Research, technological development and innovation activities

1 Theme 1: Risk Analysis: Scientific knowledge and understanding

1.1 Theme overview

1.1.1 Overall Theme Objective

The overall purpose of Theme 1 of **FLOOD*site*** is to develop scientific knowledge and understanding in critical areas for the assessment of flood risk. The scientific advances in this Theme will feed into to all other parts of the project.

Summary of Objectives - Theme 1

1.1 To Improve understanding of the primary drivers of flood risk (waves, surges, river flow etc.) through research targeted at key issues and processes that contribute most to current uncertainty in flood risk management decisions.
1.2 To Improve understanding, models and techniques for the analysis of the performance of the whole flood defence system and its diverse components, including natural and man-made defences (e.g. seawalls, embankments, dunes) and the extent of inundation.
1.3 To understand the vulnerability and sensitivity of the receptors of risk and to improve and harmonise the methods to evaluate societal consequences and to estimate flood event damages

1.1.2 Overview of approach

The **FLOOD*site*** framework and tools should be consistent. This requires a sound knowledge of relevant processes and interactions associated with flood hazard and vulnerability, including all constraints and potential change. Even with risk mitigation measures in place, a degree of residual risk will remain which requires "acceptable" flood risk to be determined. To allow the risk analysis to be performed at different decision levels, methodologies and models will be developed for feasibility level (holistic approach) as well as for preliminary and detailed design level. The proposed research in this theme is structured in three sub-themes according to the concept of hazard and vulnerability and in conjunction with the well-established source-pathway-receptor model.

Structure of Research in FLOOD*site* Theme 1

Sub-Theme 1.1 Hazards (risk sources): Understanding and assessment of the flash flood, river, estuarine and coastal flood risk sources (river flow, storm surges, waves, etc.), including extreme events and joint probabilities. These will provide the hydrological/hydraulic boundary conditions and loads for the flood defence system and structures.

Sub-Theme 1.2 Hazards (risk pathways): Understanding and assessment of the performance of the whole flood defence systems and its components, including both natural and man-made pathways. Breaching processes build the key issue as they provide the initial conditions for the assessment of the flood inundation process.

Sub-Theme 1.3 Vulnerability (risk receptors): Understanding and assessment of direct/indirect tangible losses and intangible losses including social and ecological resilience, and flood risk perception and acceptance.

The research proposed in each area focuses on the ***knowledge and understanding*** which underpins the whole flood risk management process. Development of tools and implementation of techniques is

undertaken in other Themes of the Integrated Project, building upon the research undertaken under Theme 1.

Theme 1 will extend knowledge and understanding in areas that will produce the greatest improvement in flood risk analysis, and it will do so by building upon existing knowledge and research implemented through FP4, FP5 and national research programmes (se box below). The outputs from these projects will be analysed and incorporated in **FLOOD*site***.

Current and completed EC studies that address some of the priority areas

- River morphology [FRIMAR, DEBRISFLOW, IMPACT]
- Dambreak [CADAM, IMPACT]
- River flood risk assessment [EUROFlood, EUROTAS, FLOODAWARE]
- Embankment breaching [CADAM, IMPACT]
- Estuarine Morphology [INTRMUD; COSINUS]
- Coastal Morphology ["Coastal Steepening"; G6/8M Coastal Morphodynamics; COAST3D; SASME; PACE; INDIA; SCARCOST]
- Coastal Defence Structures [G6S Coastal Structures; PROVERBS; VOWS]

1.2 Sub-theme 1.1 Hazards (Risk Sources)

1.2.1 Objective

Fundamental to an understanding of flood risk is an understanding of the "*sources"* of risk. These sources are defined as the climatic factors inducing flooding, erosion or any other "threat" to the safety or stability of the land-water fringe. These sources therefore include sea waves, storm surges, river water levels and discharge velocities and similar factors.

Objective 1.1

To improve understanding, models and techniques for the analysis of the primary sources of flood risk (flash flood, river and estuarine floods, coastal flooding), including their uncertainties. Focus will be put on extreme events and joint probabilities.

1.2.2 Approach

The FP6 Work Programme makes specific reference to a research requirement on coastal extremes. Coastal extremes result from a combination of astronomic and meteorological conditions giving rise to wave and surge loading on the coastline. Flash floods in small catchments (< 500 km^2) have been recognised as posing particular hazard to life and property. The research will focus methodologies to account for the joint probability of occurrence of the different loading factors, their temporal and spatial coherence and dependencies to support the design and assessment of flood defence performance and the methodology to produce a European Flood Risk Atlas. The methods will examine the treatment of "memory" in the physical systems through residual influences from previous loading events, which influence the performance of the flooding system in subsequent events.

The research focuses on extreme events and joint probabilities, including climate variability effects; and to achieve the overall objective, the following key issues have been identified:

- Theoretical analysis of climatic extremes including theoretical probability (asymptotic and multi-parametric distributions and incorporating long term trends) and statistical techniques.
- Coastal, river and estuarine extremes, including extreme probability distribution functions (PDF) and sensitivity to the analysis technique and sample size. It also includes the memory effect from previous events (e.g. morphodynamic changes in hydraulic control or the wetness of soils within a catchment) and the variation with time-scale. It also includes the spatial variability (e.g. change in PDF for neighbouring coastal stretches)
- Linkage to climatic long-term trends and uncertainties associated to meteorological downscaling.
- Predictive capabilities and error bounds for flash floods and similar sudden events (with emphasis on the joint occurrence of marine-riverine extremes)
- Assessment of the loads induced by these extremes on natural land-water fringes (coastal, riverine and estuarine) and defence structures
- Development of a framework to build a European Flood Risk Atlas. It will include the methodology and the production of hazard and vulnerability maps for a sample of pilot sites.

This research will ensure that European and national authorities have access to appropriate up-to-date techniques to assess likely future environmental loads and their spatial and temporal dependencies. The specific issues selected for research within **FLOOD*site*** are:

- Coastal extremes (joint wave/surge events, morphodynamic and other memory effects and extremal PDF)
- River extremes (flash flood hazard identification and memory effects and extremal PDF)

- Estuarine extremes (joint marine/riverine occurrence of extremes and morphodynamic and ecological interactions) together with types of extremal PDF
- Link to general meteorological and marine climates (climate variability effects and downscaling)
- Hydraulic loads on sand beaches and dunes and also on typical flood defences selected from the pilot study areas
- Methods for statistical model assessment

The research under this sub-theme is organised into two specific tasks. These are summarised in the box below and outlined in the following *Task descriptions*.

Key Research Tasks in Sub-theme 1.1

Task 1: Identification of flash flood hazards
Task 2: Estimation of extremes (river, estuarine and coastal extremes, incl. marginal extremes, joint probabilities, temporal and spatial variability)
- Theoretical analysis
- Analysis of coastal, riverine and estuary extremes
- Hydraulic loading

1.2.3 Task Descriptions

Task 1 Identification of flash flood hazards

The key objective of Task 1 is to advance the understanding of the major atmospheric and hydrologic factors leading to extreme flood events, especially those affecting small to medium ungauged basins. Three specific issues are examined in Task 1:

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

The concentration on extreme floods (locally relatively rare) dictates that the observational and modelling activity is organised not on specific watersheds but on specific extreme events. For these reasons, the observational resources used here will be provided by a number of hydro-meteorological pilot areas in Europe (described in Theme 4), where a flash-flood focused co-ordinated observational strategy has been already implemented. In these relatively large geographical areas (about 10,000 to 30,000 km^2), the monitoring activity combines careful analysis of radar and satellite observations with analysis of flash flood events observed on experimental basins and collection of complementary information from field investigations carried out during the days following the events.

Partner No	Short Name	Contribution to Task 1 (Identification of Flash Flood Hazards)
43	TUD	Update of hydrologic-hydraulic model at regional scale
8	**INPG**	**Report on identification of meteorological factors**
16	UniPad	Identification of critical controlling process
18	WUR	Development of software based on hsB approach Test application of the model
40	GRAHI	Hydrological model parameterisation for application in ungauged basins

Task 2 Estimation of extremes

Task 2 will focus on the improved understanding of extreme events (river, estuarine and coastal extremes, incl. marginal extremes, joint probabilities, temporal and spatial variability). Three research issues are specifically addressed in Task 2:

- Theoretical analysis of marginal and joint distributions of extremes using existing present and paleo data. This will include a review of existing extreme distributions, including their sensitivity and sources of uncertainties. Analysis will use different statistical methods.
- Collection of "recent" (not previously included in PDF) extremes and hindcast selected extremes from the recent past. This will be done using available meteorological, riverine and marine observations and improved meteorological riverine and marine forecasting models with emphasis on downscaling of boundary conditions from general models and meso- and micro-scale forecasting (hindcasting) runs, including associated errors
- Derivation of methods to provide the hydraulic loading at the flood defence structure as an input needed for Sub-theme 1.2. The source-load relationships for a number of natural and man-made defence structures will be determined for selected pilot sites.

