1983). Submodels which describe NO_x emissions and deposition are presently being added to the RAINS system. In the interim, sulfur is assumed to be the principal long term contributor to acidification of Europe's environment.

The use of such a source-receptor matrix to evaluate international control strategies raises some basic issues :

1. What are the appropriate time and space scales of this matrix ?
2. What is the appropriate input and output for using the matrix to evaluate control scenarios ?
3. What is the uncertainty in using such a matrix ?

MATRIX INPUTS AND OUTPUTS

We select the spatial and temporal scales of the matrix input and output based on the following pragmatic considerations. The country-scale is the appropriate spatial scale for matrix input because (1) Most countries in Europe report their sulfur emissions as country totals, although a few report additional spatial information, (2) most proposed international control policies (for example, the "Thirty Percent Club") refer to country-scale sulfur emissions. The EMEP grid element is an appropriate spatial

* EMEP is the acronym for the Cooperative Program for the Monitoring and Evaluation of Long Range Air Pollution Transmission in Europe. There are actually a number of models being developed under the EMEP program but only the long range model of sulfur in Europe developed at the Norwegian Meteorologic Institute by A. Eliassen and J. Saltbones has thus far been well documented in the open literature. For the purpose of this paper we will refer to the Eliassen and Saltbones model as the "EMEP" model.

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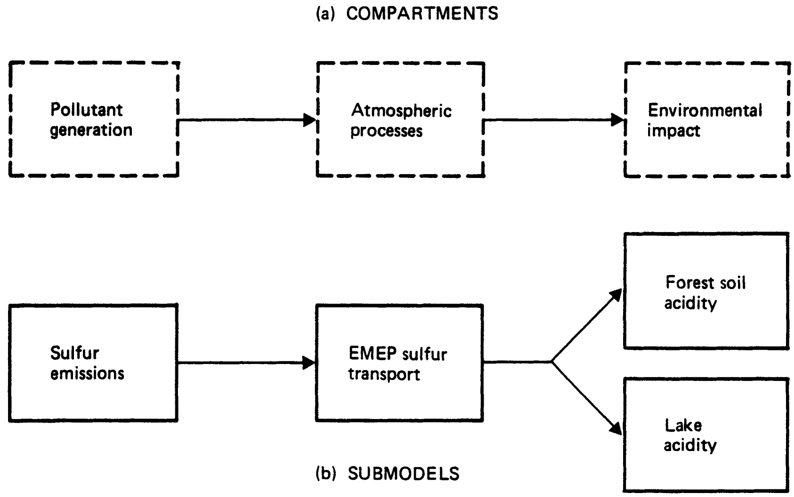

Fig. 1 Submodels in IIASA European-scale RAINS model

scale for matrix output since a coarser resolution would be unsuitable for analyzing known spatial variations of environmental impact (such as forest damage) which occur within countries. In addition, since a model for analyzing international control policies in Europe should cover all of Europe, a spatial scale much smaller than 150 km may increase the number of computational steps to an unacceptable level.

The time scale of the matrix should consider that confidence in any air pollution model increases with the averaging period of results*. In addition the time step should take into account the long time period and broad spatial coverage needed for policy analysis (the RIANS Model uses a 50 year time horizon andall of Europe). With these considerations in mind, an annual time step is taken to be an appropriate scale. This time step is also appropriate for assessing forest damage since most field studies record annual pollutant deposition or air concentration.

We may summarize the discussion to this point by recommending a matrix time resolution of one year, country-scale as the input spatial resolution, and EMEP grid elements as the appropriate output spatial resolution. The relationship, therefore, between deposition, sulfur emission ** and a source receptor matrix can be expressed as :

$$\sum_{i=1}^{27} d_{ij}^{t} = \sum_{i=1}^{27} S_i^t A_{ij} + B_j$$

where

d_{ij}^{t} = total sulfur deposition at grid element j due to country i at time t ($g\ S\ m^{-2}\ yr^{-1}$)

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* As an example, one EMEP review states that the model "continued to demonstrate its effectiveness in modelling air concentrations and depositions when averaged over seasons or years" (WHO, 1983).

** From 27 of the geographically larges countries in Europe.