Joint Defra / Environment Agency Flood and Coastal Erosion Risk Management R&D Programme

FLOODsite liaison interim report February 2006

R&D Technical Report SC040035

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Environment Agency

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Our work includes tackling flooding and pollution incidents, reducing industry's impacts on the environment, cleaning up rivers, coastal waters and contaminated land, and improving wildlife habitats.

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Executive Summary

The first round of the Sixth Framework Programme of the European Commission (2002-2006) includes an integrated project on flood risk management called FLOODsite. It is the largest ever EC research project on floods, with a budget of €14 million, and is scheduled to take five years. The programme aims to provide a European approach to the management of flood risks from rivers, estuaries and the sea.

Other programmes covering similar ground are currently running or are due to start in the near future. These include:

- The *Flood risk management research consortium* (FRMRC) is a nationally funded, multi-agency research programme, supported by the Environment Agency and the Department for Environment, Food and Rural Affairs (Defra). The Engineering and Physical Sciences Research Council (EPSRC) grant to fund the consortium's work totals approximately £6.5 million and is due to run until 2008.
- *Flood risk from extreme events* (FREE) programme, funded by the Natural Environment Research Council (NERC), has a budget of £5.8 million.

The FLOODsite liaison project was established to identify the strands of these research programmes which link to the Environment Agency's work and which will feed into the joint Defra/Environment Agency *Flood and coastal erosion risk management R&D programme*. In so doing, the project will allow the Environment Agency to influence the direction of research, by targeting funding and support to those areas of benefit to its flood forecasting and warning work.

In 2005, four task groups were commissioned for their expertise, to liaise with appropriate strands of the research programmes and to report back. This report is a summary of the interim reports produced by the four groups as of February 2006.

In November 2005, a meeting was held to discuss the initial findings of the task groups. The following tasks were selected as those which Environment Agency staff should become involved in:

Task 11: Risk perception, community behaviour and social resilience
This task takes account of Environment Agency work on vulnerable groups but does not consider other work on *Environmental inequalities* or *Public response to flood warnings* projects. The liaison project will ensure that Environment Agency social policy staff are involved in this task.

Task 19: Development of a framework for flood event management planning
This task links with work areas within the FRMRC programme. The Thames estuary will be used as a trial site, so there are also links with the Environment Agency's National Flow Forecasting System (NFFS). The liaison project considers it an important task for the Environment Agency and will ensure that its flood risk management staff are involved.

Task 20: Development of a framework for the influence and impact of uncertainty
This task was considered important to the Environment Agency as there are overlaps with work areas within the FRMRC programme. The liaison project agreed that the Environment Agency would need to influence the outcomes of this work and recommended involvement of its flood forecasting staff.

The other tasks will continue to be monitored and the groups will report back periodically.

Contents

1 Introduction

1.1 Background

Flood risk management has been identified as a priority for research within the UK and more widely in Europe, with several major R&D programmes starting in 2004 and 2005. These include the FLOODsite, *Flood risk for extreme events* (FREE) and *Flood risk management research consortium* (FRMRC) programmes (see Section 2), as well as a range of projects within the overall joint Environment Agency/ Department for Environment, Food and Rural Affairs (Defra) *Flood and coastal erosion risk management R&D programme.*

As part of the incident management and community engagement (IMC) theme within the overall Environment Agency/Defra programme, a need has been identified to liaise with the FLOODsite, FREE and FRMRC programmes to avoid duplication of work and to maximise the benefits of these programmes in the general areas of flood forecasting and warning (FFW).

Aspects of these programmes which link to Environment Agency business needs will then feed into the Environment Agency/Defra joint R&D programme. This will allow the Environment Agency to influence the direction of research, by targeting funding and support to those areas of benefit to its IMC work.

In 2005, the Flood Forecasting and Warning Theme Advisory Group (later incorporated into the IMC theme) commissioned four external experts (see Section 2.2) to liaise with appropriate strands of the research programmes and to report back. The task groups were given three objectives:

- to develop and maintain familiarity with FLOODsite projects and with relevant areas of other research programmes, including the FRMRC programme and the FREE project;
- to advise the Environment Agency on funding and support for FLOODsite projects, to identify overlaps with other programmes, and to identify projects which could be developed to support the Environment Agency's operational strategy;
- to monitor the progress of projects and to recommend further work within the Environment Agency/Defra programme.

The main objective for these groups is to produce an interim report at an early stage and a final report towards the end of the FLOODsite programme. Further ad-hoc reports may be required as appropriate during the programme. This report summarises the interim reports as of February 2006. It provides a preliminary review of work packages within the FLOODsite, FREE and FRMRC programmes and highlights where these may lead to results that are relevant to the work of the Environment Agency.

1.2 Structure of the report

This report has six further sections:

- Section 2 introduces FLOODsite and the structure of the four FLOODsite task groups. It then outlines the research programmes being reviewed by the FLOODsite project..
- Sections 3 to 6 summarise the findings of the four task groups.
- Section 7 lists the recommendations to the Environment Agency by the four task groups and discusses the findings of the project board meeting of November 2005.

2 Research programmes

Sections 2.1 and 2.2 introduce the FLOODsite programme and the structure of the FLOODsite liaison task groups. Sections 2.3 to 2.5 provide an overview of the three main research programmes being reviewed by the task groups.

2.1 FLOODsite

FLOODsite is a €14 million project that began in March 2004 with funding from the European Commission (€9.7 million) and associated national projects and contributions. It is the largest ever EC research project on floods and is scheduled to take five years. The consortium includes 36 institutions from across the EU and brings together scientists from many disciplines, along with public and private sector involvement. The project addresses the environmental, ecological and socio-economic aspects of floods in order to design a European approach to the management of flood risks from rivers, estuaries and the sea.
FLOODsite will:

- carry out research on sources of flooding, the effectiveness of defences and the impact of floods;
- look at the management of flood risks, from long-term planning to new technologies for flood warning;
- study real flood cases in Belgium, the Czech Republic, France, Germany, Hungary, Italy, the Netherlands, Spain, and the UK.