The combined and simultaneous use of meteorological/river/marine forecasting models is a significant step ahead in the state-of-art for this field and will allow an assessment of extreme risk sources at a much more reliable level than before. Task 2 will provide statistical estimations of the extreme distributions for the pilot sites considered in **FLOOD*site*** (where enough previous information exists to allow a meaningful analysis). It will furthermore update the existing information with the most recent data and application of the techniques reviewed and/or developed within **FLOOD*site*** to estimate extreme (marginal and joint) distributions.

Partner No	Short Name	Contribution to Task 2 (Estimation of Extremes)
1	HRW	Methodologies for the inclusion of temporal sequencing in loading extremes and provision of JOINSEA software Best practice guidance (on joint probability methods) Review of extreme event analysis and joint pdf Different flood mechanisms
2	Delft	Wave transformation over shallow foreshore
3	LWI	2D frequency distribution Wave-induced flow over sloped structures
12	TUD	Generalised Pareto distribution and POT
13	**UPC**	**Review, selection and development of pdf** **POT and torrential climates** **Morphodynamic control of distributions** **Wave-soil-structure interactions**
19	UniLund	Coupling of coastal processes to long-term sea level data Impact on coastal morphology
23	UR3	Singular Spectrum Analysis (SSA)
27	IBW	Neural Network Canonical correlation analysis (CCA)
29	AUTh	Spatial and temporal correlation procedures
31	UOP	Resampling techniques, best fit analysis and methods

Task 3 Contribution to European Flood Hazard Atlas

Task 2 will focus on development of a framework for building a European Flood Hazard Atlas that will be based upon the FLOOD*site* methodology. This will include an assessment of the uncertainty in flood mapping, such that appropriate techniques can be determined as applicable to different flood

area characteristics. Use will be made of the pilot study sites (Theme 4) with presentation of all project information for the pilot sites (including hydraulic boundary conditions) on a single database system. The system will be developed so as to allow presentation of hazard maps in a clear and readily understandable format (such that the information can be directly used by Sub-Themes 1.2 to 1.3).

Partner No	**Short Name**	**Contribution to Task 3 (European Flood Hazard Atlas)**
3	LWI	Guidance document on methods for Flood Risk Atlas - design
13	**UPC**	**Guidance document on methods for Flood Risk Atlas – sub-activity leader**
27	IBW	Guidance document on methods for Flood Risk Atlas – application Baltic Sea
29	AUTH	Guidance document on methods for Flood Risk Atlas – application Greek coast

1.3 Sub-theme 1.2 Hazard (Risk Pathways)

1.3.1 Overall objective

Flood defences form the barrier on the potential pathway between the hazard posed by the risk source and the damage experienced by the receptor of potential harm. The primary objective of this Sub-theme is to provide a better understanding of the performance of the flood defence system, including natural and man-made defences. In tandem with research into defence performance, effort will also be directed towards developing improved capabilities in flood inundation modelling.

Objective 1.2

Improve understanding, models and techniques for the analysis of the performance of the whole flood defence system and its diverse components, including natural and man-made defences (e.g. seawalls, embankments, dunes) and the extent of inundation.

1.3.2 Overview of approach

The flood management agencies across Europe maintain main thousands of kilometres of coastal and flood linear defences and a myriad of associated barriers, gates and pumps. In the UK alone the government annually spends about €700 Million on flood defence and management. Approximately two thirds of this total is on the improvement, operation or maintenance of linear defences; with the most significant expenditure associated with maintenance of existing earth embankments. To provide an efficient public service, flood defence managers need asset management systems that enables them to assess the risks associated with a system of defences, and provide a means of identifying the optimum programme of management interventions to achieve a particular outcome – some desirable reduction in flood risk. Specific needs are:

- To improve the prediction of the future condition of assets (i.e. deterioration)
- To improve the prediction of the performance of assets (reliability) under load (including both better understanding of failure modes and their interactions)
- To improve capabilities in predicting breach initiation and growth
- To improve capabilities in modelling flood inundation

The research under this sub-theme is organised into five specific tasks. These are summarised in the box below and outlined in the following *Task descriptions*.

Key Research Tasks in Sub-theme 1.2

Task 4: Understanding and predicting failure modes
Task 5: Predicting morphological changes in rivers, estuaries and coasts
Task 6: Modelling breach initiation and growth
Task 7: Reliability analysis of flood defence structures and systems
Task 8: Flood inundation modelling/methodologies from breaching

1.3.3 Task Descriptions

Task 4 Understanding and predicting failure modes

The research under this heading will gather the substantial body of existing information of defence failure mechanisms and extend knowledge in a number of critical areas. This will be achieved through a review of current knowledge for all kind of defence structures and a detailed analysis of initial failure modes by desk studies and hydraulic model testing as follows:

- A review of current knowledge internationally will be undertaken and collated through new guidance documents
- Detailed failure mode analysis (1) - Geotechnical instability
- Detailed failure mode analysis (2) - Crest and rear face erosion by wave overtopping
- Detailed failure mode analysis (3) - Block removal by wave impacts
- Data gathering through physical model testing including:
  - Small scale testing of breach initiation mechanisms and / or large scale testing of breach growth under the influence of wave conditions

Partner No	Short Name	Contribution to Task 4 (Understanding and predicting failure modes)
1	**HRW**	**Consideration of failure modes for embankments, shingle beaches and seawalls** **Overview of models available from IMPACT** **Identification of gaps on erosion** **Consideration of failure analysis of blockwork structures and shingle beaches**
2	WL | Delft	Failure modes for revetments and dunes Failure analysis of revetments
3	LWI	Failure modes for sea dikes Review of large-scale tests on erosion Failure analysis of coastal embankments Hydraulic model tests on impacts
12	TUD	Failure modes for special structures
22	IHE	Review of small-scale tests on erosion and failure analysis
27	IBW	Air trapping phenomenon and cracking
36	INFRAM	Predictions for wave overtopping, review of failures

Task 5 Predicting morphological changes in rivers, estuaries and coasts

The assessment of sea defence assets seldom takes account of the morphological variability of the bed levels and slopes in front of the defence. Changes in bed morphology can have a significant influence on the wave conditions reaching the defence and may also lead to siltation (closing) of river mouths (e.g. under microtidal conditions as is the case in the Mediterranean) and, thus, enhance flooding risks. Additionally there still exists significant uncertainty in determining the pre-storm foreshore morphology and its likely drawdown during a storm (both at the toe of the defence in terms of scour as well as more extensive foreshore lowering). Therefore, the research in this task aims to improve our ability to predict morphological change in the short and longer term through detailed analysis of coastal and riverine morphological processes and changes.

Partner No	Short Name	Contribution to Task 5 (Predicting Morphological Changes in Rivers , Estuaries and Coasts)
1	HRW	Development of rapid coastal evolution models Suitable modelling approaches to assess the potential for morphological change
13	UPC	Regional evolution models for regional changes
19	UniLund	Dune models
31	**UOP**	**New techniques describing statistical behaviour**
35	UCL	Contributions to suitable modelling approaches to assess the potential for morphological change

Task 6 Modelling breach initiation and growth

The research under this heading aims to extend existing capabilities in breach modelling being developed through ongoing research initiatives (such as IMPACT) by inclusion of the knowledge developed under Tasks 1 and 2 above. The occurrence, frequency, location and severity of defence breaches is still very difficult to predict. These issues will be investigated by large and / or small scale model tests to develop better breach models that include the processes of initiation and growth in dikes/embankments with typical protective coverings. The new models will be developed in parallel with the improved understanding of particular failure modes. In particular this task will extend existing and on-going research activities (in particular through the IMPACT study) to develop improved breach models.

Partner No	Short Name	Contribution to Task 6 (Modelling Breach Initiation and Growth)
1	**HRW**	**Review of information from numerical models** **Improvement of numerical models for breach initiation and growth**
3	LWI	Review of probabilistic approach Breach initiation from landward side Breach initiation from shoreward side
12	TUD	Review of mathematical models Improvement of analytical models for breach initiation and growth

Task 7 Reliability analysis of flood defence structures and systems

The potential complexity of the relationship between the condition of individual elements of a flood defence and its overall performance is poorly understood and difficult to predict routinely (i.e. the combination of failure modes and their interaction and change in time and space). This task will focus on developing reliability analysis techniques they incorporate present process knowledge on individual failure modes and interactions between failure modes (collated through Task 3 above), interactions between failure modes and length effects of flood defences.

Partner No	Short Name	Contribution to Task 7 (Reliability Analysis of Flood Defence Structures and Systems)
1	HRW	PRA for test pilot site Thames Database of uncertainties for models and parameters Applicability of reliability analysis methods
3	LWI	PRA for test pilot site German Bight Database of uncertainties for models and parameters Applicability of reliability analysis methods
12	**TUD**	**PRA for test pilot site Scheldt** **Review and classification of uncertainties** **Description of reliability analysis used within FLOODsite** **Flexible software tool for reliability analysis** **Identification of key areas for further research**

Task 8 Flood inundation modelling / methodologies

Over recent years many flood inundation models and have been developed using a range of modelling approaches (1-D, 2-D, 3-D and hybrid approaches). This topic aims to develop a consistent hierarchy of flood inundation methodologies exhibiting a range of complexities and capabilities linked with a range of data requirements.). It will then seek to develop these capabilities through the innovative use of remote sensed data to facilitate rapid model construction. Recently developed technologies are topographic input through LiDAR and SAR and automated hydraulic roughness characterisation

through utilising CASI based information. Thus this research task will need to link to actions within the context of the EC GMES initiative.

