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Errata

In the article 'Competition is tough' by W. Blankley (*S. Afr. J. Sci.* **91**, 499), the following values of gross domestic products should have been cited: for Ireland, US$52.1 billion; for Mexico, US$377.1 billion; the GDPs for Finland, Denmark and Norway range between US$98 billion and $146 billion.

Atmospheric pollution maps to aid policy-making and focus research

Kim Olbrich, Robert Skoroszewski and Mieke van Tienhoven

Pollution-related research in this country is fragmented, unfocused and inadequate to meet the needs of policy-makers. To address this problem, the CSIR has devised a draft scheme which aims to address and integrate the three main components of the air pollution problem: assessment and measurement of air quality, evaluation of the effects of poor air quality, and management of air quality.

This scheme, dubbed ADRAS for Atmospheric Deposition Risk Advisory System, is aimed at involving all parties interested in air quality. It provides a framework by which information gathered by means of nation-wide research efforts and monitoring can be integrated and presented to policy-makers in a form that is concise and easy to interpret. The integrating tool of ADRAS is the 'critical loads' approach. This has been developed in Europe, largely through the United Nations Economic Commission for Europe (UN-ECE), which is using critical loads to refine sulphur and nitrogen emission protocols for Europe.[1] The critical load is defined as the maximum quantity of a given pollutant that a receptor can tolerate without suffering any adverse effects.

The critical load approach involves three steps. The first is to map the actual levels of deposition of a given pollutant. The second step is to plot the critical load of the receptor of interest (such as humans, vegetation, soils, waters, buildings) for that pollutant. The third step is to contrast the two maps, and identify the areas where actual loads exceed the critical amounts — resulting in so-called 'exceedance' maps. The areas where critical loads are exceeded are the high risk areas where negative effects are most likely to occur. 'Integrated assessment models' have been developed in Europe which evaluate the costs of different pollution control options in relation to the benefits in terms of reducing areas of exceedance.[2] These cost-benefit analyses, together with the exceedance maps, provide policy-makers with the tools they need to plan an effective air quality management strategy.

The construction and comparison of the maps is done using a geographic information system (GIS). It is the production of the maps that provides the integrating feature — and these maps are of most use to policy-makers, particularly when the com-bined assessment models are incorporated. The actual load maps require the integration of the results from a monitoring network, and atmospheric chemistry and transport models. Such maps are compared annually to establish whether pollution loads are increasing or decreasing. The method used to map the critical load of the chosen receptor depends on the quality of data available. A number of steps have been defined for this process.[3] The key process is to determine the critical chemical limit, which links the observed effect on the receptor to some change in the environment.[4] This is defined as the 'highest value of a critical chemical parameter or combination of parameters that does not cause a significant harmful response in a biological indicator'.[5] For example, acid deposition may increase aluminium in the soil to the point where it is toxic to the roots of a selected indicator tree species. In this case, the critical limit would be the level of aluminium at which root growth is first affected. Once the critical chemical limit is determined, the distribution and areal extent of the receptor needs to be defined. In the example above, the soil is the receptor, the pollutant is acid deposition.

The next step is to select the computation method. This is highly dependent on the quality and quantity of data available. The UN-ECE has defined three levels of approach.[5] The level 0 approach uses existing data to assign critical load classes based on ecosystem sensitivity. The level I approach applies steady-state models to derive critical loads for total acid (sulphur and nitrogen). The level II approach uses dynamic models, which are useful to predict the time before a critical chemical value is reached. Once the level of approach is selected, the input data need to be collected, incorporated into the GIS, and the critical loads calculated. This process identifies where there are gaps in information, and so helps to prioritize and focus research.

The CSIR has conducted a pilot study in Mpumalanga province (formerly the East-

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ern Transvaal), where we attempted to define the actual deposition loads of sulphate, and the critical loads for soils and surface waters.[6–8] Actual wet deposition loads of sulphate were mapped for the region, based on sixteen monitoring sites from Eskom's network. Dry deposition was not included.

A level 0 approach was applied to the soils, to develop a map of potential soil sensitivity to sulphate deposition. Sensitivity was based on the underlying lithology, land cover features and the soil characteristics of the region. The Mpumalanga escarpment was classified as sensitive to atmospheric deposition because of the combination of slow-weathering bedrock, acid soils and commercial forestry as the predominant land cover. A provisional critical load for these sensitive areas was calculated based on the estimated weathering rates of the soils. It is assumed that the weathering rate represents the ability of the soil to neutralize acid inputs from the atmosphere,[9] and so is equivalent to the critical load. Comparing this estimated critical load with the actual wet deposition load map showed that, at this stage, there are no exceedances. However, this ignores the additional acidity contributed by dry deposition.

