DEPARTMENT for ENVIRONMENT, FOOD and RURAL AFFAIRS **CSG 15**

Research and Development

Final Project Report

(Not to be used for LINK projects)

Two hard copies of this form should be returned to:
Research Policy and International Division, Final Reports Unit
DEFRA, Area 301
Cromwell House, Dean Stanley Street, London, SW1P 3JH.
An electronic version should be e-mailed to resreports@defra.gsi.gov.uk

Project title	Review of impacts of rural land use and management on flood generation; short term improvement in modelling and future research plan
DEFRA project code	**FD2114**
Contractor organisation and location	School of Civil Engineering and Geosciences University of Newcastle Newcastle upon Tyne NE1 7RU
Total DEFRA project costs	£ 141,955
Project start date	27/01/03
Project end date	31/12/04

Executive summary (maximum 2 sides A4)

The objectives specified for this work were: (1) to review the factors contributing to runoff and flooding in the rural (managed, not natural) environment, and to scope out the research needed to improve the identification of the management policies and interventions to reduce the impact of flooding; and (2) to deliver in the short term an improvement in the estimation of the effects of changes in rural land management on flood generation to the Catchment Flood Management Plans (CFMP) programme.

A review of the impacts of rural land use and management on flood generation was carried out by a team drawn from the disciplines of agriculture, soil science, hydrology, hydrogeology and socio-economic science and a research plan developed. This plan takes into account the findings from the review and maps a way forward in defining and implementing best practice in flood prevention and mitigation associated with rural land use change and management practices and for operational assessment of the likely effects of prevention and mitigation measures. In the medium and longer term (5-10 years), the planned research should lead to an improved scientific understanding and better methods for predicting impacts. For the short term, a procedure has been developed for use within the Modelling and Decision Support Framework (MDSF) in preparing CFMPs.

The review covered the following topics and areas:

(1) Field experiments, available data, models, and flood analysis and prediction methods.
(2) Catchment modelling and the prediction of impacts.
(3) Current state of managed land in England and Wales: arable (including cereals, oilseed rape, maize and root crops); annual feed crops; woodland; grassland; livestock; and field under-drainage.
(4) Effects of current farming practices on soil structure and runoff.
(5) Flood mitigation practices, including cover crops, minimum tillage, hillslope runoff control, use of machinery, retention structures and wetlands.
(6) Monitoring and modelling studies (plots, fields, hillslopes and catchments).
(7) Socio-economic aspects, including the response of land managers to measures and policies, categorized in terms of a drivers-pressure-state-impact-response (DPSIR) framework.
(8) The future. Agri-Environmental Schemes, CAP reforms, long-term Foresight scenarios, climate change, etc.
(9) Integrated runoff management at the farm scale, generating wider benefits by reducing erosion and agricultural pollution.

(10) Implications for water resources.

A Source-Pathway-Receptor framework was used in a critical assessment of the review material, to quantify the current state of knowledge about impacts. Changes in local-scale surface runoff are the Source where 'local-scale' includes plots, fields, small hillslopes and areas at field edges. The effects then propagate through the surface water network – the Pathway. The Receptor is the loction where the flood impact takes place

The main conclusions are as follows. Significant changes in land use and management practices in the last fifty years have resulted in the intensification of agricultural land use, as a direct response to the incentives provided by agricultural policy, modified by local and farm factors. Changes in land use and management practices affect runoff generation at the local scale, but the effects are complex. Local changes are transferred to the surface water network and propagate downstream. There is very little firm evidence of impacts downstream, at larger scales, but there are very few studies in which evidence has been sought. There are many measures that can be taken to mitigate local flooding by delaying runoff, such as using grass buffers. An integrated approach is needed in applying these measures so that the maximum overall benefit is gained for flood and pollution mitigation and erosion reduction. There is considerable uncertainty about how effectively land managers will respond to any promotions or policies related to particular flood prevention or mitigation measures. There is no generally-accepted theoretical basis for the design of a rainfall-runoff model suitable to predict impacts. It is not known which data have the most value when predicting impacts. There are limitations in the methods available for estimating the uncertainty in predictions. A considerable amount of high-quality field data on impacts will be needed to support the development of robust methods for predicting impacts.