Partner No	Short Name	Contribution to Task 8 (Flood Inundation Modelling / Methodologies)
2	**WL | Delft**	**Improvement and guidelines for 2D inundation model** **Application of more sophisticated model to selected pilot sites**
15	UniBristol	Simple wave propagation model Application of simple model to selected pilot sites
35	UCL	Application of SoA 2D inundation models

1.4 Sub-theme 1.3 Vulnerability (Receptor exposure and consequence)

1.4.1 Overall objectives

The prime objective is to understand the vulnerability and sensitivity of the receptors of risk and to improve and harmonise the methods to model societal consequences and to estimate flood event damages and losses. The research should lead to harmonised and improved quantitative assessment of the expected flood damages, including tangible direct and indirect costs as well as intangible losses.

Objective 1.3

To improve the understanding of the vulnerability and sensitivity of the receptors. Generate new methods to improve and harmonise methods to model societal consequences and flood event damages and losses, including tangible and intangible losses (loss of life, cultural, ecological and other social losses).

1.4.2 General approach

Considering the overall objective, the following key issues and needs have been identified:

- Developing harmonised EU guidelines on the socio-economic evaluation of the most important types of flood damage based on systematic collation of existing experience and research results.
- Refining modelling and estimation methods to better model loss of life, to estimate the effectiveness of flood warning systems in terms of avoided damage, and to deal with the evaluation of damage in case of heterogeneous damage criteria with uncertainty characteristics.
- Understanding and learning from the behaviour of societal receptors in terms of preparedness, vulnerability, social resilience, and acceptance of natural flooding events.

These key issues present some extraordinary challenges with regard to trans-boundary river basins in Europe and the requirement of the EU Water Framework Directive to achieve an integrated river basin management unbounded by national borders. Although several national studies have already addressed some of these aspects, the international dimensions of these issues demand research efforts to tackle them in a coordinated, European context.

The research under this sub-theme is organised into three specific tasks. These are summarised in the box below and outlined in the following *Task descriptions*.

Key Research Tasks in Sub-theme 1.3

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

1.4.3 Task Descriptions

Task 9 Guidelines for socio-economic flood damage evaluation

Flood and coastal defence decisions hinge on the quantification of the significance of risks and the costs required to mitigate them. However, the methods used in Europe to quantify the costs of flood damage and the benefits of remedies to reduce flood risks vary considerably. On the one hand often only financial losses are included into the damage calculations, excluding the quantification of intangible environmental and cultural values or the indirect economic effects emerging due to the interconnectedness of the economy through built infrastructure. On the other hand different methods exist to estimate monetary damages with very different results depending on the method chosen. To address this problem in the setting and regulation of trans-boundary flood defence systems in Europe, again within the context in the WFD, this sub-theme aims to provide harmonised methodologies for the evaluation of flood damages in form of proposals for EU flood damage evaluation guidelines.

Partner No	Short Name	Contribution to Task 9 (Guidelines for Socio-Economic Flood Damage Evaluation)
44	**UFZ**	**Methods and deficits in flood damage evaluation** **Guidelines for establishing flood damage databases**
10	MU/FHRC	Literature survey on flood damage evaluation methods Guideline on Willingness-to-pay survey Guideline on Flood warning effects
17	UT	Guideline on Contingent valuation methods (CVM) Guideline on Indirect economic effects
26	JRC-IPSC	Contributions to Guideline on Indirect economic effects

Task 10 Socio-economic evaluation and modelling methodologies

Another field of pressing socio-economic research needs on the European level relates to improved understanding and methods to map potential loss of life, to assess the effectiveness of flood warning systems and to deal with complex multi-criteria decisions. Some promising research results have been achieved on the national level. Existing models of the UK and the Netherlands need to be refined and to be adjusted to the social and geographical conditions of other EU countries.

The incidence of fatalities during floods indicates that there are some flood damages which cannot or should not be measured in monetary terms. In order to include these effects multi-criteria evaluation methods need to be refined in order to process uncertain data resulting from GIS-based hydrological flood modelling and spatial damage assessment in order to support decision making on pre-flood measures. Using such methods on a European level also requires the formulation of methodological minimum standards.

Assessment of flood warning systems is another neglected aspect of socio-economic flood research. Today there is a trend – especially after big floods – to increase the efforts to build up improved technical flood forecasting and flood warning systems and improved centralised flood disaster management strategies. However, from research in the UK and the Netherlands, socio-demographic characteristics of the areas affected and especially the varying degree of the preparedness of the local people, is crucial to avoid damage. Understanding better the effectiveness of flood warning systems will contribute to better decisions in this field, i.e. it sometimes might be more effective to invest in local preparedness than accelerating and improving technical pre-flood warning systems.

Partner No	Short Name	Contribution to Task 10 (Socio-Economic Evaluation and Modelling Methodologies)
2	Delft	State-of-the-art on environmental vulnerability State-of-the-art ecotoxicological models Expert meeting on further steps
44	UFZ	Literature review of GIS based MCA approaches Setup of methodology Exemplary GIS land register link methodology to the GIS database
10	**MU/FHRC**	**Loss of life - Phase I - factors leading to risk** **Loss of life - Phase II - relation of risks to people and hazards** **Loss of life - Phase III - calibration of model** **Loss of life - Phase IV - flood risk maps incl. model** **Data collection for floods and flood warnings** **Application of database to selected pilot studies**

Task 11 Risk perception, community behaviour and social resilience

Local societal actors are critical in achieving effective response to flood warning. During the past decades flood defence in many EU countries was mainly determined by centralised planning and computer-based flood forecasting. Linking these top-down policy approaches more to the bottom, i.e. to the affected local societal actors, might be promising as a way to increase the effectiveness of overall flood defence management strategies. However, such preparedness strategies – as they will be subject of research in Sub-theme 2.1 – need a better fundamental understanding of the degrees of preparedness, social resilience, vulnerability and general acceptance of flood events which vary with the different social, cultural and natural circumstances of EU river basins and coastal zones. Therefore, to shed more light on this issue, a comparative inter-country analysis with case studies of three EU countries (Germany, Italy, UK) is planned in Sub-theme 1.3. Different types of communities and their preparedness to flood events will be characterised and the major driving forces of flood defence behaviour will be examined. Understanding these aspects will better facilitate the formulation of specific EU flood risk management policies in Theme 2.

Partner No	**Short Name**	**Contribution to Task 11 (Risk Perception, Community Behaviour and Social Resistance)**
44	**UFZ**	**Common survey approach** **Preparation of empirical phase** **Data collection by interviews and data analysis** **Inter-country analysis** **Lessons learned from case studies**
10	MU/FHRC	Set of indicators
33	ISIG	Contributions to Preparation of empirical phase Contributions to Data collection and analysis

2 Theme 2 Innovative mitigation and sustainable flood risk management

2.1 Theme overview

2.1.1 Overall Theme Objective

The overall purpose of Theme 2 is to develop approaches and methods to support the implementation of innovative and sustainable flood risk management.

Summary of Objectives - Theme 2

2.1 To evaluate flood risk management measures and instruments ex-post (afterwards) and to develop sustainable flood risk management strategies and evaluate these ex-ante (before implementation) for a range of different physical and societal conditions.

2.2 To improve flood risk management measures that are applied during a flood event, through improved technology for flood warning in small flash-flood catchments and through evacuation planning

2.1.2 General approach

The traditional approach to manage the impacts of floods on human society can be characterised as "flood protection" or more recently "flood management", which have sought to fully control the hazard. A key step within **FLOOD*site*** is to move from these approaches to that of comprehensive flood risk management, based on the recognition that absolute flood prevention is unachievable and unsustainable, because of the high costs and inherent uncertainties. As in the analysis of flood risk, both the flood hazard and the societal vulnerability must be considered. Management may aim at both controlling the hazard on the one hand and lowering the vulnerability on the other hand. This approach to the management of flood risks was elaborated in the EU-funded IRMA-SPONGE programme[1] and also relates to the sequence identified in the RIBAMOD Concerted Action[2]. This provides a natural structure to the research in Theme 2.

Structure of Research in FLOOD*site* Theme 2

Sub-Theme 2.1 Pre-flood Measures: These will evaluate flood risk management measures and instruments in current conditions to identify sustainable flood risk management strategies and evaluate these under consideration of a wide range of different physical and societal scenarios.

Sub-Theme 2.2 Flood event management: The research will improve flood risk mitigation measures that are applied during the flood event, through improved technology for flood warning in small flash-flood catchments and through measures for emergency evacuation for river, estuary and coastal events

Sub-Theme 2.3 Post flood measures. These affect the recovery of a community or industry damaged by floods and the sustainable regeneration of the economy in the affected area.

