

General enquiries on this form should be made to:
Defra, Science Directorate, Management Support and Finance Team,
Telephone No. 020 7238 1612
E-mail: research.competitions@defra.gsi.gov.uk



defra
Department for Environment
Food and Rural Affairs

SID 4

Annual/Interim Project Report for Period July 12 2005 to July 11 2006.

• ACCESS TO INFORMATION

The information collected on this form will be stored electronically and will be required mainly for research monitoring purposes. However, the contents may be used for the purpose of notifying other bodies or the general public of progress on the project. Defra may also disclose the information to any outside organisation acting as an agent authorised by Defra to process research reports on its behalf.

Defra may be required to release information, including personal data and commercial information, on request under the Environmental Information Regulations or the Freedom of Information Act 2000.

However, Defra will not permit any unwarranted breach of confidentiality or act in contravention of its obligations under the Data Protection Act 1998. Defra or its appointed agents may use the name, address or other details on your form to contact you in connection with occasional customer research aimed at improving the processes through which Defra works with its contractors.

- This form is in Word format and boxes may be expanded or reduced, as appropriate.

Project details

1. Defra Project code

CPEA 19

2. Project title

Critical Loads and Dynamic Modelling for Acidity and Nitrogen

3. Defra Project Manager

Samantha Baker

4. Name and address of contractor

Centre for Ecology and Hydrology
Orton Building, Deiniol Rd
Bangor
Gwynedd

Postcode LL57 2UP

5. Contractor's Project Manager

Christopher Evans

6. Project: start date.....

12 July 2004

end date.....

11 July 2007

Scientific objectives

7. Please list the scientific objectives as set out in the contract. If necessary these can be expressed in an abbreviated form. Indicate where amendments have been agreed with the Defra Project Manager, giving the date of amendment.

Terrestrial dynamic modelling: Site-based model testing; method development, testing and application of models at the national scale; incorporation of improved nitrogen, climate change and management controls in the model; prediction of changes in vegetation due to atmospheric deposition

Freshwater dynamic modelling: Model validation at long-term monitoring sites; extension of regional surface water model applications; prediction of biological recovery.

Critical loads: Management of UK Critical Loads NFC; maintenance and updating of critical loads dataset and website; provision of critical load and dynamic model data to UNECE Coordination Centre for Effects.

Scenario analysis Provision of critical load and dynamic model scenario assessments to Defra on request

Contribution to international activities: Chairing of UNECE Joint Expert Group on Dynamic Modelling; UK NFC for ICP-IM programme.

Summary of Progress

8. Please summarise, in layperson's terms, scientific progress since the last report/start of the project and how this relates to the objectives. Please provide information on actual results where possible rather than merely a description of activities.

The following summary and listed progress in relation to milestones cover the period since the half-year report was submitted in Feb 2006. The appended report covers the full one-year reporting period.

WP1. Dynamic Modelling of UK soils MAGIC validation runs have been carried out for Forest Level II plots with long-term soil solution monitoring data, and show generally good agreement between modelled and observed recovery from acidification. MAGIC has also been applied to the Moorhouse ECN site, replicating climate-related seasalt variation and drought-induced sulphate flushes. This suggests that much of the apparent 'recovery' at this peatland site may in fact be climate-related. Model upscaling work has included the creation of a national input dataset in Access, based on the critical loads input dataset, from which the updated Very Simple Dynamic (VSD) model can now be applied. Trial regional model runs have been undertaken for a 100 km² area of NE Wales, and outputs compared to MAGIC-calibrated simulations from Ruabon experimental site, located within the square. Further testing is ongoing. The MAGIC model itself has now been substantially upgraded for the project, to include new N dynamics, and the capacity to run large (i.e. national-scale) batch runs.

WP2. Dynamic Modelling of UK freshwaters. A major MAGIC recalibration of all existing regions was undertaken for the Feb 2005 CCE data submission during the last reporting period. A manuscript comparing UK and Scandinavian modelling results is in preparation. Data for the new North York Moors region have also been collated prior to MAGIC application. MAGIC has been recalibrated to three Scottish AWMN catchments for model validation, using an improved 2-box model formulation (a manuscript has been submitted on this work). N uptake has been included in the model, and a new set of carbon pool estimates English and Welsh catchments has been derived from National Soils Research Institute data. Some concerns have been identified with individual soil types and these are being addressed; for now, existing C pool estimates will be retained.

