Chapter (non-refereed)

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Critical loads mapping at the UK Critical Loads Mapping Centre – data requirements and presentation

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INTRODUCTION

The UK Critical Loads Mapping Centre (known in European terms as the National Focal Centre) at ITE Monks Wood is responsible for producing critical and target load maps for Great Britain, and maps showing the exceedance of critical load by acid deposition. Critical and target load maps for soils have already been forwarded to the UN-ECE Co-ordination Centre for Effects (CCE) at Bilthoven in The Netherlands, along with data and maps at the European scale, based on the European Monitoring and Evaluation Programme (EMEP) grid.

In generating critical load maps, the resolution, together with the statistical method used for calculating the critical load, has been taken into consideration. The choice of these factors can influence the resulting maps and may affect subsequent interpretation and use of the data. For this paper, the Laser-Scan Horizon geographical information system (GIS) has been used to generate a series of maps to demonstrate these effects.

DATA FOR MAPPING

The various subgroups of the Critical Loads Advisory Group (CLAG) of the UK Department of the Environment (DoE) provide critical loads data to the Mapping Centre in a variety of formats from available data sources.

The soils subgroup derived critical loads for the dominant soil type for each 1 km square of Great Britain, based on the 1:250 000 maps and data bases of the Soil Survey and Land Research Centre (SSLRC) and the Macaulay Land Use Research Institute (MLURI). The Skokloster classification (Nilsson & Grennfelt 1988) is aimed at forest soils but, at present, all mineral soils are treated in a similar way. For peat areas, the critical load is defined in terms of an acceptable pH shift. To allow for agricultural liming in some areas, a land use modification was applied to the soil critical loads data at the Mapping Centre, using the ITE land use classification data for 1 km squares; the critical load was decreased by one class (to become less sensitive) for each square where either arable or improved grassland was the dominant land use.

The freshwaters subgroup of CLAG is carrying out a sampling programme of lakes throughout Great Britain. One site in each 10 km square is sampled, by selecting a lake (or first-order stream where no lake exists) in the most (geologically) sensitive part of each square. The critical loads data are calculated from chemical analysis of water samples for these sampling points, and the results are then forwarded to the Mapping Centre.

Incoming data to the Mapping Centre are converted to standard ASCII format and loaded on to an ORACLE data base where information can easily be manipulated, eg to convert grid references from letters and numbers to values in kilometres. The data are then passed through various formatting programs to generate vector or raster maps, as appropriate, on the GIS.

Revisions to both data and maps are made following discussion with the appropriate CLAG subgroups. At intervals, agreed versions of data and/or maps are made available to CLAG, the DoE or the UN-ECE CCE in Bilthoven, as required.

PRESENTATION OF MAPS

Traditionally, critical load maps have been presented as coloured grid squares, so the size of the square (the mapped unit) is an important consideration in presenting the data as maps. The maps of soil critical loads are initially presented as 1 km squares of the Ordnance Survey's National Grid for Great Britain, which are coloured according to their critical load value. Subsequently, critical load values for each 10 km and each 20 km square of the National Grid are calculated from the distribution of the 1 km data set and mapped. Figure 1 shows the different maps obtained from plotting the critical load which indicates the modal value (see below) of a typical data set at four different resolutions. The maps for soils are being used as the official national critical load maps and the data are forwarded to the UN-ECE. For freshwaters, the data are mapped with each 10 km square of the National Grid being coloured according to the critical load value of the water sample collected from it.