Because post-flood measures are the least important in lowering flood risks, **FLOOD*site*** puts emphasis on pre-flood and event management measures. The review activity in post-flood measures can be considered as "preparing the next round of pre-flood measures and flood-event measures". The lessons that can be learned from past flood events are included in the research on pre-flood measures

[1] Hooijer, A., F. Klijn, J. Kwadijk & B. Pedroli (eds.) (2002). *Towards sustainable flood risk management in the Rhine and Meuse River basins*; main results of the IRMA-SPONGE research program. NCR-publication 18-2002. ISSN 1568-234X. 39 pp

[2] Kundzewicz Z & Samuels P G (1997), *Real-time Flood Forecasting and Warning*, Conclusions from the Workshop and Expert Meeting, Proceedings of the Second RIBAMOD Expert Meeting, Published by DG XII, European Commission, Luxembourg, ISBN 92-828-6074-4

and policy instruments and on event management. However, some research may be directed towards questions such as how to deal with toxic sediments after a flood in a later stage of **FLOOD*site***.

2.2 Sub-theme 2.1 Pre-flood measures

2.2.1 Background

Pre-flood measures provide the physical, institutional and social infrastructure for the delivery of sustainable flood risk management. Strategies for preventive Flood Risk Management use a combination of:

- Technical measures for flood control and management: storage, retention areas, barriers, (sets of) dikes, pumps, channel capacity, storage, beach and dune recharge, walls, groynes, offshore reefs, etc;
- Regulatory instruments: land use planning, spatial planning and building regulations for flood-resistant and flood-proof design of buildings;
- Financial instruments: insurance, subsidies, fees, and other economic incentives;
- Communicative instruments: between national, regional and local authorities, civil protection and emergency management agencies, but also directed towards raising awareness to flood risk in general and the preparedness of the population at risk in particular.

2.2.2 Objective

The challenge is to develop scientific knowledge that can help to define future strategies for flood risk management which are robust in view of long-term uncertainties, and which also benefit local stakeholders. The question of the sustainability of flood risk management measures and strategies is especially important in view of the foreseeable changes in climatic boundary conditions and (somewhat less foreseeable) demographic and socio-economic conditions. What worked in the past (**ex-post** evaluation), may no longer be effective in future (**ex-ante** evaluation). Thus Sub-theme 2.1 will evaluate flood risk management measures, instruments and strategies for a wide range of different physical and societal conditions as analysed in Theme 1.

Objective 2.1

To evaluate flood risk management measures and instruments ex-post (afterwards) and to develop sustainable flood risk management strategies and evaluate these ex-ante (before implementation) under consideration of a wide range of different physical and societal conditions

2.2.3 Approach

FLOOD*site* focuses on the complex effects which result from technical measures and their realisation by specific policy instruments. The societal costs and benefits of flood defence and damage mitigation can be identified. This is especially important because of current planning horizons for the realisation which limits the efficiency of flood risk mitigation concepts. At the same time technical measures highly influence the society by claiming financial resources. Moreover, there are non-monetary effects such as decrease of natural watercourses with their floodplains, human interference in coastal areas, change of biodiversity, etc. These will be appraised for sustainability using multi-criteria approaches.

Pre-flood measures serve for precautionary and defensive flood risk mitigation of fluvial, estuarine and coastal hazards. Physical impacts on concentration of runoff, dynamic of discharge, extension of inundation and damage potential are governed by various measures such as:

- Land use change in source and receptor areas
- Technical measures for flood control and defence: storage, channel capacity, retention areas, (mobile) barriers, dikes, pumps, beach recharge, walls, groynes, offshore reefs
- Building and construction codes to enhance the resilience of buildings and infrastructure
- Reduction of damage by owners moving their possessions to safety

These measures are applied by regulatory instruments (spatial planning, regulations for flood resistant design of buildings, etc.) and financial instruments (burden sharing, insurance, etc.). Together they are

combined in planning strategies which range from strategic programming, contingency planning to preparedness strategies. It is assumed that the suitability of integrated strategies depends on the different types of flood.

Within this sub-theme we have identified the priority to undertake a review of research, strategies and practice, within the context of the existing FP5 RTD advances (ACTIF cluster, FLOBAR, RIPFOR) and an evaluation of actual and possible measures, instruments and strategies for the proposed pilot areas (Theme 4). Based on these, innovative strategies for flood risk management considering cost-effectiveness, sustainability, reliability, social acceptance, etc. will be designed and evaluated. Despite of a common method differences of geographical and societal conditions are regarded.

The research under this sub-theme is organised into three specific tasks. These are summarised in the box below and outlined in the following *Task descriptions*.

Key Research Tasks in Sub-theme 2.1	
Task 12	Identification and ex-post (afterwards) evaluation of existing flood risk management measures
Task 13	Integrated strategies combining planning instruments and measures to increase preparedness
Task 14	Design and ex-ante (before implementation) evaluation of innovative strategies for flood risk management

2.2.4 Definition of Tasks

Task 12 Identification and *ex-post* evaluation of existing flood mitigation and defence measures

Currently applied physical measures and policy instruments will be analysed and assessed. The physical measures are considered through their whole life-cycle of design, management, maintenance and operation. This review will produce an inventory and evaluation of effectiveness considering societal costs and benefits (economic and intangibles such as natural, cultural and scenic landscape qualities), social (acceptance) and institutional (cooperation, coordination) aspects. A method for Flood Risk Management Assessment (FRMA) will be developed, which can be applied all over Europe. It nevertheless takes into account that physical context (topography, basin characteristics, etc) partly determines the effectiveness of physical measures and the particular socio-economic and cultural context partly determines the appropriateness of physical measures and instruments. The method shall be applied in some of the Pilot studies of FLOODsite Theme 4. Finally strengths and weaknesses of flood risk management activities used in European countries and potentials for their improvement can be derived. In this context, different types of floods, like flash floods and slow swell floods in river catchments as well as estuarine and coastal floods with their specific management activities will be taken into account.

Partner No	**Short Name**	**Contribution to Task 12 Identification and *ex-post* evaluation of existing flood mitigation and defence measures**
2	WL | Delft	Identification and systematisation of applied pre-flood measures
4	**IOER**	Task leader, Developing Methodology, Case studies “Transnational Elbe basin” and “”Odra River
6	GEO	Case study “Moldava river”
7	Heura	Case study “Tisza river-A”
8	INPG	Flood forecasting: Decision making under uncertainty; Case study “Gard river”
11	UniPo	Case study “Lowland range of the Elbe river”
21	Vituki	Case study “Tisza river-B”

Task 13 Investigation of integrated strategies considering planning and communicative instruments (to increase preparedness)

Integrated strategies can be understood as combinations of regulatory, financial and communicative instruments with regard to different types of floods and related conditions. Following findings in the research field of Strategic Management, strategies of strategic programming, contingency planning and preparedness will be considered. Strategic programming assumes an extrapolation of trends without changing the organisation. Strategic contingency planning aims at developing plans for foreseeable change and at anticipating potential developments. In contrast to these strategic options "preparedness strategies" increase organisational activities in order to deal with strategic surprise which by definition cannot be anticipated. The set of integrated strategies will be developed from recent research work on organisational learning and knowledge, learning regions, management of technology and environmental decision making. It also takes the assessment of social resilience under Sub-theme 1.3 into consideration.

Partner No	Short Name	Contribution to Task 13 Developing integrated strategies combining planning instruments and measures to increase preparedness
4	**IOER**	Task leader, strategic framework, case studies Weisseritz, Vereinigte Mulde
10	FHRC	Typology of situations, case study Thames river
16	UniPad	Analysis warning and communication technology; case study Adige

Task 14 Designing and *ex-ante* evaluation of innovative strategies for flood risk management

This task will identify innovative strategies for flood risk management and evaluate these ex ante (before implementation). Hence, the research results of Tasks 11 and 12 will be synthesised. The sustainability of different comprehensive flood risk management strategies will be assessed for different situations by trying the approach in two pilot studies (Elbe for fluvial and Scheldt for estuarine/coastal) and in view of uncertainties of physical (climate), demographic and economic developments. It will be explored which flood risk management strategy suits a certain physical situation (coast, river, etc.) best. Further, the effectiveness/ vulnerability of different flood risk management strategies coherent with different management styles (related to world-views as distinguished in social science) will be explored with regard to an uncertain future (by assessing different scenarios of future development). Conclusions on 'the best practice/ strategy' for different situations will be drawn and made available as input for Theme 5.

Partner No	Short Name	Contribution to Task 14 Designing and ex-ante evaluation of innovative strategies for flood risk management
1	HRW	Modelling of flood risk Elbe, assessment of strategies Elbe, reporting
2	**WL | Delft**	**Task leader, modelling of flood risk Scheldt and Elbe, assessment of strategies Scheldt and Elbe, reporting**
4	IOER	Defining innovative strategies of pre-flood measures
12	TUD	Modelling of flood risk Scheldt, assessment of strategies, reporting
18	WUR	Definition of future scenarios, assessment of strategies, reporting

2.3 Sub-theme 2.2 Flood event measures

2.3.1 Background

Flood event measures provide risk mitigation by hazard control and damage reduction during the event by using a combination of:

- detection and forecasting of hydro-meteorological conditions (rainfall, river flow, tide, surge and wave climate), and timely warning of the relevant authorities and/or the public;
- operation of flood defence structures, such as storm surges, and other flood control structures, e.g. the operational management of dams or detention areas (where appropriate with real-time control);
- deployment of temporary and de-mountable flood defence systems;
- implementation of emergency management plans and evacuation;
- emergency control and temporary repair of breaches in dikes and failures of defence system components.