WP3. Coordination of critical load activities. No updates have been made to the national steady-state critical loads database. The NFC maintains a watching brief on developments in critical loads research. National databases of the areas of designated sites, including RAMSARs, are in the process of being updated for use under WP5.

WP4. National Focal Centre for Critical Loads and Dynamic Modelling. It has not been necessary to submit any data to the CCE in the last year. The current national data are being used for the development and testing of national-scale dynamic modelling for terrestrial habitats. The NFC web site is being maintained and there are plans for its further development. The NFC represented the interests of the project and Defra at the Task Force meeting of the UNECE ICP on Mapping and Modelling.

WP5. Scenario analysis and advice to Defra and devolved administrations. Critical load exceedance statistics (area, percentage, accumulated exceedance) by habitat and country have been generated using (a) deposition data for 2002-04; (b) time series data for 1970 and 2020; (c) scenarios for the RIA Marine Fuels Directive; (e) scenarios for Defra's Air Quality Strategy. For the latter exceedance of air quality objectives (gaseous concentrations) were also assessed.

WP6. Chairmanship of the UNECE Dynamic Modelling Expert Group. The final report of the 2006 Joint Expert Group, and the report of the workshop on nitrogen and biodiversity modelling, have been submitted to the WGE. A date has been set and initial invitations issued for the 2007 meeting in October.

WP7. National Focal Point for ICP-Integrated Monitoring. The project has contributed to ICP Integrated Monitoring through assessments of the impact of climate change on recovery from acidification, estimation of MAGIC-derived critical and target loads, and calculation of heavy metal budgets.

Amendments to project

9. Are the current scientific objectives appropriate for the remainder of the project?.....YES NO
If **NO**, explain the reasons for any change giving the financial, staff and time implications.

Contractors cannot alter scientific objectives without the agreement of the Defra Project Manager.

Progress in relation to targets

10. (a) List the agreed milestones for the year/period under report as set out in the contract or any agreed contract variation.

It is the responsibility of the contractor to **check fully that all milestones have been met** and to provide a detailed explanation when they have not been achieved.

Milestone		Target date	Milestones met	
Number	Title		In full	On time
M1.2	Completion of dataset for new site-specific model applications	Oct 2005	✓*	✓
M1.3	Creation of database for national-scale modelling	Oct 2005	✓	✓
M1.4	Trial 'regional' soils model applications and testing	Mar 2006	✓	✓
M1.5	Model analysis of land-management impacts	Mar 2006	✓	✓
M2.3	New estimates for catchment C and N pools	Oct 2005	✓	✓

M2.4	Model validation runs for AWMN sites	Mar 2006	**	**
M2.5	Testing of biological predictions at AWMN sites	Mar 2006	**	**
M2.6	Initial MAGIC calibration to all regions	Mar 2006	✓	✓
M3.2	Updated SSSI, SAC, SPA data	May 2006	✓	✓
M4.2	Updates to UK dynamic modelling database	Jan 2006	✓	✓
D4.3	Respond to CCE call for data	Feb 2006	No response required	
D5.2	Critical load and dynamic model assessments	2005 on request	✓	✓
M6.2	Report on 5 th JEG Meeting delivered at WGE	Aug 2005	✓	✓
M6.3	<i>6th JEG Meeting organised and held</i>	Oct 2005	✓	✓
D6.3	Draft report on 6 th JEG Meeting completed	Nov 2005	✓	✓
D6.4	Final report on 6 th JEG Meeting submitted to WGE	May 2006	✓	✓
D7.2	Final report on DM and climate interactions to WGE	Aug 2005	✓	✓
M7.4	Completion of database for 2004	Oct 2005	✓	✓
M7.5	Data transmission to EDC Helsinki	Nov 2005	✓	✓
M7.6	Attendance at ICP-IM Task Force	Apr 2006	✓	✓

(b) Do the remaining milestones look realistic?.....YES NO
If you have answered **NO**, please provide an explanation.

Notes on milestones and deliverables above:

* Dataset will continue to be expanded as further data become available (e.g. Whim and Thursley experimental sites, where soil solution sampling began in 2005).

**Milestones partially met (see Annex), but completion delayed due to periods of parental leave by two members of the consortium. Remaining work for this element of the work programme will be completed by autumn 2006; no adjustments to the work programme are required.