Paul Samuels, project coordinator (HR Wallingford), in summarising the project (Samuels, 2003) states the main objective of the project is to:

"support the development of an integrated framework for flood risk management from operational to strategic planning time horizons. Our ambition for the project is to support:

- *an integrated European methodology for flood risk analysis and management;*
- *the development of a consistent approach to the analysis and management of the whole flooding system, comprising the natural hazard, the socio-economic vulnerability and the natural ecological and human cultural values;*
- *consistency across flooding sources from rivers, estuaries and the sea (not including urban drainage or groundwater at this stage, since this is not specific to this particular EC call and these issues are covered by other research initiatives);*
- *practical guidance on the framework to support integrated flood risk management;*
- *sustainable pre-flood measures (infrastructure provision, planning and vulnerability reduction);*
- *flood event management (early warning, evacuation and emergency response);*
- *post-event activities (review and regeneration);*
- *integration with and advancement from other EC and national research".*

The programme is divided into seven themes, with sub-themes, as follows:

- Theme 1: Advanced scientific knowledge and understanding (risk analysis)
  - Sub-theme 1.1: Hazard (sources), such as fluvial and coastal extremes
  - Sub-theme 1.2: Hazard (pathways), such as coastal/fluvial defences,

morphodynamics
- Sub-theme 1.3: Vulnerability: receptor exposure and consequences, such as environmental/social response
- Theme 2: Innovative mitigation and sustainable management (risk management)
  - Sub-theme 2.1: Pre-flood measures, for example guidance and best practice
  - Sub-theme 2.2: Flood event management, for example emergency/control
  - Sub-theme 2.3: Post-event activities, such as review/repair
- Theme 3: Technological integration (rivers, estuaries and coasts)
- Theme 4: Pilot application sites (estuaries)
- Theme 5: Training activities (knowledge transfer, training and update, guidance and tools)
- Theme 6: Project networking and harmonisation (such as National and European initiatives)
- Theme 7: Project management

2.2 FLOODsite liaison task groups

Four task groups were established for this project, each focusing on specific FLOODsite tasks as listed below. Details of the consultants employed are given in Table 2.1.

- Task Group 1
  - Task 1: Identification of flash flood hazards
  - Task 15L Radar and satellite observation of storm rainfall for flash flood forecasting in small to medium basins

- Task Group 2
  - Task 9: Guidelines for socio-economic flood damage evaluation
  - Task 10: Socio-economic evaluations and modelling methods
  - Task 11: Risk perception, community behaviour and social resilience

- Task Group 3
  - Task 16: Real-time guidance for flash flood risk management
  - Task 20: Development of a framework for the influence and impact of uncertainty *(in flood forecasting and warning)*

- Task Group 4
  - Task 17: Emergency flood management – evacuation planning
  - Task 19: Development of a framework for flood event management planning.

Table 2.1: List of liaison experts employed

FLOODsite tasks	Liaison consultants	Key contact person
1 and 15	University of Salford	Chris Collier
9, 10 and 11	Collingwood Environmental Planning	Clare Twigger-Ross
16 and 20	Atkins	Kevin Sene
17 and 19	HR Wallingford	David Ramsbottom

2.3 Flood risk management research consortium (FRMRC)

The FRMRC is a four-year programme of research into all aspects of flood risk, which started in 2004. Funding is from the Engineering and Physical Sciences Research Council (EPSRC), in collaboration with the Environment Agency/Defra joint R&D programme on flood and coastal defence, UKWIR (UK Water Industry Research Ltd.), the Natural Environment Research Council (NERC), the Scottish Executive and others. The EPSRC grant totals approximately £6.5 million.

The objectives of the programme include:

- the development of tools and techniques for more accurate flood forecasting and warning, improvements to flood management infrastructure and a reduction in flood risk to people, property and the environment;
- the establishment of a programme of high quality science to enhance our understanding of flooding and improve our ability to reduce flood risk through sustainable flood management.

More than 24 British universities and research organisations are involved in the programme. Overall project management is provided by HR Wallingford and academic leadership by the University of Bristol.

The research programme is split into nine work packages (WP) listed below. Lead organisations are given in brackets:

- WP1: Programme management
- WP2: Land use management (Imperial College, London)
- WP3: Real-time forecasting (University of Bristol)
- WP4: Infrastructure management (HR Wallingford)
- WP5: Whole-system modelling (Herriot Watt University)
- WP6: Urban flood management (University of Sheffield)
- WP7: Stakeholder and policy (University of Manchester)
- WP8: Morphology and habitats (University of Nottingham)
- WP9: Risk and uncertainty (Lancaster University)

2.4 Flood risk from extreme events (FREE)

The FREE project concentrates on the science of extreme events. The programme was developed in response to the threat of more frequent and intense storms, leading to more frequent flooding and more severe flash flooding.

The programme started in 2005 and will run to 2010. It aims to carry out research on the following themes (NERC, 2005a):

- Estimation of the probability and associated risks of extreme events leading to flooding occurring in the period from minutes to weeks ahead. Research will cover such areas as: ensemble prediction methods; down/up scaling; aggregation/disaggregation and propagation of uncertainty through flood forecasting; other statistical methods; warning systems.

- Changes in the intensity and frequency of flooding, and associated weather regimes, resulting from natural and anthropogenic climate change over the next century. Factors dictating our ability to predict the risk of flooding on timescales from seasons to decades will be determined.

- Integrated 'clouds-to-catchment-to-coast' (CCC) flood simulation involving meteorological, hydrological and shelf ocean models linked to user products. This modelling framework will be developed and used for holistic flooding scenarios such as combined storm surges and heavy rainfall.

A science plan for FREE became available in December 2005 (NERC, 2005b) with the following aims:

- to develop and extend the science underpinning integrated modelling frameworks, enabling models to work sensibly and more effectively together;
- to identify and spread scientific improvements in model initialisation, data assimilation and the processing of forecast ensemble outputs across modelling communities;
- to understand and quantify the propagation of uncertainty within a changing environment and within rapidly changing catchments;
- to develop techniques for reducing uncertainty at the output stage, enabling the communication of risk assessment to the user community and its use by that community;
- to improve mitigation of, and adaptation to, floods by providing advice on flood risk management system development;
- to seek the use, or re-analysis and use, of existing datasets whilst organising and creating a methodology to enable specific data to be collected following any extreme event that might occur during the period of FREE;
- to engage with the national and international community and stimulate knowledge transfer and user engagement;
- to provide training opportunities through research studentships including CASE awards, and to encourage the involvement of students funded via other means in FREE activities.

2.5 Environment Agency/Defra joint R&D programme

The Environment Agency and Defra run a joint programme, the *Flood and coastal erosion risk management R&D programme,* which feeds into their work on flood risk management in England and Wales. The programme has four themes, one of which is incident management and community engagement (IMC), which includes flood forecasting and warning. The FLOODsite project is commissioned by the IMC theme.

3 FLOODsite Tasks 1 and 15

3.1 Task 1: Identification of flash flood hazards

This task looks primarily at indicators of flash flood potential, as well as rainfall run-off and other models for estimating floods, particularly in ungauged catchments.

The main aims of this task are to:

- analyse the space-time characteristics of flash flood triggering convective systems. The objective is to understand the meteorological factors which influence these systems, thus leading to high flash flood potential;
- model small basins prone to flash floods, which are seldom gauged and so must be modelled without calibration. This includes observational and modelling studies of extreme floods in mountainous basins, to develop a new concept for hydrological modelling of river catchments as a collection of physical entities (hill slopes);
- investigate the appropriateness and parameterisation of rainfall run-off models used in flash flood situations.