The maps provide a good indication of the area of

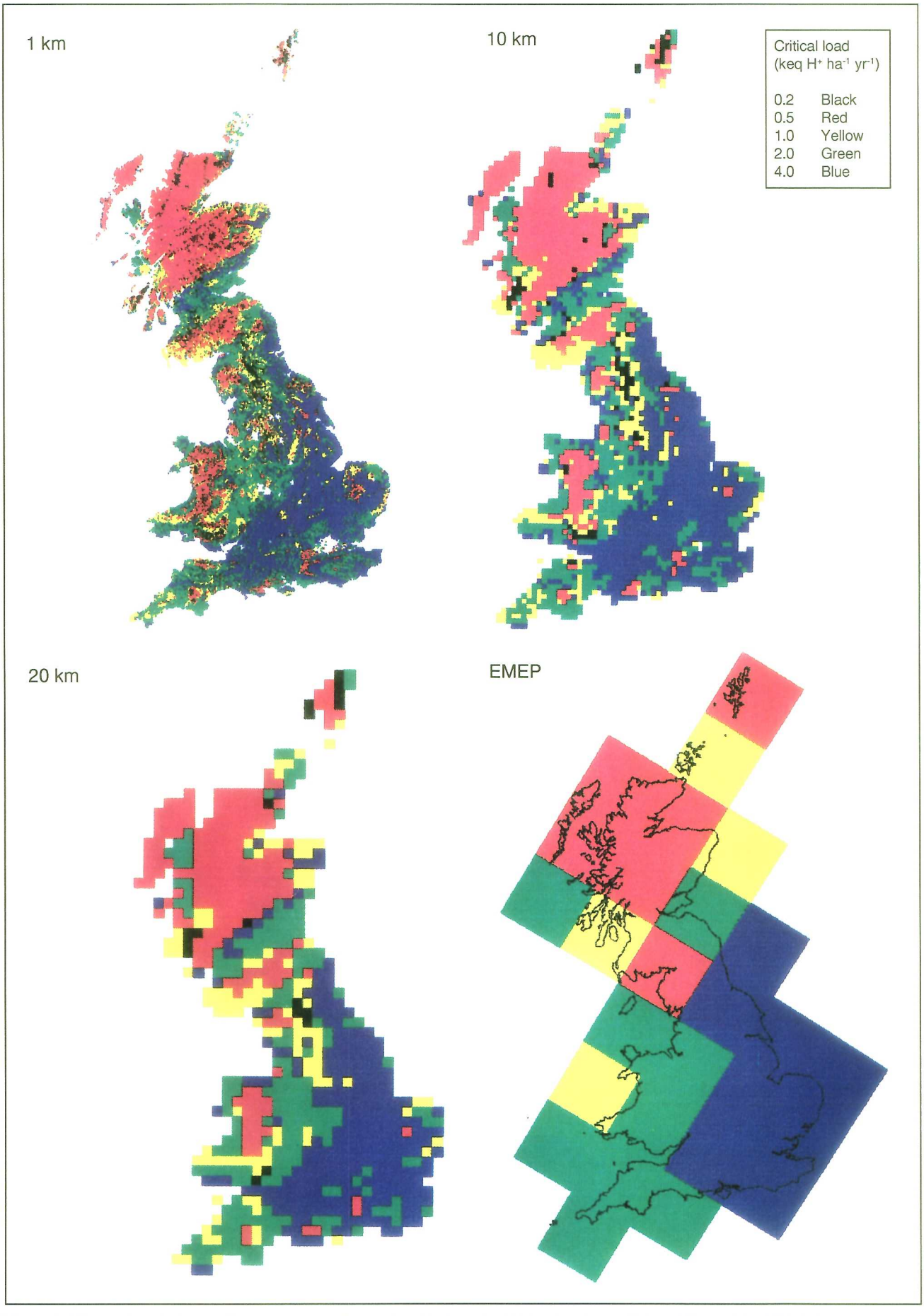

Figure 1. Effects of resolution: plotting the modal soil critical loads (March 1992 data) on 1 km, 10 km, 20 km and EMEP grids