The research requirements in this area (as elsewhere in **FLOOD*site***) must take account of the substantial European and national research programmes and experience in operational flood event management.

2.3.2 Objectives

For the **FLOOD*site*** project we have identified a particular need for improving flash-flood forecasting and warning procedures as an effective means of flood risk mitigation in relatively small, i.e. rapidly responding, river catchments of less than about 500 km^2. As the rapidly rising of the water level leaves little time to take decisions and actions, the need for timely hazard detection is crucial and in fact the most effective means of flood risk mitigation. Secondly, research into evacuation schemes must be intensified. This typically requires a trans-disciplinary approach, where technical science and socio-economic and geographical approaches must be appropriately linked.

Objective 2.2

To improve flood risk mitigation measures that are applied during the flood event, through improved technology for flood warning in small flash-flood catchments and through national schemes for emergency evacuation.

2.3.3 Approach

Firstly, Theme 2.2 will develop and validate tools integrating the available know-how in radar hydrology and in radar data assimilation in Numerical Weather Prediction (NWP) models. Previous and on-going research projects in flood forecasting are examining:

- the potential role of radar detection in quantifying and predicting rainfall (HYDROMET, CARPE DIEM, FLOODRELIEF, MUSIC) and
- the considerable uncertainties in flash-flood prediction (AFORISM, FLOODGEN).
- the identification of end-user needs for flood forecasting in medium and large basins and applicability of available meteorological data is being undertaken in 2003/04 in the ACTIF project.

Secondly, Theme 2.2 will extend at the European scale recent advances in defence monitoring and emergency repair and provision of temporary defences. During the last five years there have been a number of extreme flood events in countries across Europe. These events have tested existing water authority practices to the limit. Lessons have been learnt during these events, but are not widely disseminated.

Thirdly, Theme 2.2 will intensify research into evacuation schemes. During a flood event, an important part of the management activities consists of identifying the communities at risk, updating evacuation plans and maintaining access for rescue services. These activities can significantly mitigate the impact of severe floods on the people and the goods at risk. This requires a trans-disciplinary approach, where technical science and a socio-economic geographical approach must be appropriately linked. Applying up-to-date data on demographics and infrastructure (GIS-analysis) is essential for developing evacuation schemes that effectively prevent casualties among people and loss of cattle. Such evacuation schemes are to be based on sound breach and flooding simulations, of course, which will be retrieved from Theme 1, but a distinct task has been defined in this Sub-theme which focuses on the social geographic aspects, infrastructure and logistics. Relevant differences between narrow valleys which are flash-flood prone, versus diked alluvial and coastal plains with high population densities at long distances from safe ground will be tackled by developing a generally applicable, i.e. easily to parameterise, GIS-based method. Its development will be tuned to incorporation in the flood event management framework of Theme 3. Research may be required on warning system implementation and contingency planning at later stages in **FLOOD*site*** (depending on outcomes in Sub-theme 2.1).

The research under this sub-theme is organised into three specific tasks. These are summarised in the box below and outlined in the following *Task descriptions*.

Key Research Tasks in Sub-theme 2.2

Task 15 Radar and satellite observation of storm rainfall for flash-flood forecasting in small and medium-size basins
Task 16 Real-time guidance for flash-flood risk management
Task 17 Emergency flood management - evacuation planning

2.3.4 Definition of Tasks

Task 15 Radar and satellite observation of storm rainfall for flash-flood forecasting in small and medium-size basins

The research aims to enhance the performance and shorten the lead-time of flash-flood forecasting by linking rainfall-runoff models to real-time remotely-sensed data. The specific objective of this project is to develop and test a Structured Algorithm System for radar and satellite detection and estimation of extreme storm rainfall. In addition an assessment will be done concerning the uncertainty of the radar rainfall estimates. The developed systems will be applied in different pilot areas, a.o. the Adige and in the Ardennes and Cevennes-Vivarais areas.

Partner No	Short Name	Contribution to Task 15 Flash-flood forecasting in small and medium-size basins – radar and satellite observation of storm rainfall
43	TU Dres	Rainfall estimation by use of MSG imagery combined with radar ground stat.
8	**INPG**	Task leader; Theoretical and operational assessment of the SAS efficiency
16	UniPad	Assessment radar rainfall est. uncertainty and oper.assessment SAS on Adige
18	WUR	Theoretical development of SAS and operational assessment

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

This task is related to task 15 and aims to identify the best method for allowing the evaluation of flash-flood risk at a regional level. The two existing approaches for this are: (1) using ‘classical’ detailed hydrologic models, and (2) using the so-called Flash Flood Guidance FFG concept that directly links rain or discharge thresholds to levels of risk. These existing approaches will be compared and applied

in the pilot areas in the Adige and the Cevenes-Vivarais areas and evaluated with respect to their applicability.

Partner No	Short Name	Contribution to Task 16 Flash Flood Forecasting in small and medium-size basins – real-time guidance for flash-flood risk management
5	ENPC	Assessment of FFG on Gardon river
8	INPG	Development and assessment of rainfall-based algorithm in FFG
9	JRC-IES	Assessment of LISFLOOD for flash flood forecasting
16	**UniPad**	**Task leader, Development and assessment of Flash Flood Guidance concept**
37	UniBo	Assessment of TOPKAPI for flash flood forecasting

Task 17 Emergency flood management - evacuation planning

In the case of medium to large river floods, water rises rather slow but concerns large areas in alluvial plains. Hydraulic models can rather precisely determine fields of water depth and velocity that can be overlapped with terrain maps in order to identify communities and transport axes at risk. For a set of hydrologic scenarios and corresponding flooding patterns, evacuation strategies can be prepared in advance, to avoid complete-real time computation. This knowledge is stored in a database which can be accessed to select the scenario that most closely resembles the actual situation. Thus, authorities can immediately establish what to expect and how to best evacuate the inhabitants.

In the case of flash-floods, water levels rise suddenly and generally in small areas. During the Gard event in September 2002 more than 100 rescue vehicles were lost on flooded roads. Even a crude assessment of this type of hazard would considerably help Civil Protection services to manage road traffic and to co-ordinate rescue actions. Given the large variety of possible scenarios generating flash-floods, the pre-flood identification of all the corresponding emergency plans is still out of reach. In addition, the detailed description of the water depths and velocity fields is difficult given the type of flow and the terrain configuration. The challenge is to find a method to identify such localised risks and to integrate this information into a real-time road management system.

Partner No	Short Name	Contribution to Task 17 Emergency flood management - evacuation planning
1	HRW	2-D inundation modelling
2	**WL | Delft**	**Task leader, 2-D inundation models, Evacuation models**
4	IOER	Identification of road/river crossing points on maps
5	ENPC	Coupling of rainfall-runoff models to road vulnerability modules
26	JRC-IPSC	Development of population flows model and related evacuation measures
21	VITUKI	Testing of the open modelling system on one of the pilot areas (Tisza River)

2.4 Sub-theme 2.3 Post-flood measures

The post-flood measures promote the recovery of the population and regeneration of businesses in the area affected by flooding; it involves:

- Relief measures during and in the immediate aftermath of the event,
- Repair and reconstruction of flood damage to buildings and infrastructure,
- Review of the operation and effectiveness of the flood defence system and the emergency procedures.

No priority research actions have been identified under this sub-theme. However, during the project we shall evaluate the need for further actions using for example Earth Observation data based upon the results of on-going FP5 activities as co-ordinated through the ACTIF cluster and the guidance produced in EU-MEDIN.

3 Theme 3: Frameworks for technological integration

3.1 Overall Theme Objective

The scientific knowledge and understanding generated in Themes 1 and 2 of **FLOOD*site*** will be brought together in a consistent and coherent manner to facilitate its application to two specific decisions encountered in flood management practice. Particular attention will be needed to communicate information across the typical "boundaries" between the professions involved in flood mitigation activities in practice (long-term economic appraisal, policy development, spatial planning, technical and ecological performance of infrastructure provision, real-time event management etc.) and influence of uncertainty on decisions made.

Summary of Objectives - Theme 3

3.1 To integrate the scientific, technological and procedural advances to support long term flood risk management decisions.
3.2 To integrate the scientific, technological and procedural advances to support flood event management decisions.
3.3 To develop a framework for the identification and quantification of the influence of uncertainty in the process of flood risk management.