The main contributors to this task are:

- Institut National Polytechnique de Grenoble, France – Report on identification of meteorological factors (lead organisation);
- Technical University of Delft, Netherlands – Update of hydrologic-hydraulic model at regional scale;
- University of Padova, Italy – Identification of critical controlling process;
- Wagenigen University, Netherlands – Development and testing of software based on the hillslope-storage Boussinesq (hsB) approach;
- Group of Applied Research in Hydrometeorology, Catalonia, Spain – Hydrological model parameterisation for use in ungauged basins.

3.2 Task 15: Radar and satellite observation of storm rainfall for flash flood forecasting in small to medium basins

This task deals primarily with real time algorithms (a structured algorithm system or SAS) to detect and estimate extreme storm rainfall using weather radar. The uncertainty in estimates is also considered. The techniques developed will be applied to test catchment areas such as the Adige catchment in Italy and the Ardennes and Cevennes Vivarais areas of France.

All components within this task fall within the general area of *Extreme event recognition.* The project is being led by the Institut National Polytechnique de Grenoble (INPG), France and the main tasks from INPG and the other contributors are:

- Technical University of Dresden, Germany – Rainfall estimation by use of MSG imagery combined with radar ground stations'
- Institut National Polytechnique de Grenoble, France – Theoretical and operational assessment of the SAS efficiency;
- University of Padova, Italy – Assessment of uncertainty in radar rainfall estimation and operational assessment of the SAS on the Adige pilot catchment;

- Wagenigen University, Netherlands – Theoretical development of SAS and operational assessment.

3.3 Links with FRMRC

Work Package 3.3 on weather radar and remote sensing includes work relevant to these areas. For more details, see Section 5.3.1.

3.4 Links with FREE

As of February 2006, the FREE project was still at the planning stage and no links could be ascertained at that time. Research proposals were invited for early 2006 in the following area of uncertainty estimation in flood forecasting applications:

> *Estimation of the probability, and associated risks, of extreme events leading to flooding occurring in the period from minutes to weeks ahead. Research will be carried out to increase scientific knowledge of: ensemble prediction methods; down/up scaling; aggregation/disaggregation and propagation of uncertainty through flood forecasting; other statistical methods; warning systems.*

3.5 Links with Environment Agency/Defra R&D programmes

The following projects have relevance to flash flood hazard and radar and satellite observation:

- *Extreme event recognition* FD2208
- *Rainfall run-off and other modelling for ungauged/low benefit locations* SC030227
- *Assessment of radar data quality in steep upland catchments* SC040023
- *Modelling extreme rainfall events* FD2210

3.6 Summary of Tasks 1 and 15

3.6.1 Task 1: Identification of flash flood hazards

There appears to be considerable overlap between the work carried out in Task 1, in FREE and in the Defra *Extreme event recognition* projects I and II. The hydrological model work in Task 1 promises a new approach which is worth later assessment.

3.6.2 Task 15: Radar and satellite observation of storm rainfall for flash flood forecasting in small to medium basins

The proposed work is likely to be of interest, but on the radar side little new work may emerge. The work on vertical reflectivity may be of use. The satellite algorithm development could reveal a new approach to using MSG data, although there is already much work being

undertaken in this field. TU Dresden report that they have begun to develop an algorithm which will enable detection of extreme rainfall using high resolution satellite imagery, which may be of interest.

4 FLOODsite Tasks 9, 10 and 11

4.1 Task 9: Guidelines for socio-economic flood damage evaluation

The aim of Task 9 is to develop:

> *"harmonised guidelines on the socio-economic evaluation of the most important types of flood damage based upon systematic collation of existing experience and research results and apply it to at least one of the pilot areas"* (Messner, 2004, p4).

Work has been carried out on the evaluation of flood damage in different countries and this task will bring together that work to produce consistent guidelines, so that flood damage across Europe can be evaluated using the same framework. Task 9 uses an economic framework and social research methods. Key representatives from institutions involved are listed in Table 4.1. The draft guidelines are available for comment from the FLOODsite project website (www.floodsite.net).

Table 4.1: Staff involved in Task 9

Institution	Staff representatives
UFZ- Centre for Environmental Research Leipzig-Halle, Germany (lead organisation)	Dr. Frank Messner Dr. Volker Meyer
Middlesex University Flood Hazard Research Centre, UK (MU/FHRC)	Sue Tapsell Prof. Edmund Penning-Rowsell Dr. Colin Green Amalia Fernandez-Bilbao
University of Twente, Netherlands (UT)	Joerg Krywkow Prof. A. van der Veen
European Commission – Joint Research Centre (EC-JRC)	Christiaan Logtmeijer

4.2 Task 10: Socio-economic evaluations and modelling methodologies

5.1 The aim of Task 10 is to:

> *"improve the valuation of flood damage by (i) refining a loss-of-life model and developing a methodology for mapping life risks; (ii) advancing an econometric model to estimate the flood forecasting and warning systems; (iii) modelling the effects of floods on ecological systems and species; and (iv) multi-criteria evaluation to evaluate flood risk and flood damage under uncertainty"* (Messner, 2004, p4).

This task is based on previous work undertaken by MU/FHRC, RPA and HR Wallingford as part of the Environment Agency/Defra *Flood risks to people* project (FD2317). Key representatives from institutions involved are listed in Table 4.2.

Table 4.2 : Staff involved in Task 10

Institution	Staff representatives
MU/FHRC, UK (lead organisation)	Sue Tapsell Prof. Edmund Penning-Rowsell Dr. Angela Boitsidis Amalia Fernandez-Bilbao
UFZ, Germany	Dr. Frank Messner Dr. Volker Meyer
WL/Delft Hydraulics, Netherlands	Arjan Wijdeveld
University of Padova, Italy (UniPad)	Prof. Marco Borga

4.3 Task 11: Risk perception, community behaviour and social resilience

The aim of Task 11 is:

> *"to understand better the impacts of floods on communities and the latter's capability to respond and recover from such events"* (Steinfurher, 2004, p4)

The task aims to understand flood risk from the perspective of communities. Key representatives from the institutions involved are listed in Table 4.3.

Table 4.3: Staff involved in Task 11

Institution	Staff representatives
UFZ, Germany (lead organisation)	Dr. Frank Messner Dr. Volker Meyer Dr. Annett Steinfurher (on maternity leave 2005) Christian Kuhlicke
MU/FHRC, UK	Sue Tapsell Prof. Edmund Penning-Rowsell Amalia Fernandez-Bilbao
Istituto di Sociologia Internazionale di Gorizia (ISIG), Italy	Dr. Bruna de Marchi; Anna Scolobig

This research falls within the disciplines of sociology, geography and psychology, where:

> *"the research will be based upon risk theories and approaches stemming from sociology, geography and psychology which will help to integrate concepts like vulnerability and social resilience into the broader theoretical paradigms of the social sciences"* (Steinfurher, 2004, p6).

