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SID 5 Research Project Final Report

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Project identification

1. Defra Project code: FD2120
2. Project title: ANALYSIS OF HISTORICAL DATA SETS TO LOOK FOR IMPACTS OF LAND USE AND MANAGEMENT CHANGE ON FLOOD GENERATION
3. Contractor organisation(s): Lancaster University, Newcastle University, Cranfield University, JBA Consulting Ltd
4. Total Defra project costs (agreed fixed price): £ 144,582
5. Project: start date ..... 27 April 2006
   end date ..... 31 March 2008

6. It is Defra's intention to publish this form.
   Please confirm your agreement to do so.....**YES** ☒ **NO** ☐

   (a) When preparing SID 5s contractors should bear in mind that Defra intends that they be made public. They should be written in a clear and concise manner and represent a full account of the research project which someone not closely associated with the project can follow.
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Executive Summary

7. The executive summary must not exceed 2 sides in total of A4 and should be understandable to the intelligent non-scientist. It should cover the main objectives, methods and findings of the research, together with any other significant events and options for new work.

The purpose of this study was to provide an analysis of historical data sets to ascertain whether any impacts of land use and management change on flood generation could be identified. This report presents the results of the study. Data on the nature of change in agricultural land use and management are reviewed. These data were then used to choose catchments for which change had been developed and for which hourly hydrological data were available over several decades. The change identification methodologies used were Dynamic Harmonic Regression (DHR) methods to examine longer term trends in monthly rainfalls and flows and Data Based Mechanistic (DBM) models, with a State Dependent Parameter (SPD) nonlinear filtering of rainfall inputs to examine changes in storm responses using the shorter periods of available hourly data.

In general, variability between years and inconsistencies in the rainfall and flow data appear to dominate any tendency to changes over time or with hydrological conditions. In the DHR analyses, only monthly flows could be shown to exhibit any significant trend and then only for 2 of the 9 catchments prioritised for study, the Axe and the (nearby) Isle. In the DBM analysis of modelled hydrograph characteristics most catchments showed no clear changes over time. Where tendencies for change in hydrograph characteristics with time are evident, they are masked by year to year variability. There was some tendency to reflect the hydrological conditions as represented by maximum flow in a period. This suggests that the modelling strategy has not captured all of the information content of the data.

A method was developed to test the analysis methodology by imposing changes to runoff generation in a consistent way by modifying the measured data series, retaining the natural variability and inconsistencies in the datasets in the modifications. Data for two catchments were modified in this way. In both cases, it proved difficult to identify the changes relative to year to year variability in response. This may be a result of real variability, uncertainty induced by data inconsistencies, and uncertainty induced by the statistical assumptions of the analysis not being met.

The most promising method of change identification in the catchment dynamics was found to be to analyse groups of "similar" events classified by antecedent condition and peak flows. This analysis was applied to the Axe catchment only, but revealed some consistent changes in the DBM model parameters for some of the classes, including an apparent change in response in the pre-1980 period.

The policy implications of the results are considered with the following recommendations:

1. Both climate variability, particularly rainfall variability, and land use and management affect changes in flood runoff. Changes in discharge should not be analysed without consideration of

changes in catchment rainfall inputs.

2. The preliminary study of catchment responses within different event classifications was the most promising form of analysis developed during this project. Different classification schemes should be investigated to check the nature of changes, including a more complete uncertainty analysis. Careful quality control of existing datasets is necessary in carrying out such analyses. The method should also be tested against modified data sets produced by the Juke methodology.
3. Adequate information about past land management changes and soil conditions is not readily available but will need to be collected and made available in future for different land use categories if improved understanding of the links between runoff and land management is to be gained and used at catchment scales.
4. The results of this project show that there will be a real difficulty of estimating the benefits of such measures in respect of any reduction of flood risk. Further monitoring of studies aimed at reducing runoff should be carried out to evaluate the effectiveness of different types of measure at the local level in the context of farm environment schemes
5. The difficulty in identifying consistent change given the limitations of the available data means that land management measures cannot be relied on as alternatives to more proven flood risk management options.
6. The difficulty in identifying consistent change given the limitations of the available data does not mean that change is not happening and should not be taken to imply a policy of doing nothing. Contextually relevant management practice guidelines (linked to land use, soil type, antecedent condition) should be developed and monitored to deliver multiple benefits including reduced runoff generation and local flood risk.

Further science needs

There are in addition implications for science in the results of the study. While points 4 and 5 effectively rule out for the moment reliance on land management measures as an alternative to more proven flood risk management options, there are indications that there may be some impacts hidden in climate variability and uncertain data.

It is noted for instance that the failure to identify impacts may be in part a result of the limitations of the data available for both rainfall and discharges. It is also noted that there were changes in catchment dynamics for different classes of events in the Axe catchment. This appears to show quite different trends in response for different classes of events, with an increase in the speed of the fast responses in one class, and a decrease in two other classes.

It is therefore concluded that while reliable assessment is not possible at this time, there is a strong case for continuing with the present research projects on land use and runoff experimentation and modelling in FRMRC2, in the NERC FREE programme and in project SC060092 (Multiscale Experimentation, Monitoring and Analysis of long-term land use changes and flood risk). By careful measurement and analysis, these promise to increase our understanding and allow progress towards providing improved predictive tools to assess sensitive locations, sensitive types of flood events, and robust FRM options in the future. These projects do, however, cover only a limited range of land management classes and there is a need to identify suitable sites for catchment scale studies of the impacts of changes in arable management practices.

Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:
   - the scientific objectives as set out in the contract;
   - the extent to which the objectives set out in the contract have been met;
   - details of methods used and the results obtained, including statistical analysis (if appropriate);
   - a discussion of the results and their reliability;
   - the main implications of the findings;
   - possible future work; and
   - any action resulting from the research (e.g. IP, Knowledge Transfer).

References to published material

9. This section should be used to record links (hypertext links where possible) or references to other published material generated by, or relating to this project.

Keith Beven, Renata Romanowicz, Peter Young, Ian Holman, Helena Posthumus, Joe Morris, Steve Rose, Enda O'Connell and John Ewen, 2008, An event classification approach to the identification of hydrological change, Proceedings DEFRA Flood and Coastal Management Conference, 2008.