3.2 Overview of approach

FLOOD*site* is characterised by its integrated modelling for flood risk and support for strategic coastal and river management. This raises a number of important issues including:

- The application of interdisciplinary knowledge and approaches of the project team, including climatology, hydrology, river and coastal hydraulics, engineering, ecology, economics, spatial planning, social sciences to provide rounded flood risk management solutions.
- The development of generic techniques and tools to support the handling of uncertainty within research, practice in flood risk management across spatial planning organisations; river, estuary and coastal management organisations; civil protection and emergency management organisations, meteorological institutes, hydraulic research institutes, etc.
- At a European level, communication between the different national planning and decision systems as well as the instruments applied.

Relevant national and EC initiatives

RASP – Risk assessment for strategic planning - A project funded by the Environment Agency, UK this current project is developing a tiered approach to flood risk management decision making from national policy to local interventions

HarmonIT - The objective of this project, funded by the EC, is to develop, implement and prove a European Open Modelling Interface and Environment (OMI) that will simplify the linking of models and hence allow flood risk managers to explore the likely outcomes of different policies

Foresight – Flooding Project – Funded by the Office of Science and Technology in the UK this project is taking a forward look as to how flood risk and flood risk management responses might change by the 2050s and 2080s. It is currently developing four co-evolutionary futures of socio-economic development, climate change, morphology response, land use as well as flood management responses under four possible scenarios (World Markets, National Enterprise, Global Responsibility or Local Stewardship)

IRMA SPONGE - The IRMA-SPONGE Umbrella Program funded by the EU, comprised 13 European scientific projects on flood risk management issues along the Rivers Rhine and Meuse, and was one of the largest and most comprehensive efforts of its kind. The aim was to develop methodologies and tools to assess the impact of flood risk reduction measures and scenarios and support the spatial planning process in establishing alternative strategies for an optimal realisation of the hydraulic, economic and ecological functions of the trans-national Rhine and Meuse River Basins.

FloodRiskNet - This is a UK funded, cross-disciplinary network that aims to address the problems of flooding, dam safety, and coastal erosion using risk and uncertainty analysis methods. It is concerned with statistical analysis of rainfall, fluvial flows and marine storms, reliability of flood defence and dam systems, and uncertainty in the analysis of inundation and impacts of flooding and erosion. FloodRiskNet is a response to contemporary demands for improved flood risk and uncertainty analysis and risk-based decision-making that are emerging from industry and government

The research under this sub-theme is organised into three specific tasks. These are summarised in the box below and outlined in the following *Task descriptions*.

Structure of Research in FLOOD*site* Theme 3

Theme 3 has no sub-themes, but is structured in three Tasks as follows:

Task 18 Framework for long-term planning in flood risk management: The framework for long-term planning will consider the integration of flood risk management activities and their impact on broader social, economic and natural systems over time-scales up to 50 or 100 years.

Task 19 Framework for flood event management planning: Flood event management planning involves pre-event preparation and the operational activities of forecasting, warning and emergency response.

Task 20 Development of framework for the influence and impact of uncertainty: A framework is necessary for the identification and quantification of the influence of uncertainty in the process of flood risk management at all spatial and management time scales.

3.3 Description of Tasks

Task 18 - Framework for long-term planning in flood risk management

Long-term planning is an integral part of developing sustainable flood risk management polices and intervention measures. In particular, it enables decisions makers to explore strategies, set targets, and question the status quo and the merits of innovative ideas. In particular this task aims to:

- Make clear long-term planning issues that are relevant to flood risk management, to the research community, decision makers and the general public (awareness raising objective)
- Enable the influence of management options (strategy development / planning support objective) to be explored and quantified.

The scientific outcome of this task will be a conceptual framework that incorporates the developments, management options and interrelations that are relevant to flood risk management in a range of European environments. The framework will be accessible (and therefore useful) through a Decision Support System (DSS). This DSS will be primarily targeted at the research community and planners, who will be able to test the long-term (20, 50 and 100 years) effects of specific management options, in specific locations. Such concrete questions will be dealt with in the 'planning support' mode. However, the DSS will also have an 'educational mode' that gives access to libraries (representing the conceptual framework and background material), and will have a non-site-specific 'flood risk planning simulator'. In this mode, the tool shows the role and principles of flood risk management, integrated with land-use and water resources management, for particular 'example areas' (the output of Floods*ite* Theme 4, Pilot Application Sites, will be used for this). The 'educational mode' DSS could be accessed through the Internet, for example, with minor adaptations.

In essence, the framework will formalise interactions between scenarios of change and strategies for flood risk management responses:

- *Scenarios for change* - involve developments that are largely autonomous from the actions of flood risk managers, i.e. they can not be controlled in the context of flood risk management. They include *risk sources* (climate change, sea level rise, population growth, macro-economic developments), and to a lesser extent some risk *pathways/receptors* (societal resilience, attitudes, preparedness; ecological developments).

- *Strategies for flood risk management response* - consist of measures that can be taken, i.e. the management response. Such measures will include *flood prevention* (e.g. in river basins upstream of flood prone areas), *flood control* (technical works near flood-prone areas) and *preventive flood damage reduction* (in flood-prone areas) and the role of cross-border agreements

Note in developing both of these aspects a number of links exist between this task and other Themes and sub-themes.

Partner No	Short Name	Contribution to Task 18 - Framework for long-term planning in flood risk management
1	**HRW**	**Overall Task leader and lead in the development of the conceptual framework and inputs to inundation, measures and interface modules.**
2	Delft	To provide input to the development of the conceptual framework and lead activities on the inundation and measures modules and lead the coding of the DSS interface.
4	IOER	To provide input to the development of the conceptual framework and lead activities on the land use, socio-economic and flood vulnerability modules.

Task 19 - Framework for flood event management planning

Flood event management planning involves pre-event preparation and the operational activities of forecasting, warning and emergency response. The first step in considering the needs of the flood event management planner is to identify the physical constraints within which they have to make their

specific decisions. Therefore, the specification and desired functionality of a decision support system will be defined for a range of flood event management situations, including small rivers with flash floods, large lowland rivers (diked or natural valleys), estuaries and coastal plains. Across all of these physical setting a generic set of queries will be asked by the planner and will need to be supported by the underpinning integrated framework embedded within the a DSS aimed specifically at support flood event management decisions. Based on this functional design, the decision support system will consist of a linked series of models and data (depending on the situation) as follows:

- An early warning system
- Identification of possible breach locations (initiation) and likely breach growth
- Inundation
- Evacuation model

This task will:

- Link models and related procedures to support emergency management planning and practice.
- Provide an end-to-end modelling framework that spans from hazard (e.g. precipitation, storm) forecasts to evacuation planning tools embedded in an open modelling platform, complying with HarmonIT standards.
- Narrow the bandwidth of possible forecasts by rejecting unlikely scenarios with the aid of uncertainty-quantification techniques, to support more robust decisions and limit false alarms.
- Optimise safe escape logistics for secure evacuation in case of disaster through evacuation modules.

Partner No	Short Name	Contribution to Task 19 - Framework for flood event management planning
1	HRW	Will provide input to the development of the conceptual framework and design of the DSS (and lead the development of the breach location module). HRW will also lead the testing through the Thames.
2	**WL | Delft**	Will lead the development of the framework, the design and construction of the DSS (in particular leading the inundation and forecast modules). Delft will also lead the application to the Schedlt.
12	TUD	Will provide input to the development of the framework and breach location module of the DSS and lead the development of the evacuation module.
24	SOG	

Task 20 - Development of framework for the influence and impact of uncertainty

A framework is necessary for the identification and quantification of the influence of uncertainty in the process of flood risk management at all spatial and management time scales. In particular this tasks aims 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 specific support to decision analysis techniques in policy and emergency situations.

In flood defence there is often considerable difficulty in determining the probability and consequences of important types of event. Most engineering failures, including flood defence failures, arise from a complex and often unique combination of events and thus statistical information on their probability and consequence may be scarce or unavailable. Under these circumstances the engineer has to resort to models and expert judgement. Models will inevitably be an incomplete representation of reality so will generate a probability of failure, which is inherently uncertain. Similarly, expert judgement

(mental models and personal understanding of a situation) are subjective and inherently uncertain. Thus practically every measure of risk has uncertainty associated with it. Understanding this uncertainty within predictions and decisions is at the heart of understanding risk. In recognising uncertainty it is possible to acknowledge lack of knowledge of the behaviour of the physical world (knowledge uncertainty), its inherent variability (natural variability) and the complexity of social or organisational values and objectives (decision uncertainty).

Substantial work on uncertainty handling in flood risk models has been funded by Member States, the EU and elsewhere internationally in recent years. Besides necessary review work, **FLOOD*site*** will focus on novel areas of uncertainty analysis and decision support, namely:

- Efficient methods for propagating uncertainty through complex hybrid models that are used in flood risk analysis
- Analysis of the model uncertainty of different components in a complex hybrid model in order to make statements about the model uncertainty associated with the hybrid model prediction,
- Development of decision support techniques that help decision-makers better account for uncertainty in their flood management practices.