Qualitative and quantitative surveys are being carried out in the catchments of the Adige (Italy) and Mulde (Germany). Three datasets collected by MU/FHRC in England and Wales are also being re-analysed to broaden the base for the cross-cultural analysis.

4.4 Links with FRMRC

The FRMRC programme has nine priority areas (see Section 2.3), within which Work Package 7 is *Stakeholder and policy*, consisting of five projects (see Table 4.4).

Table 4.4: Projects within the *Stakeholder and policy* work package (WP7) of FRMRC

Project title	Institution
7.1 *Stakeholder involvement*	University of Manchester
7.2 *Policy*	University of Manchester
7.3 *Risk communication* – focused on communication between organisations	MU/FHRC
7.4 *Integrated sustainable development of floodplains and wetlands* - joint with *Morphology and habitats*	
7.5 *Socio-psychological dimensions of flood risk managemen*t - not yet started, waiting for more funding	

From an initial review of these projects, the only synergy with FLOODsite Tasks 9 to 11 appears to be that of Project 7.3 with Task 11. However, a discussion with the researcher involved (Dr. Simon McCarthy, MFHRC) suggests that Project 7.3 focuses on aspects of risk communication between organisations rather than how communities understand and perceive risk.

There appear to be no obvious synergies with FLOODsite Tasks 9 or 10.

4.5 Links with FREE

The FREE programme does not have a social science component and therefore, does not have any overlap with the social science projects in FLOODsite, including Tasks 9, 10 or 11.

4.6 Links with Environment Agency/Defra R&D programme

Tables 4.5, 4.6 and 4.7 show the social science projects that have been carried out, or are ongoing, within the joint Environment Agency/Defra research programme since 1999, which are relevant to FLOODsite Tasks 9, 10 and 11 respectively. For Task 11, in addition to the projects listed in Table 4.7, there is the *Environmental inequalities* (EI) project, which is partly focused on flooding and sets issues of flooding and inequality within a wider framework.

Table 4.5: Relevance of Environment Agency/Defra projects to Task 9

Project title	Aims	Relevance to Task 9
Research theme: policy development		
The appraisal of human-related intangible impacts of flooding January 2001– July 2003	To develop and validate survey instruments using focus groups and pilot surveys for i) health impacts and ii) estimation of willingness to pay and to undertake a national survey and based on the results, develop an economic appraisal methodology.	Directly inputting into Tasks 9 and 10
Research theme: flood forecasting and warning		
Public response to flood warnings May 2004 - May 2005	To provide a detailed understanding of the ways in which the 'at risk' public understand, interpret and respond to flood warnings.	Of some relevance to parts of Task 9 and 10

Table 4.6: Relevance of Environment Agency/Defra projects to Task 10

Project title	Aims	Relevance to Task 10
Research theme: flood and coastal defence		
Flood risk to people phases 1 and 2 2001-2004	This project developed a method to map the risk to life or serious injuries from floods.	Directly inputting into Task 10
Research theme: policy development		
The appraisal of human-related intangible impacts of flooding January 2001– July 2003	To develop and validate survey instruments using focus groups and pilot surveys for i) health impacts and ii) estimation of willingness to pay and to undertake a national survey and based on the results, develop an economic appraisal methodology.	Directly inputting into Tasks 9 and 10
Research theme: flood forecasting and warning		
The social performance of flood warning technology Feb 2003 – March 2005	To identify the social barriers to effective performance of communication and dissemination technology currently available and likely to impact in the 2000-2010 period, and make recommendations for maximising the effectiveness of current and new technology in order to assist the Environment Agency in achieving its performance targets.	Direct input into Task 10
Public response to flood warnings May 2004 - May 2005	To provide a detailed understanding of the ways in which the 'at risk' public understand, interpret and respond to flood warnings.	Of some relevance to parts of Task 9 and 10

Table 4.7: Relevance of Environment Agency/Defra projects to Task 11

Project title	Aims	Relevance to Task 11
Research theme: policy development		
The appraisal of human-related intangible impacts of flooding January 2001– July 2003	To develop and validate survey instruments using focus groups and pilot surveys for i) health impacts and ii) estimation of willingness to pay and to undertake a national survey and based on the results, develop an economic appraisal methodology.	Directly inputting into Tasks 9 and 11 (the data collected for this project is being re-analysed for Task 11)
Community and public participation: risk communication and improving decision-making in FCD October 2001 – April 2003	To review the effectiveness of consultation and community procedures and practices in flood and coastal defence in England and Wales and from this, to suggest best practice methods to enable the public and affected groups to better appreciate flood and coastal defence issues.	Of some relevance to Task 11
Research theme: flood forecasting and warning		
Flood warning and vulnerable groups July 2001 - April 2004	To document the social distribution of flood risk (are some social groups disproportionately likely to experience flooding?), the variance of awareness of flood risk within populations in flood risk areas, and the variance in ability to respond to flood warnings and cope with flood events within populations in floor risk areas.	Direct relevance to Task 11
Inclusion of organisations in flood planning and warning supporting activities February 2002 – March 2005	To support a workshop and related activities to establish best practice for the involvement of agencies and local communities in the flood planning and warning process, to ensure effective delivery of the service.	Of some relevance to Task 11 as is community based
Community engagement with its flood history - understanding risk July 2004 - July 2006	To increase community engagement and participation by getting communities involved in establishing, analysing, debating, disseminating and 'owning' their local flood history and risk information within a longer-term environmental change context.	Direct relevance to Task 11
Managing the social aspects of flooding Jan 2005 – May 2005	To gain a better understanding of the social aspects of floods and effective ways of addressing these. There are six parts to the project: 1.Understanding social impacts: urban & rural communities; 2.Understanding social impacts: vulnerable and deprived groups; 3.Improving stakeholder engagement in decision-making and delivery; 4.Improving community & citizen engagement in decision-making, delivery and flood response; 5.Improving the contribution of social science to the FRM science programme; 6.Synthesis	Part 2 is part of the *Environmental inequalities* project and is of direct relevance to Task 11

4.7 Summary of Tasks 9, 10 and 11

4.7.1 Task 9: Guidelines for socio-economic flood damage evaluation

The development of guidelines for socio-economic flood damage evaluation sits firmly within the economic valuation work that MU/FHRC has been involved with for several years. It also aligns closely with work that has been supported by the Environment Agency/Defra research programme, specifically within the policy theme, and in that sense has most links with appraisal work carried out under the policy theme. In addition, these projects should be of interest to economists within the Environment Agency.