Project costs and staffing input

11. In this reporting period what was:	approved project expenditure	£ 156257
	actual project expenditure.....	£ 168943
	approved staff input (days).....	406
	actual staff input (days)	419

Publications and other outputs

12. (a) Please give details of any outputs, e.g. published papers/presentations, meetings attended during this reporting period.

Reports produced during the reporting period (full year)

Rowe, E.C., Moldan, F., Emmett, B.A., Evans, C.D., and Hellsten, S. (2005). Model chains for assessing impacts of nitrogen on soils, waters and biodiversity: a review. Centre for Ecology and Hydrology/ASTA Programme report for the 6th meeting of the Joint Expert Group on Dynamic Modelling under the Working Group on Effects of the Convention on Transboundary Air Pollution. 63 pp.

Hall, J., Dore, A., Heywood, E., Broughton, R., Stedman, J., Smith, R.I. & O'Hanlon, S. (2006). Assessment of the environmental impacts associated with the UK Air Quality Strategy. Report to Defra 2006. 106pp.

Hall, J., Ulyyett, J., Evans, C., Rowe, E., Aherne, J., Helliwell, R., Ferrier, R., Jenkins, A. and Hutchins, M. (2005). UK National Focal Centre report. In: Posch, M., Slootweg, J., Hettelingh, J.P. (eds.) European critical loads and dynamic modelling. CCE Status Report 2005. Netherlands Environmental Assessment Agency, Report 259101016/2005. Bilthoven, Netherlands. p158-160.

Joint Expert Group Meeting on Dynamic Modelling: Summary report on the sixth meeting prepared by the organisers. Report to the Working Group on Effects of the Convention on Transboundary Air Pollution.

Workshop on Nitrogen Processes and Dynamic Modelling. Summary report on the meeting prepared by the organisers. Report for the Joint Expert Group on Dynamic Modelling of the Working Group on Effects, Convention on Transboundary Air Pollution.

Hutchins, M. and Jenkins, A. Use of dynamic modelling forecasts of streamwater chemistry to derive future target loads for N and S in atmospheric deposition. Chapter 4, ICP-IM Annual Report, <http://www.environment.fi/default.asp?contentid=17110&lan=en>.

Papers accepted for publication during the reporting period

Hall, J., Ulyyett, J., Wadsworth, R.A. & Reynolds, B. The applicability of national critical loads data in assessing designated sites. *Water, Air and Soil Pollution: Focus*.

Rowe, E.C., Evans, C.D., Emmett, B.A., Reynolds, B., Helliwell, R.C., Curtis, C.J., and Coull, M.C. Vegetation type affects the relationship between soil carbon to nitrogen ratio and nitrogen leaching. *Water, Air and Soil Pollution*.

Papers published during the reporting period

Evans, C.D. (2005) Modelling the effects of climate change on an acidic upland stream. *Biogeochemistry*, 74, 21-46

Evans, C.D., Caporn, S.J.M., Carroll, J.A., Pilkington, M.G. Wilson, D.B., Ray, N., Cresswell, N. (2006). Modelling nitrogen saturation and carbon accumulation in heathland soils under elevated nitrogen deposition. *Environmental Pollution*, 143, 468-478.

Evans, C.D., Cooper, D.M., Juggins, S., Jenkins, A., and Norris, D. (2006). A linked spatial and temporal model of the chemical and biological status of a large, acid-sensitive river network. *Science of the Total Environment*, 365, 167-185

Evans, C.D., Reynolds, B., Jenkins, A., Helliwell, R.C., Curtis, C.J., Goodale, C.L., Ferrier, R.C., Emmett, B.A., Pilkington, M.G., Caporn, S.J.M., Carroll, J.A., Norris, D., Davies, J., Coull, M.C. (2006) Evidence that soil carbon pool determines susceptibility of

semi-natural ecosystems to elevated nitrogen leaching. *Ecosystems*, 9, 453-462.

Wright, R.F., Aherne, J., Bishop, K., Camarero L., Cosby, B.J., Erlandsson, M., Evans C.D., Forsius, M., Hardekopf, D.W., Helliwell, R., Hruska, J., Jenkins, A., Kopáček, J., Moldan, F., Posch, M., and Rogora, M. F. (2006). Modelling the effect of climate change on recovery of acidified freshwaters: relative sensitivity of individual processes in the MAGIC model. *Science of the Total Environment*, 365, 154-166.

