Status of UK critical loads and exceedances June 2008

Jane Hall
UK National Focal Centre
CEH Bangor
Environment Centre Wales

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1. Introduction

This short note briefly documents:

(i) changes made to the UK critical loads database in March 2008
(ii) changes to the GIS methods used to calculate critical load exceedances
(iii) the impacts of these changes on critical load exceedances

2. Changes to the UK critical loads database March 2008

In November 2008 the Coordination Centre for Effects (CCE) in the Netherlands issued a call for data asking countries to submit critical loads of acidity and nutrient nitrogen and dynamic model (VSD, MAGIC) outputs, with a deadline of 10th March 2008 for all data submissions.

In preparation for this call two main changes were made to the UK critical loads database:

(i) Acidity critical loads (CLmaxS, CLminN, CLmaxN) for 35 freshwater sites (all in the North York Moors) were added to the freshwater database. These are sites for which data also exist for future dynamic modelling activities. The inclusion of these sites increases the total number of freshwater sites in the database to 1752 and increases the total freshwater habitat area considered in the UK by 67 km^2 to a total of 7857 km^2.

(ii) The removal of nitrogen through fire (N_{fire}) in heathland systems is incorporated in the calculation of CLminN (and hence CLmaxN). The values used for N_{fire} (4.5 kg N ha^{-1} $year^{-1}$ for wet heaths and 15 kg N ha^{-1} $year^{-1}$ for dry heaths) can have a significant impact on the critical load values, their exceedances and the predictions of nitrate leaching in the future. Following a brief consultation with members of the Terrestrial Umbrella on the values, the value for wet heaths was reduced to 10 kg N ha^{-1} $year^{-1}$ on the basis of recent measurements (Power et al, 2004; Terry et al, 2004). The values of CLminN and CLmaxN for the dwarf shrub heath habitat were subsequently updated.

A full description of the data submitted has been prepared and will be included in the CCE 2008 Status Report (due for publication August/September 2008).

Power, S.A., Ashmore, M.R., Terry, A.C., Caporn, S.J.M., Pilkington, M.G., Wilson, D.B., Barker, C.G., Carroll, J.A., Cresswell, N., Green, E.R. & Heil, G.W. 2004. Linking field experiments to long-term simulation of impacts of nitrogen deposition on heathlands and moorlands. Water, Air and Soil Pollution: Focus 4, 259-267. [16]

Terry, A.C., Ashmore, M.R., Power, S.A., Allchin, L. & Heil, G.W. 2004. Modelling of impacts of elevated atmospheric nitrogen deposition on Calluna dominated ecosystems in the UK. Journal of Applied Ecology, 41, 897-909.

3. Changes to the GIS methods used to calculate critical load exceedances

Until recently the critical load summary exceedance statistics were generated using a suite of C programs called from an ArcInfo GIS macro. These methods have now been migrated into the newer GIS package ArcGIS and re-written in a suite of linked "Python" programs. Both methods will give identical results for identical data sets.

One advantage of ArcGIS is its better and easier handling of map projections; this has enabled us to easily convert our critical loads data for Northern Ireland, that were originally mapped on the Irish Grid, to the Ordnance Survey GB grid in its correct location (earlier critical load maps show NI in an approximate, but not correct position). This data transformation has resulted in minor changes to the values of habitat area and/or critical loads in some 1x1 km grid squares.

An additional benefit of the new method is that it no longer requires us to convert CBED or FRAME deposition estimates for Northern Ireland to values for squares of the Irish Grid; the data can be used as provided. This means that deposition values used now may differ slightly from previous values that had been transformed to the Irish projection.

This new method also automatically generates GIS maps of critical load exceedance and Accumulated Exceedance (AE) for each habitat. A new method is still to be developed to generate maps of exceedance for all habitats combined (using a percentile or other approach).

4. The impacts of these changes on critical load exceedances

Three sets of critical load exceedances based on CBED deposition for 2003-2005 have been calculated and compared:

(i) Original 2004 critical loads using the ArcInfo macro/C programs method.
(ii) Original 2004 critical loads but with Irish data converted to OS GB grid and using the ArcGIS Python programs.
(iii) Updated 2008 critical loads (incorporating changes outlined in 2 and 3 above) using the ArcGIS Python programs

The results are summarised in the tables below.

Table 1. Comparison of acidity exceedance results for the UK

Critical loads data	Method	Area exceeded (km^2)	% area exceeded	AE (keq $year^{-1}$)
2004 (i)	ArcInfo & C	43349	55.6	3644653
2004 (ii)	ArcGIS & Python	43247	55.4	3639740
2008 (iii)	ArcGIS & Python	43649	55.9	3673846

Table 2. Comparison of nutrient nitrogen exceedance results for the UK

Critical loads data	Method	Area exceeded (km^2)	% area exceeded	AE ($keq\ year^{-1}$)
2004 (i)	ArcInfo & C	43754	58.8	3861274
2004 (ii)	ArcGIS & Python	43625	58.6	3860068
2008 (iii)	ArcGIS & Python	As above (ii): no other changes to CL		

Overall the changes to the data and methods make very little difference to the percentage area of sensitive habitats exceeded in the UK. However, for acidity an extra 300 km^2 of sensitive habitat is exceeded due mainly to changes in the critical loads for dwarf shrub heath and additional areas of freshwaters exceeded following the inclusion of the North York Moors sites. Using the new methods the total area exceeded for nutrient nitrogen in the UK has decreased by 129 km^2; this is due to (a) minor changes in the habitat areas and critical loads following transformation of the data from the Irish Grid to the GB grid; (b) not having to transform the deposition data. These factors also play a role in the differences observed for acidity.

5. Conclusions

- All summary critical load exceedance statistics will now be generated using the updated critical loads data and ArcGIS/Python methods as described above.
- A short review on N_{fire} will be produced and circulated.
- Due to the differences observed between the old and new data and methods, summary exceedance statistics have been recalculated using the new data and methods for the CBED deposition data sets (1995-1997, 1998-2000, 1999-2001, 2001-2003, 2002-2004, 2003-2005), since these data are used for one of the Defra sustainable indicators (see indicator no. 28 at http://www.sustainable-development.gov.uk/progress/national/index.htm). The updated summary statistics will be circulated and provided to Defra so this indicator can be updated.