A provisional critical load map for surface waters was produced using the Steady State Water Chemistry model (Fig. 1).[10] This showed the sensitive areas to be primarily in the upland regions (along the escarpment and the Groblersdal area). The lowland parts of the Kruger National Park were also shown to be sensitive. Comparisons with the actual load map identified provisional areas of exceedance along the escarpment (east of Nelspruit and in the vicinity of Piet Retief), as well as around Groblersdal.

Although the critical loads approach is pivotal to determining policy options for pollution control in many European countries, this is the first time, to our knowledge, that the approach has been used in Africa.

It is important to recognize the limitations of this procedure, and to acknowledge that the estimates of critical loads are not absolute. Two concerns are, first, that the quality of baseline data in South Africa is questionable and too inadequate at this stage even to attempt the compilation of actual load or critical load maps. The second concern is that the assumptions underlying the approach may not be explicitly expressed, and the maps produced taken too literally. Thus, the critical loads approach may be viewed as too sophisticated for South Africa, and its adoption premature.

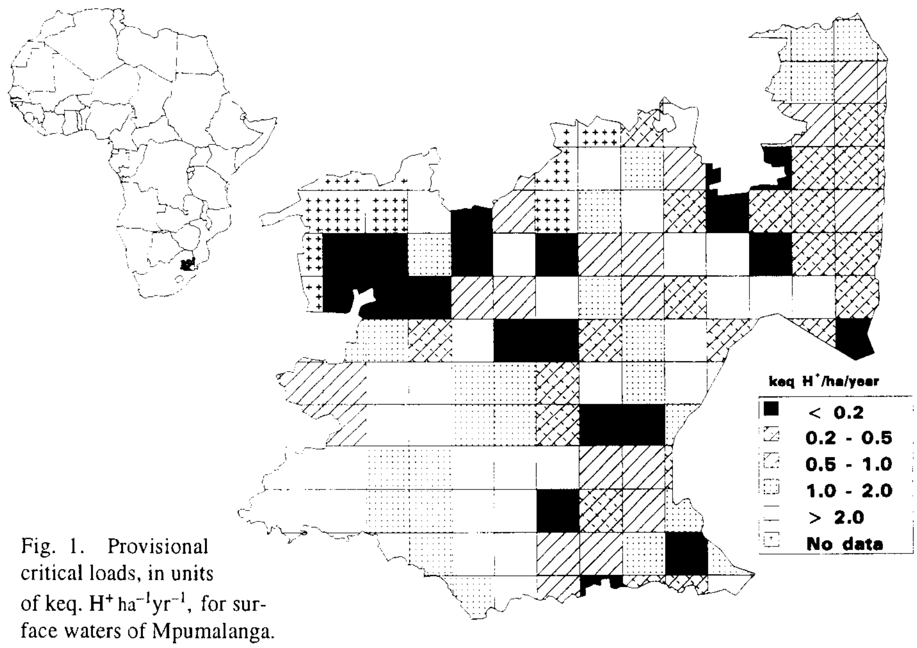

Fig. 1. Provisional critical loads, in units of keq. H^{+} $ha^{-1}yr^{-1}$, for surface waters of Mpumalanga.

To address these issues, it is important to stress that this monitoring procedure is a reiterative one, where estimates are continually revised as new information becomes available. The critical loads approach is expressly designed to cater for varying degrees of data quality and quantity. Its greatest strength is that it focuses research — identifying where the largest gaps in knowledge exist, and the areas that are at greatest risk from negative influences. It forces the integration of air quality assessment and impact assessment, and attempts to address the needs of the policy-maker. Another benefit is that there is a large pool of international expertise from which we can draw for assistance.

In South Africa, where economic growth is vital for development, industrial expansion based on present energy and manufacturing technologies may worsen air pollution. It is therefore essential that we continue to assess air quality and the impact of poor air quality on the environment. The proposed ADRAS scheme uses the critical loads approach as the tool to focus on air pollution and its associated effects in an integrated manner, thereby allowing policies and strategies for further industrial development to be continuously improved.

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Population trends

According to UNISA's Bureau of Market Research, South Africa's population in 1995 was estimated to be 40.9 million, which represents an average annual growth rate of 2.1% overall since the 1991 population census. The black population has been growing by 2.4% annually since the beginning of the decade, the coloured community by 1.4%, the Asian by 1.3%, and the white population by 0.7%. KwaZulu-Natal and Western Cape are the most populous provinces, Northern Cape the least. The largest number of blacks live in KwaZulu-Natal (about 7.2 million) and of whites in Gauteng (2.1 million).