Meetings attended

Workshop of the Co-ordination Center for Effects, Bled

Task Force Meeting of the ICP on Mapping and Modelling, Bled

Joint Expert Group on Dynamic Modelling and workshop on nitrogen modelling, Brighton

Working Group on Effects, Geneva

Defra Ammonia Research Coordination meeting, IGER, Devon

Acid Rain 2005 Conference, Prague

Biogeomon Conference, Santa Cruz

Air Pollution Research in London (APRIL): October 2005 & January 2006

Posters and presentations

J. Aherne, R.C. Helliwell, A. Lilly, R.C. Ferrier, A. Jenkins. Dynamic modelling of the acidification process: the two soil-layer approach. Poster, Acid Rain Conference, Prague.

C.D. Evans, E.C. Rowe, C.J. Curtis, R. C. Helliwell, B. Reynolds, B.A. Emmett and M.C. Coull. Can organic soil C/N ratios be used to predict inorganic nitrogen leaching in acidification models? Presentation, Acid Rain Conference, Prague.

C.D. Evans, B. Reynolds, O. Kaste, R. Wright, F. Moldan. The potential influence of changing climatic extremes on acidic episodes and recovery from acidification. Poster, Acid Rain Conference, Prague.

C.D. Evans. Report from the workshop on nitrogen processes and dynamic modelling. Presentation, CCE Workshop, Bled

C.D. Evans, D. Monteith, P. Chapman, J. Clark. Dissolved organic carbon, sulphur and nitrogen: Is everything connected to everything else? Presentation, Biogeomon Conference, Santa Cruz

J. Hall, J. Ulyett, R.A. Wadsworth, B. Reynolds. The applicability of national critical loads data in assessing designated sites. Presentation, Acid Rain Conference, Prague.

R.C. Helliwell, C.D. Evans, M.C Coull, A. Jenkins, R.C Ferrier, B. Reynolds, J. Davies, J. Aherne. Predicting the potential recovery from acidification in response to reduced nitrogen deposition across the UK: a new approach to model parameterisation. Poster, Acid Rain Conference, Prague.

F. Moldan, J. Aherne, C. Evans, R. Helliwell, V. Kronaas, T. Larssen, M. Posch. Target load functions and scenario analysis for recovery of acidified surface waters in Europe.

Poster, Acid Rain Conference, Prague.

R.F. Wright, J. Aherne, K. Bishop, L. Camarero, B.J. Cosby, C.D. Evans, D. Hardekopf
R. Helliwell, J. Hruska, A. Jenkins, F. Moldan, M. Posch, M. Rogora. Modelling the effect
of climate change on recovery of acidified freshwaters: relative sensitivity of individual
processes in the MAGIC and SMART models. Poster, Acid Rain Conference, Prague.

- (b) Have opportunities for exploiting Intellectual Property arising out of this work been identified?YES NO
If **YES**, please give details.

- (c) Has any other action been taken to initiate Knowledge Transfer?YES NO
If **YES**, please give details.

Future work

13. Please comment briefly on any new scientific opportunities which may arise from the project.

Some future priorities for work in this area are considered to be:

1. Development of a model framework linking models of nitrogen, carbon, acidity, plant growth and biodiversity change.
2. Improved representation of key feedbacks and interactions within the MAGIC model, such as feedbacks between DOC and acidity, between N immobilisation and organic matter accumulation, and the role of sulphate release from wetlands as a climate-dependent delay to recovery in peats
3. Development of a spatially distributed version of MAGIC, in order to predict specific areas of vulnerability to N-induced biodiversity change within the landscape, e.g. within designated sites
4. Generation of biodiversity-based critical loads for nitrogen
5. Prediction of the impacts of climate change on critical loads, and on modelled timescales of recovery from acidification and nitrogen saturation.
6. Large-scale model validation, e.g. against Countryside Survey data
7. Extension of MAGIC applications for surface waters to the full Freshwater Critical Load dataset
8. Development of a tool to predict long term changes in the chemical and biological status of unmodelled UK surface waters by 'matching' with modelled sites

Declaration

14. I declare that the information I have given is correct to the best of my knowledge and belief.

Name

Christopher Evans

Date

19 July 2006

Position held

CEH Project Manager