4.7.2 Task 10: Socio-economic evaluations and modelling methodologies

Certain activities within the task are of interest to the Environment Agency, as they build on existing work and aim to develop a method of assessing a range of different impacts. Again, these would be of interest to economists within the Environment Agency.

4.7.3 Task 11: Risk perception, community behaviour and social resilience

Task 11 links closely with work that the Environment Agency has commissioned within the areas of flood forecast and warning (FFW), in particular relating to *Flood warning and vulnerable groups*, and *Social policy* (*Environmental inequalities* (2)). It should also be of interest to those within the risk theme. However, the task has not considered other work the Environment Agency is doing on *Environmental inequalities* or *Public response to flood warning*.

5 FLOODsite Tasks 16 and 20

One question which has arisen during the preparation of this report is the definition of flash flood forecasting. Within a UK context, the occurrence of the classical 'wall of water' appearing in minutes has historically been rather rare, although it may become more common in future, particularly in terms of impact (for example, the recent August 2004 Boscastle and June 2005 North Yorkshire events). However, the techniques used for flash flood forecasting have many overlaps with the more widespread UK issue of flood forecasting on fast response catchments, so this research is also of wider application.

5.1 Task 16: Real-time guidance for flash flood risk management

Task 16 is closely linked to Task 15 (see Section 3) and deals with hydrological response during extreme rainfall events. Two approaches are being considered:

- classical detailed hydrological rainfall run-off models (distributed or semi-distributed);
- a more statistical approach (called the flash flood guidance concept or FFG) which relates rainfall or discharge thresholds to levels of hazard, or derives a rainfall threshold based on the minimisation of a Bayesian utility function.

These two approaches will be compared for the same two pilot areas to be used in Task 15, that is, the Adige catchment in Italy and the Cevennes Vivarais areas in France (including the Gardon river). The task is being led by the University of Padova, and the main tasks to be performed by the various contributors are:

- Ecole Nationale des Ponts et Chaussees, France – Assessment of FFG on Gardon river;
- Institut National Polytechnique de Grenoble, France – Development and assessment of rainfall-based algorithm in FFG;
- Joint Research Centre – Institute for Environment and Sustainability, Italy – Assessment of LISFLOOD for flash flood forecasting;
- University of Padova, Italy – Development and assessment of FFG concept;
- University of Bologna, Italy – Assessment of TOPKAPI for flash flood forecasting.

5.2 Task 20: Development of a framework for the influence and impact of uncertainty

The main aims of Task 20 are to:

- enable uncertainty to be propagated through integrated flood risk models;
- provide guidance on issues of scale, complexity and credibility in composite models of flood risk;
- provide support to decision analysis techniques in policy and emergency situations.

The project will build upon the considerable amount of research already being undertaken in the EU and elsewhere, and will focus on the following novel areas of uncertainty analysis and decision support:

- propagation of uncertainty through composite (hybrid) models using efficient computational methods, in order to provide reliable uncertainty estimates on model outputs;
- development of new methods to deal with the uncertainty issues associated with composite model construction;
- development, implementation and demonstration of methods for risk-based decision-making.

This task is being led by the University of Newcastle, UK, and the main tasks to be performed by the various contributors are:

- University of Newcastle, UK – Assessment of uncertainty issues associated with composite model construction and risk-based decision-making. Specific responsibility for dissemination of methodologies within Theme 3 (Tasks 18,19 and 20) and application in Decision Support System development.
- UNESCO-IHE Institute of Water Education, Netherlands – Lead on propagation of uncertainty through composite (hybrid) models and provision of support to University of Newcastle on risk-based decision-making (in particular case-base reasoning (CBR) and its application in the case studies).

The emphasis will be on development of techniques, rather than being tied to any particular modelling system. The aim will be to set protocols for communication between different modelling components, enabling the incorporation of nationally or regionally preferred models in any future practical implementation of the system.

The main outputs from Task 20 will include:

- technical research report describing methods for handling uncertainty;
- uncertainty propagation software;
- decision support system (DSS).

The software will be of the standard of research software, which may be used by researchers or developed into user-friendly packages.

The Thames Estuary case study (Task 24) will form the basis for much of the testing of methods and software developed under this task, although additional case studies are under consideration, for example for the investigation of uncertainty in flood forecasting applications.

5.3 Links with FRMRC

5.3.1 Task 16

FRMRC does not specifically address flash flood forecasting, although the following work packages include components relevant to this topic:

- Work Package 3.3: Weather radar and remote sensing
- Work Package 3.4: Real-time updating

Brief descriptions of the research being undertaken within these two work packages are given below.

Work Package 3.3: **Weather radar and remote sensing**

The main aim of this work package is to develop radar signal processing algorithms for the new dual polarising radar being installed in Kent in 2005, based upon techniques that have already been proven at a research level on very narrow beam non-attenuating S-Band systems. This work is being led by the University of Bristol with inputs from the Met Office and University of Reading. The key objectives are to:

- provide fundamental research and support for the new Environment Agency/Met Office C-band dual polarisation radar in Kent (the Thurnham radar);
- address data assimilation issues in relation to rain gauge and radar rainfall measurements;
- improve distributed modelling techniques using spatial rainfall information provided by weather radar.

Testing in an operational environment will show the potential for extension to the national radar network. Although the focus of this component is on radar studies, an existing distributed hydrological model for the Brue catchment in Somerset will also be developed further to make use of the new higher quality radar data.

Work Package 3.4: Real-time updating

The main aim of this work package is to develop improved techniques and algorithms for real-time updating of flood forecasts, together with associated uncertainty estimates. The focus is on real-time, recursive updating of parameters and states in data-based mechanistic (DBM) and related hybrid-conceptual metric (HCM) forecasting models. The methods will be evaluated on a case study for the River Severn catchment and the algorithms will be available as documented generic MATLAB® software modules, compatible with the overall uncertainty estimation framework being developed within Work Package 9 of FRMRC.

5.3.2 Task 20

FRMRC has several work packages dealing with uncertainty estimation including:

- Work Package 3.1: Uncertainty framework in real-time modelling – is considering the propagation of uncertainty through complex models in real-time;
- Work Package 3.2: Artificial intelligence applied to real-time forecasting;
- Work Package 5.4: Whole-basin modelling: uncertainty handling – uncertainty in whole system modelling of catchments;
- Work Package 9.1: Assessment of uncertainty estimation methods – developing methods and techniques to support all other components of the FRMRC, including flood forecasting applications;
- Work Package 9.2: Implementation of uncertainty and risk assessment and use in decision-making – dealing primarily with developing an overall modelling framework, and logic programming techniques, to support Work Package 5.4.