Partner No	**Short Name**	**Contribution to Task 20 - Development of framework for the influence and impact of uncertainty**
28	**UniBristol**	**Task leader with inputs to uncertainty issues associated with composite model construction and robust risk-based decision-making methodologies. Specific responsibility for dissemination of methodologies within Theme 3 and application in DSS development.**
15	IHE	Lead on propagation of uncertainty through composite (hybrid) models and provision of support to UniBristol on robust risk-based decision-making (in particular case-base reasoning (CBR) and its application in the case studies)

4 Theme 4, Pilot Application sites

4.1 Overview of objectives

It is essential that all work under the **FLOOD*site*** project contributes directly towards practical flood risk management. Whilst some aspects of the work will necessitate academic research, each component of work will ultimately contribute towards development and implementation of improved flood risk management tools and approach. To aid this process, seven pilot study projects have been identified which will permit direct interaction with research and development work throughout the Integrated Project.

Summary of Objectives – Theme 4

4.1 To provide real sites with real and specific problems upon which tools, techniques and decision support systems may be developed and tested.
4.2 To provide feedback into the research and development process from flood risk managers and river, estuary and coastal stakeholders.
4.3 To ensure that **FLOOD*site*** deliverables are of real value, practicable and usable.

The **FLOOD*site*** pilot studies will combine results from all other work packages in real world demonstration. Therefore the management of the pilot sites has been identified under a separate theme area. Each pilot study research manager will be located close to the site itself and have direct links with societal institutions concerned to practical flood risk management (water management authorities, political decision makers, business companies, private public, etc.). The research manager will constitute and co-ordinate the interface between researchers and these institutions. (Although **FLOOD*site*** will include input from authorities responsible for flood management at the test sites, communication at a local level is considered more efficient through a technical member of the Project Team.). Pilot study sites have been selected for their specific flood risk management challenges, their meaning from a European point of view as well as the availability of data and opportunity to link directly into existing 'local' management teams. In this way, **FLOOD*site*** gains immediate access to established groups of stakeholders who will be motivated to participate in the demonstration of **FLOOD*site*** deliverables.

Management of each pilot study will begin with the development of a plan specifying the requirements for data, relevance of certain institutions for flood risk management and access to local knowledge. A complementary report will subsequently be produced containing detailed information on data availability, stakeholder communication etc.

Based on Theme 3 a series of possible management options and institutional interaction will be scoped and implemented on a site by site basis. The extent and focus of this interaction will vary from site to site and will depend upon the existence and / or flexibility of any existing flood risk or environmental management schemes.

The seven pilot studies in Theme 5 covering river catchments, estuaries and coastal zones

- River Elbe (Transnational – Czech Republic, Germany)
- River Tisza (Transnational – Hungary, Rumania)
- European flash flood catchments (examples) (Multinational – European countries)
- River Thames Estuary (UK)
- River Scheldt Estuary (Transnational – Belgium, Netherlands)
- River Ebro Delta (Coastal) (Spain)
- German Bight (Coastal) (Germany)

4.2 General approach

For all pilot study sites an overall approach in terms of interfaces between physical flood processes and the societal flood risk management will be used. This framework provides a common structure which allows an identification and comparison of all activities for implementation and application of research deliverables. It covers modelling of physical processes by natural science, investigations on vulnerability and mitigation measures as well as planning strategies for the decision making processes. For every site further detailed approaches are developed and applied depending on the site specific flood management issues. These are described for every pilot study site in the following brief descriptions of the work packages.

4.3 Task Descriptions

Task 21 Pilot Study of the River Elbe

The first case study is dedicated to mitigation measures in the transnational Elbe river catchment, where the most serious flood damages ever in Europe occurred in August 2002. It deals with methods for solving land use conflicts in source areas, pathways and receptor areas. As a main aspect effectiveness of physical flood precautionary and flood defence measures will be acquired using hydrological models (see theme 2.2) and economic cost-benefit-analysis (see theme 2.1). Subsequently multi-criterial evaluations are carried out in terms of sustainability (see theme 1.3). Based on this suitability of different planning strategies with certain instruments are considered (see theme 3).

In four in-depth studies characteristic flood issues within the Elbe river catchment will be investigated. Two of them, one in the Czech Republic and one in Germany, focus upland areas with their typical flash floods. Hydrological effects of reservoirs and land use changes on water levels are the most important tasks, especially for floods of middle time of return. Events of higher recurrence are considered in a special pilot site study. The others cases, again in both countries, are concerned to decrease of water levels by enhancing inundation areas (e.g. controlled polders) and avoiding the flooding of settlements. For this 2-dimensional hydraulic models are run (see Sub-theme 1.2), then multi-criteria evaluation is done. As application instruments spatial planning including the participation of societal institutions will be further developed in terms of flooding.

Finally results of the regional investigations will be used for the flood risk management on the level of the whole Elbe river catchment. A qualification of the parameterisation of LISFLOOD will be provided; this model is used to calculate the trans-national effects of mitigation measure scenarios. In addition, deliverables from planning strategies will be used to advice further activities in terms of harmonising cross-boundary legal, spatial planning and burden sharing instruments.

Partner No	Short Name	Contribution to Task 21 Pilot study site “River Elbe"
4	**IOER**	**Task leader, Modelling the flood hazards and vulnerability**
6	GEO	study on impacts of changes in source area of floods
11	UniPo	Assessment of peak discharge reduction by using flood detention basins
39	CTU	Assessment of flood defence structures and effects of the river environment
43	TU Dres	
44	UFZ	

Task 22 Pilot Study of the River Tisza

The experience and consequence of the floods of the past 5 years along the Tisza river as well as the broader knowledge accumulated on its flood problems may serve as a firm basis to investigate precautionary and sustainable management solutions. The river basin is shared among five countries (SK, UA, RO, HU and YU) and the problems in the generation, runoff and propagation of floods, as well as the existing and planned structural and non-structural measures both in the national and international scale need careful investigation. The flood management problems in Hungary alone are

obvious for over 400 communities housing 1.2 million inhabitants on a floodplain extending to 15,640 km^2, protected by 2,940 km defences. Thus the Tisza basin presents not only serious flood management issues within Hungary but also has significant international dimensions to it management extending beyond the EU and Accession States. The pilot study of the Tisza Basin will concentrate on the following issues:

- development of river basin based, precautionary and sustainable flood management strategies, form investigation and analysis of previous floods
- raising public awareness and public participation by risk communication, stakeholder involvement, etc using techniques developed in **FLOOD*site***
- fostering international co-operation

Partner No	Short Name	Contribution to Task 22 study site "River Tisza"
44	UfZ	analysis of effects of pollution due to flooding
7	HEURAqua	analysis of river capacity problems
21	**VITUKI**	**Task leader, analysis variants on land, forecasting, data exchange, IT developments, virtual common flood management centres**

Task 23 Flash flood basins – monitoring and validation

The objective of this pilot study are the demonstration and assessment of flash flood risk mitigation strategies in close collaboration with operational organisations, local communities and stakeholders in four sites. The study areas were chosen due to especially high flash flood risks. They are the Cévennes-Vivarais Region (France), the Adige River (Italy), the Besos River and the Barcelona Area (Spain), the Ardennes Area (Transnational). Data and development of a network of flash flood pilot application sites will favour the creation of a transnational end-user community, and then will allow to identify and generate solutions for these problems. The physical and socio-economic data gathered will provide necessary input to research work planned in Sub-theme 1.1 (flash flood hazard), Sub-theme 1.3 (Social resilience) and Sub-theme 2.2 (Flash flood forecasting). The observational and organisational platform will provide a testing phase for models and procedure developed in Theme 2.2 (flash flood forecasting).

The investigations of this pilot study covers the development and testing of flash flood risk mitigation strategies. It refers to main problems of current activities which suffer from 1) lack of data and 2) dispersion of responsible operational services. The rigorous application of a common observation strategy across Europe will allow the selection and the analysis of selected events in a common framework. Based on this the flash flood forecasting and warning system platform developed in theme 2.2 will be implemented and validated. For the flash flood events an assessment exercise will be carried out concerning the overall effectiveness and efficiency of forecasting, warning, response, and preparedness actions. For each pilot site, a procedural model of these actions will be prepared, identifying major physical, organisational and institutional structures, and their response under the flash flood forcing.

Partner No	Short Name	Contribution to Task 23 pilot study site "Flash flood basins"
5	ENPC	Assessment of FFG on the Cevennes pilot site
8	INPG	Development and assessment of the FFG
16	**UniPad**	**Task leader, Development and assessment of Flash Flood Guidance concept**
18	WUR	Assessment of the FFG on the Ardennes pilot site

Task 24 Pilot study of the River Thames Estuary

The River Thames Estuary extends from its tidal limit at Teddington in west London to the North Sea. In this reach the character of flooding changes from fluvial dominance at the upstream end to the hazards posed by storm surges and waves at the seaward limit. The estuary has a dynamic sediment regime with sequences of erosion and deposition on each tide. The area also has tidal salt marsh towards its eastern end and extensive mudflats exposed at low water, which offer important habitat conditions. The hinterland is of high economic importance nationally, with London alone accounting for about 10% of the national total of assets exposed to flooding hazard. In addition there are substantial commercial sites downstream of London including petro-chemical industry on Canvey Island, which was severely affected by the 1953 storm surge, and substantial transportation infrastructure. The area known as the "Thames Gateway" along the Estuary has been identified for significant residential development over the next 20 years in response to demographic pressures (which require an additional 4 Million homes nationally) and a coastal site for a new major airport is being considered in this region. The Thames Barrier and current tidal defence embankments were raised in the late 1970's and provide a standard of protection of about 0.1% annual probability. The Barrier is midway through its design life and a strategic review is underway of the flood defence along the entire estuary as part of the Planning for Flood Risk Management in the Thames Estuary project.

