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Defra, Science Directorate, Management Support and Finance Team,
Telephone No. 020 7238 1612
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SID 5 Research Project Final Report

- **Note**
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Project identification

1. Defra Project code: FD2118

2. Project title:
   Broad Scale Modelling - a Scoping Study on catchment scale modelling for MAR vision

3. Contractor organisation(s):
   Imperial College Consultants Ltd
   2nd floor, 47 Prince's Gate
   Exhibition Road
   London
   SW7 2QA

4. Total Defra project costs (agreed fixed price): £ 41800

5. Project: start date ..... 01 January 2006
   end date ..... 31st March 2007

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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In all cases, reasons for withholding information must be fully in line with exemptions under the Environmental Information Regulations or the Freedom of Information Act 2000.

(b) If you have answered NO, please explain why the Final report should not be released into public domain

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 management of flooding in the UK has been evolving rapidly in recent years, and Defra's policy 'Making Space for Water' (MSW) embodies a radical change in perspective for flood risk management from earlier approaches that focussed on local assessment of hard defences. MSW emphasizes the need for integrated management of flood risk at the spatial scale of the whole catchment or the whole shoreline. This requires consideration of both structural and non-structural measures, including rural land use solutions, and a more integrated approach to specific issues such as urban drainage, coastal flooding and erosion. MSW also emphasizes the need to 'deliver the greatest environmental, social and economic benefits consistent with the Government's sustainable development principles,' which requires broadly-based multi-criterion assessment. MSW must also be seen in the context of European developments, in particular the Water Framework Directive, which has wide-ranging implications for water management and the protection of ecological quality, and the forthcoming Floods Directive. Implicit in this new perspective is the need for new and broader approaches to decision support systems and modelling; it is these challenges that this report addresses.

The Modelling and Risk (MAR) Theme of the Defra/EA Flood and Coastal Erosion Research Programme has recognised the need to develop a medium-term (5 years) and longer term (10 years) vision of integrated decision support systems. It therefore established project FD2118 to address:

- The extent to which an integrated modelling system of the physical environment is feasible and desirable, given the specific individual requirements of fluvial, estuarial and coastal flood management.
- How current developments such as continuous rainfall and runoff simulation and risk-based flood impact modelling may be assembled into a coherent set of tools, useable by the FRM community.
- How such a set of catchment tools would interface with similar sets of tools currently being developed for the estuarial and coastal areas.
- The extent to which broader issues of environmental management such as socio-economic aspects can be integrated with the physical systems model(s)

FD2118 has assembled a team of leading UK researchers to review the state-of-the-art in their respective fields, to consider the technical developments that they foresee as feasible over the 5 and 10 year timescales, and hence to identify a vision of a future decision support framework to meet the challenges of MSW. Consistent with the scope of work and available resources, FD2118 has focused on developing the

vision, and, while aware of developments such as RASP, PAM and MDSF2, has not set out explicitly to undertake detailed mapping of connections to the existing Defra/EA research and development programme. FD2118 has, however, outlined a programme of integrating research needed to bring the vision to fruition, the first stage of which is based on existing methods and hence naturally meshes with current work.

Appendix A to this report presents the full detail of the FD2118 outputs, including detailed topic reviews and identified research needs and priorities in individual areas. This Summary Report presents the vision for Broad Scale Modelling within a DPSIR (Drivers-Pressures-States-Impacts-Responses) framework, a summary of technical developments and future vision for component areas, and an outline programme of integrating research.
Key aspects of the DPSIR-BSM framework (section 3) are:

- Quantitative scenario modelling of the drivers and pressures that impact upon flood risk,
- Whole catchment and shoreline modelling of flood and erosion risks under uncertain future climatic and socioeconomic conditions, and under a wide range of response options;
- Integrated assessment of portfolios of response options based on economic, social and environmental criteria, including measures of vulnerability, resilience, adaptability and reversibility;
- Integration of technical and socioeconomic modelling through agent-based modelling approaches;
- Quantification of the various sources of uncertainty and their propagation through the modelling/decision-making process;
- Supporting a multi-level participatory stakeholder approach to decision-making.

This framework requires a broader scope of modelling, and poses methodological challenges to incorporate a wider range of processes and to couple models across spatial and temporal scales; a programme to achieve this is proposed, placed in the context of expected developments over a 5 and 10 year horizon. Our vision of the future includes significant developments in computing systems and in the availability of data. For example, remote sensing is already playing a key role in providing data on topography, vegetation and flood inundation extent. A new generation of wireless sensors is likely to revolutionize the availability of real-time information on water levels and water quality. These data can and will support the development of more complex models, and be used to constrain model uncertainty. Following developments in Europe, we foresee for the UK major changes in modelling over this time-frame, specifically the development of ‘models of everywhere’, with places acting as agents for the assimilation of hard and soft data by models which will act as a focus for learning about places.

Moving beyond consideration of the purely physical systems, socio-economic issues have been highlighted as fundamental to the assessment of the consequences of flooding, with respect to both the impacts on receptors, and the assessment of response effectiveness. Socio-economic science is also needed to provide insights into the fundamental driving forces that are causing changes in risk, and to understand how governance impacts on the formulation and delivery of responses. The long term vision is to incorporate interactive modelling of these effects within the planning process.

Summaries of the visions of the 5 and 10 year future developments can be found as follows:
Socio-economic aspects (section 4)
Computing, data systems, data assimilation and uncertainty (section 5)
Modelling for catchments, estuaries and coasts (section 6)
Urban flooding and infrastructure (section 7)

Essential integrating research to achieve these objectives is presented as a phased programme, defined initially as a £2.5 million 5 year programme. This is aimed to deliver:

- A DPSIR-BSM framework in 3 years, based on 2 integrating case study applications, and largely current technology
- Enabling technology to support the next generation of DPSIR-BSM decision support system, in the areas of model integration and socio-economics
- A strategic review of data and modelling aspects to underpin the 10-
- year vision of models of everywhere
- New research on national assessment of risks from extreme extremes

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.