5.4 Links with FREE

As of February 2006, the FREE project was still at the planning stage and no links could be ascertained at that time. Research proposals were invited for early 2006 in the following general area of uncertainty estimation in flood forecasting applications:

> *Estimation of the probability, and associated risks, of extreme events leading to flooding occurring in the period from minutes to weeks ahead. Research will be carried out to increase scientific knowledge of: ensemble prediction methods; down/up scaling; aggregation/disaggregation and propagation of uncertainty through flood forecasting; other statistical methods; warning systems.*

5.5 Links with Environment Agency/Defra R&D programme

5.5.1 Task 16

The following ongoing projects have some relevance to flash flood forecasting:

- *Extreme event recognition* – FD2208
- *Storm scale modelling* – FD2207
- *Assessment of radar data quality in a steep upland catchment* - SC040023
- *Modelling extreme rainfall events*- FD2210

5.5.2 Task 20

A review of planned and ongoing projects in February 2006 suggested several projects under discussion dealing with uncertainty estimation for flood forecasting (and in meteorological forecasts).

5.6 Summary of Tasks 16 and 20

In considering Task 16 on real-time guidance for flash flood risk management, and Task 20 on the development of a framework on uncertainty in flood forecasting and warning, the following tables (5.1 to 5.3) indicate where these subject areas are being considered within each research programme. Note that the entries for FREE are left blank at present, since they will not start to be defined until later in 2006 when the detailed research proposals are selected.. Note also that, in most cases, many more of the entries could be shaded if the scope was widened to include R&D themes outside the areas covered by Tasks 16 and 20.

Table 5.1: Current R&D related to the detection of flash floods (in shaded areas)

General Area	Technique	FLOODsite	FRMRC	FREE	Agency/Defra
Satellite Techniques	Rainfall Estimation			Invitation for outline proposals early 2006	
	Catchment Conditions				
Weather Radar	Signal Processing				
	Improved Hardware				
Numerical Weather Prediction	Storm Scale Models				
	Automated Identification of Extreme Events				
Microwave	Rainfall Measurement				
Catchment State	Direct Measurement				
	Regional Modelling				
Raingauges	Measurement				
	Telemetry				
River Monitoring	Measurement				
	Telemetry				

NOTE: these programmes cover many other topics outside the area of flash flood risk management

Table 5.2: Current R&D related to flash flood forecasting (in shaded areas)

General Area	Technique	FLOODsite	FRMRC	FREE	Agency/Defra
Rainfall runoff modeling	Conceptual			Invitation for outline proposals early 2006	
	Distributed/grid based				
	Data based				
Real time updating	Data based models				
	Hydrodynamic models				
Catchment rainfall	Raingauge averaging				
Urban flooding	Surface/drainage/groundwater				
	Real time control				
Ungauged catchments	Regionalisation of model parameters				
Extreme event indicators	Rainfall threshold				
	Artificial Intelligence/Bayesian				
Cataloging flash floods	Meteorological extremes				
	Flooding extremes				

Note: these programmes cover many other topics outside the area of flash flood risk management

Table 5.3: Current R&D related to uncertainty estimation in flood forecasting (in shaded areas)

General Area	Technique	FLOODsite	FRMRC	FREE	Agency/Defra
Fluvial uncertainty	Forward propagation			Invitation for outline proposals early 2006	
	Conditioning approaches				
	Real Time data assimilation				
Meteorological uncertainty	Numerical Weather Prediction				
	Radar				
Model emulation	Hydrodynamic models				
Uncertainty propagation	Catchment forecasting				
	Coastal forecasting				
Performance Measures					
Operationsl Response					

Note: these programmes cover many other aspects of uncertainty estimation for applications other than flood forecasting (and exclude projects started after February 2006)).

Task 20 in particular is considered important to the Environment Agency as there are overlaps with work within the FRMRC programme. It is recommended that the Environment Agency should aim to influence the outcomes of this work and ensure the involvement of Environment Agency flood forecasting staff.

6 FLOODsite Tasks 17 and 19

6.1 Task 17: Emergency flood management – evacuation planning

The aim of Task 17 is to identify generic methods for emergency response to flood events. In particular, the task aims to develop methods and tools for identifying appropriate evacuation and rescue plans. Existing generic methodologies and tools for emergency flood event planning will be reviewed for incorporation into a decision support system (DSS) framework in Task 19 (see Section 6.2).

The proposed approach to evacuation planning relies on linking the outputs from a flood forecasting system to pre-defined models to assess the vulnerability of communities and transport networks. Two methods will be developed to cover different scales of flood events. The first relies on already well-established flood forecasting and flood simulation approaches and emphasises the merging of information on exposure and vulnerability. The information will be used to decide which areas need to be evacuated in advance, and how this should be done. The second piece of work is a feasibility study to develop a method for a similar approach for flash floods. In the case of flash floods, it is not possible, or desirable, to evacuate populations over long distances (most of the people killed during flash floods are trapped in their cars on roads). The focus will be on identification of safe routes for rescue services to reach flooded areas.

The outcomes of Task 17 will comprise:

- a report on available methods and models for evacuation and rescue planning in lowland areas and flash flood areas;
- a framework for an open 'model' system that enables integration of generic methods and procedures, 2-D inundation modelling and evacuation module/s for emergency planning and escape-route optimisation and timing. The framework will focus on evacuation planning but will include all aspects of emergency planning for both lowland and flash flood events;
- a report which includes best-practice guidelines for emergency and evacuation management in lowland rivers;
- maps of road/river crossings;
- a report offering a generic framework for the identification of vulnerability in a flash flood-prone area and rescue route planning;
- a prototype vulnerability database of the Gard region;
- specifications of a flash flood warning system for roads;
- a final end-user workshop, possibly in cooperation with Tasks 18 and 19.

6.2 Task 19: Development of a framework for flood event management planning

Task 19 aims to link knowledge, current practice and model results from FLOODsite themes 1 and 2 in a prototype DSS in support of emergency management planning and practice.

The specific objectives are to:

- Design, in association with Task 18, a DSS that enables storage, use and visualisation of model results and additional information needed to support emergency management planning and practice, in particular evacuation and rescue planning.
- Implement and test an outline DSS, applied to different pilot sites.
- Narrow down the bandwidth of possible forecasts by rejecting unlikely scenarios with the aid of uncertainty-quantification techniques, in order to reduce the false alarm rate. For example, under any given loading condition multiple inundation scenarios are possible. A defence may breach in one (or more) of many possible locations, leading to distinctly different inundation scenarios and hence evacuation strategies. Probabilistic techniques will be used to identify the most likely inundation scenarios, given the forecast loading conditions. This will be done through consideration of the loading condition, defence standard and condition, and inundation.
- Optimise safe escape logistics for secure evacuation in case of disaster (through evacuation modules). This will include determination of safe access routes for rescue personnel where flood warning time is minimal. This will be a difficult task which will rely on the systematic construction of the DSS and an ability to test multiple management responses rapidly and establish optimum strategies.
- Deliver a system which demonstrates best practice in flood event management and planning.