In designing the research plan, a wide view was taken of how management decisions about flood prevention and mitigation will be made in the future, including how an integrated whole-catchment multi-function approach to decision making will evolve. Consideration was also given to the wider context of the work, including the Water Framework Directive. The following five recommendations were made and followed through in the detailed design of the research plan:

(1) There is a need to learn what can be learned about the flood impacts of changes in rural land use and management that have taken place in the past. In particular, there is a need to apply modern modelling and statistical techniques to examine existing rainfall-runoff records and isolate and quantify flood impacts. Also, there is a need for multiscale monitoring in catchments to build up the knowledge base related to how catchments function and in particular how the effects of changes in land use and management propagate downstream.
(2) For general use in research and in impact assessment and policy making, there is a need for an electronic map identifying the catchments that are vulnerable to local and downstream flooding as a result of changes in rural land use and management.
(3) There is need for field trials of flood mitigation measures, to build up the knowledge base. There is also a need for best practice to be established, both for selecting which flood prevention and mitigation measures should be used to meet local needs and how these measures should be promoted.
(4) A coherent approach is needed in modelling the flood impacts of changes in land use and management. Ideally, this would represent socio-economic, agricultural and hydrological effects and responses. It would be in the form of a decision-support tool for estimating the likely outcome of implementing flood prevention and mitigation measures and the outcomes when policies and promotions are used to encourage the uptake of measures. The tool would take account of uncertainty, could be used to examine future scenarios for climate, land use and management, and would give a basis for rigorously testing rainfall-runoff modelling so that issues related to the theoretical basis of modelling and the value of data can be addressed.
(5) A solid research base must be established and maintained if real progress is to be made in assessing the flood impacts of changes in rural land use and management and in establishing best practice for flood prevention and mitigation. It is essential, therefore, that the research work in the research plan should be designed to leave a high-quality, useful and comprehensive legacy in the form of project reports, specification documents, datasets, open-source software, user manuals, and guidance

The research plan comprises 16 projects, in two programmes: a medium term near-user programme (11 projects) running over a period of five years, and a longer term programme (5 projects) running over a period of ten years. The bulk of the funding (70%) is allocated to data collection, assembly and various forms of analysis, and the remainder (30%) to developing and testing the necessary models.

The procedure developed for use within the MDSF in the short term is rather time consuming to apply. It involves adjusting the parameters Tp and SPR of the FEH rainfall runoff model to account for the effects of a change in land use or management practice. GIS data on HOST soil class and land use are used, in addition to data and GIS procedures from the MDSF, to define a ‘worst case’ or ‘fully degraded’ impact of agricultural intensification on Tp and SPR. The procedure makes use of a Decision Support Matrix tool called FARM (the Flood and Agriculture Risk Matrix) to assess the likely degree of degradation due to agricultural intensification within the catchment.

Project title	Review of impacts of rural land use and management on flood generation; short term improvement in modelling and future research plan	DEFRA project code	FD2114

Scientific report (maximum 20 sides A4)

There is a set of substantial Technical Reports for the work carried out in Project FD2114:

(1) O'Connell et al., 2004a: a review of the impacts of rural land use and management on flood generation. This report has several detailed appendices.

(2) O'Connell et al., 2004b: a research plan which maps a way forward in defining and implementing best practice in flood prevention and mitigation associated with rural land use change and management practices and for operational assessment of the likely effects of prevention and mitigation measures.

(3) Packman et al., 2004a: a procedure for assessing the effect of land use and management changes on the parameters Tp and SPR of the FEH rainfall runoff model, for use within the Modelling and Decision Support Framework (MDSF) in preparing Catchment Flood Management Plans (CFMPs).

(4) Packman et al., 2004b: a user manual for the procedure in (3).

O'Connell P.E., Beven K.J., Carney J.N., Clements R.O., Ewen J., Fowler H., Harris G.L., Hollis J., Morris J., O'Donnell G.M., Packman J.C., Parkin A., Quinn P.F., Rose S.C., Shepherd, M. and Tellier, S., 2004a. Review of Impacts of Rural Land Use and Management on Flood Generation, Report A: Impact Study Report.

O'Connell P.E., Beven K.J., Carney J.N., Clements R.O., Ewen J., Hollis J., Morris J., O'Donnell G.M., Packman J.C., Parkin A., Quinn P.F., Rose S.C. and Shepherd, M., 2004b. Review of Impacts of Rural Land Use and Management on Flood Generation, Report B: Research Plan.

Packman J.C., Quinn P.F., Hollis, J. and O'Connell P.E., 2004a. Review of Impacts of Rural Land Use and Management on Flood Generation, Report C2: Short-term Improvement to the FEH rainfall-runoff model: Technical Background.

Packman J.C., Quinn P.F., Farquharson F.A.K. and O'Connell P.E., 2004b. Review of Impacts of Rural Land Use and Management on Flood Generation, Report C1: Short-term Improvement to the FEH Rainfall Runoff Model: User Manual.