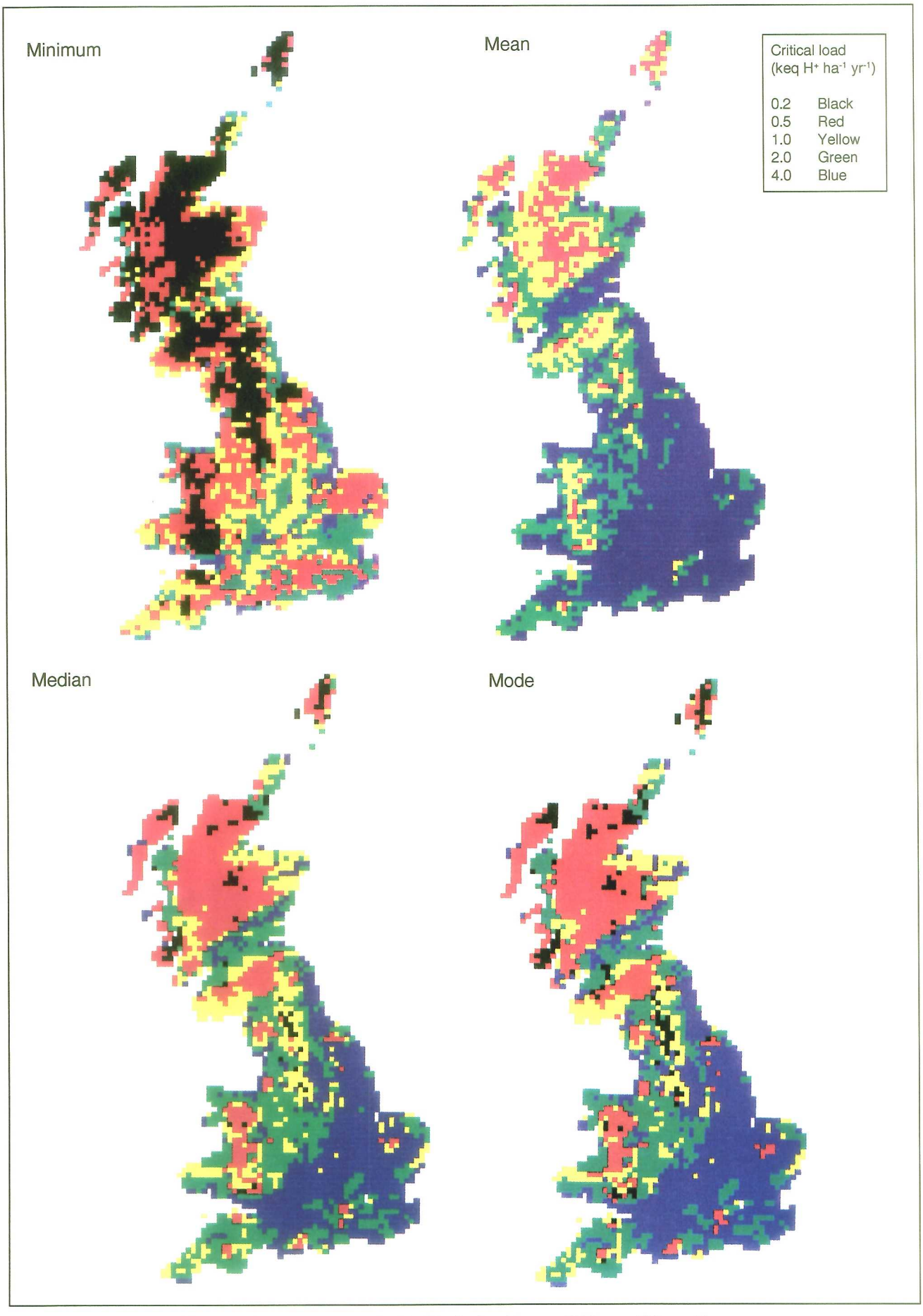

Figure 2. Effects of using different statistics to present soil critical loads data (January 1991) on a 10 km grid

Great Britain, so a coast outline is not usually included. However, a coastline or grid may be added as an aid to the location of grid squares.

Pollutant deposition data are generated by ITE and the Warren Spring Laboratory for 20 km grid squares. These are used to calculate areas where the deposition exceeds the critical load (called critical load exceedances). Such calculations may be made using the 1, 10 or 20 km critical load values, with the same deposition value assigned to each of the 1 or 10 km squares within the 20 km square. Maps of these exceedances are usually produced on a 10 km square grid. In addition, maps have been generated using modelled deposition values which show areas of the country where the critical load will still be exceeded in the year 2005, ie 'not protected' areas. These target load maps are usually presented on a 20 km square grid. Target loads for freshwaters are derived from the lowest critical load value of the four 10 km squares within a 20 km grid. This method is consistent with the CLAG freshwaters group sampling the most sensitive areas.

