An overview of recent developments in estimating critical loads of atmospheric deposition for terrestrial ecosystems

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The hypothesis of steady state is the main underlying assumption of both empirical and dynamically modeled Critical Load (CL) estimates. Furthermore, while empirical CLs are derived from direct impacts of deposition on biological properties of ecosystems, classical dynamically modeled CLs use chemical criteria as substitutes for biological indicators.

In light of the ongoing changes in climate and land use, it has become necessary to use methods able to simultaneously account for and integrate multiple drivers when estimating critical loads (1,2). One such method uses the ForSAFE-Veg family of integrated ecosystem models, which provide a platform for dynamically estimating critical loads based on chemical as well as biological indicators. The models are able to simulate terrestrial biogeochemistry as well as plant community composition.

Within the Long-Range Transboundary Air Pollution (LRTAP) work in Europe, the model ForSAFE-Veg has been used to develop a method to use plant community composition as a criterion for setting deposition caps, as it is able to reconstruct plant species presence and abundance in response to climate, atmospheric deposition, land management and interactions with herbivores (2,3). This method has been used successfully to set preliminary CLs of deposition in parts of Europe and is being introduced into the reporting on effects by member states on the LRTAP convention, providing a necessary complement to the classical CL methods.

In the US, the models PROFILE and ForSAFE-Veg have been used in successful exploratory work (4,5,6), paving the ground to possible applications of the methods being developed in Europe.

Here we would like to give an overview of the latest developments mentioned above, the potentials they provide and the uncertainties related to them.

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1 Vries, W. de et al., 2010. Use of dynamic soil–vegetation models to assess impacts of nitrogen deposition on plant species composition: an overview. Ecological Applications, **20**(1): 60-79.

2 Belyazid. S., et al., 2011. A dynamic modelling approach for estimating critical loads of nitrogen based on plant community changes under a changing climate. Environmental pollution, **159**: 789-801.

3 Belyazid, S. et al.,, S., 2010. Exploring ground vegetation change for different scenarios and methods for estimating critical loads for biodiversity using the ForSAFE-Veg model in Switzerland and Sweden. Water, Air and Soil Pollution, **216**: 289-317.

4 Sverdrup et al., 2011. Testing the Feasibility of Using the ForSAFE-VEG Model to Map the Critical Load of Nitrogen to Protect Plant Biodiversity in the Rocky Mountains Region, USA. Water, Air and Soil Pollution, doi:10.1007/s11270-011-0865-y

5 Anonymous, 2011. Application of the base cation weathering (BCw) methodology and PROFILE model to calculate terrestrial critical acid loads in Pennsylvania. Report to the US-EPA by RTI.

6 Belyazid et al., in Modelling of Pollutants in Complex Environmental Systems, Volume 2 by Hanraham, G., 2010. Past and Future Effects of Atmospheric Deposition on the Forest Ecosystem at the Hubbard Brook Experimental Forest: Simulations with the Dynamic Model ForSAFE.