The DSS aims to provide authorities with support in deciding on evacuation instructions to the community. The DSS needs to be sufficiently flexible to be practical for all emergency personnel, ranging from event planners to rescue services. The DSS also needs to be simple and straightforward, to maximise its use and application. The use of visualisation techniques and simple but informative graphics will be investigated. The DSS design will also be delivered to Theme 5(Training, dissemination and public awareness), for inclusion in the best practice guide on flood risk analysis and management, and related training activities.

The approach taken will consist of:

- identifying the needs of the flood event management planner/rescuer;
- specifying and designing the functionalities of a prototype DSS (to link with the DSS of Task 18);
- designing a generic framework for model linkage and related procedures to support emergency management planning and practice;
- implementing and testing an outline DSS spanning from hazard (flood depths, velocities and so on) forecast to evacuation planning tools embedded within an open modelling platform, (complying with HarmonIT standards). The DSS will only cover flooding from river and coasts and will not include flooding from rising groundwater and drainage (sewers).

Outcomes will include:

- a technical report outlining a conceptual integrated framework for flood management planning together with a functional design of a prototype DSS, with a working release of the DSS (scientifically fully functional but not tested or provided in packaged software);
- a report on the development of a DSS for an end-to-end chain system for flood management planning;
- knowledge and figures to incorporate in a final report (theme 5);
- a workshop with end-user communities to disseminate the results;

- a CD-ROM with a prototype system for each pilot area, to be produced by the partner responsible for the specific pilot area;
- a final report on flood event management.

6.3 Links with FRMRC

See Section 6.5.

6.4 Links with FREE

See Section 6.5.

6.5 Links with Environment Agency/Defra R&D programme

Tables 6.1 and 6.2 below show R&D projects being carried out under the main programmes reviewed in this report, that are relevant to Tasks 17 and 19 respectively. From the tables it is possible to identify areas of research being addressed by more than one programme, and therefore potential areas of overlap.

Table 6.1: Areas of potential overlap between Task 17 and other research programmes

Environment Agency R&D	Links with FLOODsite Task 17	FRMRC and FREE
Inclusion of organisations in flood planning and warning – Supporting activities (W5C-019 W5C(01)03) *Capacity building for flood risk communities* (W5E(03)04) *Public response to flood warnings* (W5-112 W5E(03)03) *Improved flood warning awareness and response in low probability/high risk flood zones* (W5-024 W5C(02)01) *Reducing the impacts of flooding – Extemporary measures* (W5C-013/3/1) *Repair and restoration of buildings following flood* (W5C-013/3/2)	▪ Review methods of emergency response planning ▪ Determine information decision-makers need ▪ Review of evacuation and rescue methods and models ▪ Scope format of evacuation/rescue models and review ▪ Design and development of evacuation/ rescue methods and models ▪ Application of evacuation models on pilot studies ▪ Flash flood warnings for road networks	*Stakeholder involvement* (FRMRC Work Package 7.1) *Risk communication* (FRMRC Work Package 7.3) *Socio-psychological dimensions of flood risk management* (FRMRC Work Package 7.5)

Table 6.2: Areas of potential overlap between Task 19 and other research programmes

Environment Agency R&D	Links with FLOODsite Task 19	FRMRC and FREE
Development of flood warning management system – Stages 2a & 2b (W5C-021 W5C(01)01) *Risk assessment for flood event management* (FDB(05)01). This is a new project under the risk theme of the R&D programme	▪ Identification of the needs of a flood event management planner ▪ Review of different types of decision support systems ▪ Specification and design of a DSS ▪ Development of DSS; includes: - Breaching - Inundation modelling - Flood event modelling - Evacuation modelling - Rescue model ▪ Application to pilot sites; includes: - Thames - Scheldt - Gard Region	*Implementation of uncertainty and risk assessment and use in decision-making* (FRMRC Work Package 9.2) *Advice on flood risk management system development* (FREE Objective 5)

6.6 Tasks 17 and 19 summary

These tasks highlight the need for systems developed by FLOODsite to be compatible with existing systems, for example police, fire and rescue services. They also emphasise the need for a DSS to automate procedures, thus allowing forecasters to make better and more rapid assessment of the requirements for flood warnings.

Task 17, in the area of emergency flood evacuation planning, covers an area that is not normally included in the Environment Agency's FFW projects and offers useful consideration of civil contingencies roles.

Task 19 links to FRMRC Work Packages 3.1, 3.2, 6.1 and 9.2. The Thames estuary will be used as a trial site, so there are also links with the Environment Agency's National Flow Forecasting System (NFFS). This task is therefore important for the Environment Agency and should have involvement from Environment Agency flood risk management staff.

7 Summary and future programme

7.1 General summary

The timing of this report is such that many of these projects are still at the planning stage, so that specific recommendations on operational applications cannot be provided at present. However, it is anticipated that this report (and related reports prepared under the FLOODsite advisory theme) will contribute to discussions on the future direction of the Environment Agency/Defra flood forecasting and warning work.

A project board meeting was held in November 2005 to discuss the initial findings of the liaison task groups. A summary of that meeting can be found in Section 7.3.

7.2 Recommendations

7.2.1 Tasks 1 and 15

No recommendations are made at this time.

7.2.2 Tasks 9, 10 and 11

Liaison work with researchers on each of the FLOODsite projects will continue over the coming months and the information obtained will be disseminated to a range of interested groups. In order to use this liaison role effectively, two recommendations are made:

- Develop a small network of interested Environment Agency/Defra staff and possibly academics, so that there are clear channels through which information can be disseminated. These people could be called “social science champions”.
- Liaise with those people either individually or collectively to find out how best to disseminate the information. This could make use of Defra’s FRM research newsletter or other information routes.

In addition, and outside the scope of this liaison role, as concluded in the report *Improving the contribution of social science to flood risk management* (Twigger-Ross, 2005), there is a wider need to coordinate and develop/plan the social science work carried out for the Environment Agency/Defra joint programme.

It would be useful to use the network of social science champions (recommended above) to start to shape the Environment Agency/Defra programme more effectively. Rather than starting a new group, those social scientists involved in the Theme Advisory Groups (as well as interested others) could be routinely updated on the social science projects, so that they would become ambassadors for social science within the TAGs. Further, at the FFW Theme Advisory Group workshop (19 July 2005) there was a call for more work that synthesised and translated current research.