The statistic selected for mapping the aggregated data will determine the final appearance of the map; different statistics may give very different pictures. The usual maps of soil data (at 10 and 20 km) show a single statistic of the underlying data - the mode of the 1 km data set. However, the 1 km data may also be used to generate different statistics. Figure 2 shows the effect of plotting the minimum critical load, which gives a 'more sensitive' map; the mean critical load, apparently less sensitive; and the median and modal critical loads, which give similar results of intermediate sensitivity. The modal value has been chosen for most of the soil maps as this is consistent with the use of the dominant soil for defining the critical load of each 1 km square. Modal maps have also been found to give similar pictures at different resolutions because the area proportions of the different critical load classes are similar.

To provide information at the European scale to the UN-ECE, the co-ordinates of each 1 km square of the soil critical load map is transformed into the EMEP projection, thus providing information for the 150 km x 150 km squares of the EMEP grid covering the UK (Figure 1). A statistic has to be selected for mapping these data. Traditionally, within the UN-ECE, percentiles of the cumulative distribution of critical load values have been favoured when presenting data at the EMEP scale. UN-ECE maps have used the 1, 5 and 50 percentiles. Each percentile may be calculated from the distribution of critical load values for each EMEP square. Comparison of percentile maps with deposition values enables 'damage' to be assessed. Non-exceedance of a 5 percentile value indicates that at least 95% of the ecosystem area mapped is 'protected'. Low percentiles are usually preferred for European maps as they give comparable results for different countries which may map different receptors using different methods. Low percentiles focus upon the most sensitive elements of the grid square. For the UK, the 25 percentile has been chosen for EMEP-scale target loads data for 2005. The areal distribution of critical loads at the EMEP scale is similar to that for the modal map at 20 km.

When calculating the statistic to be mapped for any of the above maps, a decision has to be made whether to include areas of sea in coastal squares. In general, the Mapping Centre has excluded the sea when calculating critical loads for grid squares. While it makes little difference to the higher-resolution maps, eg 1, 10 and 20 km, it has a significant effect for data plotted on the EMEP grid. Single 150 km squares could be designated as highly sensitive when only a few kilometres of sensitive land are surrounded by sea in the square, while a similar area of high sensitivity on the mainland may have a lower calculated sensitivity for the same percentile. Therefore, for EMEP grids, areas of sea are included in the calculations.

THE GIS APPROACH TO MAPPING CRITICAL LOADS

Critical load maps may be generated using a variety of different computer graphics software programs; however, there are a number of advantages in using full GIS software.

By 'zooming-in' to the screen graphics, the high-resolution 1 km maps can be examined in detail, eg to match the English/Scottish border of the soil maps. In addition, using GIS, different mapped data sets can be overlaid on one another so they can be examined together. For example, the 'not protected' squares from target load maps, catchment areas or other areas of interest can be superimposed on to the various critical load maps.

The Horizon GIS works in conjunction with the ORACLE data base, enabling communication in both directions between the GIS and data base. It allows interrogation of the data base from features (eg 10 km squares) displayed on the screen. In this way, information can be extracted from the data base and displayed for any individual feature or user-specified selection of features, eg all sites with a pH value <4.5 and a critical load value <0.5 keq ha^{-1} yr^{-1}. In addition, there is the facility to classify features on the map according to the data held in the data base, and thereby to generate new maps. Comparisons of soil and freshwater critical load values have been mapped in this way.

CONCLUSIONS

In its role of co-ordinating the mapping of critical loads, the Mapping Centre at ITE Monks Wood has examined the effects of producing maps at different resolutions, and of using different statistics on the data. Discussions within CLAG attempt to ensure that the most appropriate maps and data are presented, both for the UK and Europe. Maintaining a data base of the high-resolution data provides the facility for

examining ways of presenting different maps, eg by generating a range of percentile maps for the UN-ECE. The GIS allows flexibility in displaying maps of different resolution (either separately or together), 'zooming-in' for detailed examination of areas of interest on high-resolution maps, and direct access to information held on any area by the ORACLE link.

ACKNOWLEDGEMENTS

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REFERENCE

Nilsson, J. & Grennfelt, P., eds. 1988. *Critical loads for sulphur and nitrogen.* (Report 1988: 15.) Copenhagen: Nordic Council of Ministers.