Given this, it is further recommended that a system of synthesis, translation and dissemination is developed with the network of social science champions so that information is used effectively.

7.2.3 Tasks 16 and 20

In future, the Environment Agency will be required to introduce, or improve, flood warnings for many more fast response tributaries, and flood forecasting models will often provide the only feasible route for achieving this aim. More generally, there will be increasing pressure to assess the risk, or uncertainty, in the warnings provided, both on fast response catchments and for flow routing and hydraulic models further downstream. Some possible extensions to the FLOODsite programme which might contribute to this process are outlined below

For Task 16, the rainfall run-off models being considered for flash flood forecasting applications could be reviewed and evaluated for use in the UK. The models may include types used in Continental Europe but not well known in the UK, and/or new types of models designed for flood forecasting (where catchment processes may be significantly different to the classical water resources applications for which many models were originally developed). The test catchments are in France and Italy, but could possibly be extended to one or more UK areas. 2D inundation mapping using LISFLOOD may also be of interest (although this topic is covered in other parts of the FLOODsite programme). However, the development of integrated 'clouds-to-catchment-to-coast' models will also be a strong theme within the FREE programme.

In Task 16, the flash flood guidance (FFG) approach shares many similarities with methods already being developed under the Defra/Environment Agency *Extreme event recognition* project (and potentially under FREE), although it will build upon the current operational approach used in the USA. The two approaches could be compared for one or more UK flash flood examples, and the recommendations from the *Extreme event recognition* project might influence the direction of the FLOODsite research (plus, the flash flood catalogues and classification schemes could possibly be combined). The Bayesian uncertainty component of the FFG is a potentially novel research area in its application to flood warning, and could also possibly be tested for UK application. The use of vulnerability indicators (such as vehicles damaged) as a guide to flash flood potential may also have some features which could be used in the UK.

Under Task 20,for flood forecasting applications, the propagation of errors through complex models is a key issue if uncertainty in forecast levels and flows is to be assessed. This issue is being investigated in FLOODsite for both flood risk assessment and flood forecasting models, and will build upon similar work being performed within FRMRC (although for different types of models and case study catchments). The work on computational intelligence methods could possibly be developed for emulation of real-time hydraulic models (and hence assessing model uncertainty in real-time), and for real-time rainfall run-off modelling (such as in FRMRC).

In Task 20, the logic programming methods being developed are primarily for flood risk assessment models, but could also be used for offline assessment of uncertainty in flood forecasting models during the model build/calibration stage. Again, this work has close links to, and will build upon, related research being carried out within the FRMRC.

Again in Task 20, the case-based reasoning approach will provide methods and software to assist with risk based decision-making during flood events, particularly in situations where the time for making decisions is short. This component has possible applications for flood event management, particularly for fast response and flash flood events. The methods could possibly be trialed on one or more UK catchments. This component also has some relevance to the FFG concept being developed under Task 16, although with more of a focus on uncertainty in decision-making.

7.2.4 Tasks 17 and 19

Task 17 is primarily concerned with evacuation and rescue methods and models. There are no other projects that overlap with this, but to be helpful to the Environment Agency and those responsible for evacuation (police, fire and rescue services), the methods and models should as far as possible be compatible with existing systems.

Activity 7 of Task 17 refers specifically to road networks. This could provide very valuable support to traffic management in floods, but the above comments on compatibility with existing systems apply.

In the area of Task 19 (development of a framework for flood event management planning), the Environment Agency has existing systems for recording and transmitting data, making forecasts and disseminating flood warnings, which rely on models and procedures to operate. The Environment Agency's vision of a DSS is a system that helps to automate procedures, thus allowing forecasters to make better and more rapid assessments of the requirements for flood warnings. The DSS should also assist with rapid and efficient dissemination of flood warnings to professional partners and the public in a clearly understandable form.

Other professional partners will have their own needs in event management and response, and it is not clear whether they should use the same DSS or whether separate systems might be needed which link with systems already operated by those partners. For example, the fire and rescue services may have their own systems for deciding how to deploy their resources during flood events.

Given the Environment Agency need outlined above, there is clear benefit to working closely with Task 19, which is primarily concerned with the development of a decision support system . To be helpful to the Environment Agency, this system should link with existing flood forecasting and warning systems including the National Flood Forecasting System (NFFS). In particular, overlaps and differences between modelling approaches should be avoided.

Part of FLOODsite Task 19's remit will also be to identify needs in different countries and develop principles and methods that could be applied in all cases.

7.3 Project progress review meeting

In November 2005, a meeting was held to discuss the initial findings of the liaison task groups. Two points of concern were noted and appropriate actions agreed:

- In some areas, FLOODsite did not seem to be considering best practice already developed in UK. If the EU produces a directive on floods, it will be informed by EU R&D. Without inclusion of UK best practice, this will cause problems.
- Some other areas in FLOODsite relevant to Environment Agency business are not being monitored.

The following tasks were selected as those which Environment Agency staff should become involved in:

Task 11: Risk perception, community behaviour and social resilience

This task takes account of Environment Agency work on vulnerable groups, but does not consider other work on *Environmental inequalities* or *Public response to flood warnings* projects. The liaison project will ensure that Environment Agency social policy staff are involved in this task.

Task 19: Development of a framework for flood event management planning

This task links with work areas within the FRMRC programme. The Thames estuary will be used as a trial site, so there are also links with the Environment Agency's National Flow Forecasting System (NFFS). The liaison project considers it an important task for the Environment Agency and will ensure that its flood risk management staff are involved.

Task 20: Development of a framework for the influence and impact of uncertainty

This task was considered important to the Environment Agency as there are overlaps with work areas within the FRMRC programme. The liaison project agreed that the Environment Agency would need to influence the outcomes of this work and recommended involvement of its flood forecasting staff.

The other tasks will continue to be monitored and the task groups will report back periodically.

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List of abbreviations

AI	Artificial intelligence
DBM	Data-based mechanistic
DSS	Decision support system
EA	Environment Agency
EPSRC	Engineering and Physical Sciences Research Council
EU	European Union
FFG	Flash flood guidance concept
FFW	Flood forecasting and warning
FLOODsite	EU Framework VI flood risk management
FREE	Flood risk from extreme events
FRM	Flood risk management
FRMRC	Flood risk management research consortium
GLUE	Framework for assessment of modelling
HCM	Hybrid-conceptual metric
IMC	Incident management and community engagement
LISFLOOD-FP	2D hydraulic model
MSG	Meteorsat second generation satellite
NAM	Conceptual rainfall run-off model
NERC	Natural Environment Research Council
NFFS	National Flow Forecasting System
NWP	Numerical weather prediction
PDM	Conceptual rainfall run-off model
R&D	Research and development
SMD	Soil moisture deficit

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