The overall objective of the Thames pilot study is to develop and test the **FLOOD*site*** methodologies in the context of a Performance-based asset management system aimed at supporting maintenance of existing defences and operational decisions, with the following specific objectives:

- *Thames 1)* To explore the practicality and utility of a decision support system for asset management (including risk-based prioritisation and justification of maintenance and operational interventions)
- *Thames 2)* To explore the inspection methodologies and data needs to support such an approach
- *Thames 3)* To apply the performance-based asset management tools and concepts in support of developing the optimum strategic approach for flood risk management and thus identify issues and problems relating to risk management approaches, seeking direct feedback from the users.

Partner No	Short Name	Contribution to Task 24 Pilot study of the River Thames Estuary
1	**HRW**	**Lead the development of the pilot, including inspection methodologies defence performance and management of data**
15	UniBristol	To provide support on the development of the DSS and asset management concepts

Task 25 Pilot study of the Scheldt Estuary

The pilot study for the Scheldt Estuary refers to evaluation of technical effectiveness and socio-economic feasibility of flood management strategies and achievement of sustainable protection against flooding and effective flood event management. It contains risk analysis, analysis of flood management options and the transition management. The approach of risk analysis includes both physical hazards, now and in the future, as well as the socio-economic consequences in terms of anticipated damage, resilience and vulnerability. Flood management options and strategies will be analysed and evaluated in terms of technical effectiveness and feasibility as well as socio-economic acceptability both ex-post and ex-ante. Transition management not only involves the dissemination of knowledge and project results, but also an analysis of bottlenecks in the implementation of measures. The concepts, ideas and tools for this transition will be developed in close co-operation with end-users and stakeholders.

Partner No	Short Name	Contribution to Task 25 pilot study of the "River Scheldt Estuary"
2	**WL | Delft**	**Task leader, Preparation of flood hazard map present/scenario**
12	TUD	Data collection baseline situation and identification of critical issues
17	UT	

Task 26 Pilot study of Ebro Delta

The objective of the pilot site study for the River Ebro delta is to examine vulnerability, risk and defence needs against flooding at the Ebro delta by applying the FLOODsite methodology. This area is specially interesting since it is a low-lying coast protecting a deltaic plain with high environmental values and with intensive land-use (agriculture) in a specially vulnerable environment (about the 50% of the deltaic plain surface is below +0.5 m (above the MWL). This protection is done in a natural way since it consists in small dunes and beach ridges.

The investigations are based on a compilation of previously collected date in a catalogue of flood and breach events with information on the recovery process. In addition to that an identification of climate conditions during recorded flood and extreme events will be done and the probability of occurrence of targeted conditions (marginal and joint probabilities) will be estimated. Afterwards extreme marine/riverine effects on flooding and associated response at the coastal fringe are characterised. Therefore morphodynamic models to simulate storm and flood effects on low-lying and barrier coastal profiles will be adapted. Finally coastal vulnerability (and resilience) to these events is mapped and used to develop management strategies to mitigate flooding risks. The latter comprises the participation of all institutions which are responsible for or affected by these type of floods.

Partner No	Short Name	Contribution to Task 26 Pilot study of the "Ebro Delta"
13	**UPC**	**Task leader, and co-ordinator with local authorities**
17	UT	Integrated coastal zone modelling
19	UniLund	Contribution to study of morphology

Task 27 Pilot study of a coastal site in the German Bight

Within this pilot site study a fine-tune of present methodologies for vulnerability assessment and an expansion of current methods for the assessment for damage potentials for general improvement of risk analysis will be carried out. Based on this the transfer from micro-scale assessment methods to neighbouring flood risk areas and to flood-prone areas in Europe (long-term) is investigated. Afterwards current data from damage potential assessment with damage estimation using likely scenarios of flooding are compared.

As case study area St. Peter-Ording community will be investigated in details. This covers the analysis of socio-economic vulnerability of this town and the assessment of failure probabilities of coastal defence. To define enhanced methods dike-failure probabilities and vulnerability assessment are combined. Finally the local results will be upscaled for expanded areas and vulnerability indices by means of (semi-) quantitative indicators are derived.

Partner No	Short Name	Contribution to Task 27 Pilot study site "German Bight"
3	LWI	Task leader, collecting of data for assessment of failure probabilities
20	**CAU**	**documentation of methods for VA**

5 Theme 5: Training, Dissemination and Raising Public Awareness

5.1 Overall objective

This Theme will develop tools and training systems based on computer-based modelling tools, e-learning, knowledge engineering and management in order to support the demonstration and transfer of the developed **FLOOD*site*** methodologies in the field of integrated flood risk analysis, modelling and management. This will facilitate the transfer of the knowledge generated within the Integrated Project to the user and stakeholder communities involved in flood mitigation and management.

Summary of Objectives – Theme 5
5.1 To provide a series of Best Practice Guidance based upon the research outcomes
5.2 To disseminate, and support transfer, of knowledge to the stakeholder communities
5.3 To provide public educational tools (web-based) for school age children

5.2 General approach

The deliverables from **FLOOD*site*** divide broadly into scientific knowledge and understanding, and specific tools and methodologies. However, to facilitate the actual application of this knowledge and the developed tools and methodologies, they need to be communicated and demonstrated effectively to all stakeholders involved in the flood management practice. The audiences identified are:

- *Public*: the inhabitants of the protected or potentially affected areas, farmers, industry, environmental and other associations, these are the beneficiaries of flood defence activities
- *Professionals*: engineers working for government, consultants, academics conducting relevant research and educating the next generation of experts, these form the "user" community;
- *Educational institutes*: students at universities as well as at primary and secondary schools

Theme 5 has four tasks to reach the different stakeholders in a form that is most appropriate for them. These are summarised in the box below and in the following text outlines.

Key Tasks in Theme 5	
Task 28	Integrated information management
Task 29	Text-based knowledge transfer
Task 30	Web-based knowledge transfer
Task 31	Face-to-face knowledge transfer

5.3 Task Descriptions

Task 28 Integrated information management

This task will proved the general framework for guiding and facilitating the work on tasks 30-32 by reviewing and confirming the target audiences and the nature/content of the knowledge transfer involved. The task will also confirm the project style for delivery of knowledge transfer and the monitoring and review of the knowledge transfer of all other projects in **FLOOD*site*.**

Partner No	**Short Name**	**Contribution to Task 28 Integrated information management**
1	**HRW**	**Co-ordination with other themes, develop questionnaire and style, support assessment**
12	TUD	Task leader, conducting survey and assessment, monitoring and review

Task 29 Text-based knowledge transfer

The Best Practice Guides will integrate the results of the whole **FLOOD*site*** IP and translate them in practical terms and guidelines. The main target groups of the Best Practice Guides are the experts and the authorities that are directly involved in the flood management process. Based on the achieved results and the best practices, the guidance documents will elaborate the flood risk analysis, a sound emergency planning and a sustainable long-term flood risk management strategy. However, the guidance will also discuss how to inform and involve the other stakeholders, such as the local population. Their participation and co-operation is essential in ensuring that flood management meets the different social, environmental and economic needs, and can be thus implemented in practice. In addition to the Best Practice Guides, educational material will be developed for primary and secondary schools. A separate activity comprises the development of a Guidance Note for methods to be used for developing Flood Risk Atlases. This activity is included to link **FLOOD*site*** with other on-going activities in this field.

Partner No	Short Name	Contribution to Task 29 Text-based knowledge transfer
1	HRW	Best Practical Guide (3) on long term strategic risk management plans
2	**WL | Delft**	**Task leader, Best Practical Guide 4 on emergency management planning**
4	IOER	Best Practical Guide (2) on management measures and policy instruments
10	MU/FHRC	Best Practical Guide (1) on science of undertaking flood risk analysis
12	TUD	School book on flood management

Task 30 Web-based knowledge transfer

The Tools and Methodologies will support the communication and demonstration of the findings of the whole IP to the flood risk management and spatial planning community. It further contributes to the enhancement and adoption of training platforms based on e-learning, using computer-based modelling tools, role plays ("flood game"), visualisation and DSS in the field of integrated flood risk analysis, modelling and management. The developed tools will not be marketed but be implemented on a site by site basis.

Partner No	Short Name	Contribution to Task 30 Web-based knowledge transfer
1	HRW	Specification, modelling components of E-Flood
22	**IHE**	Task leader, specification, integration of the E-Flood platform
37	UniBo	Implementation of role plays and educational content

Task 31 Face-to-face knowledge transfer

The Knowledge Transfer and Dissemination task focuses on under and post-graduate training and education of (future) experts, and on production of materials (course-ware) for knowledge transfer and dissemination of the information to the general public. This work package will also integrate the project results for a design of an European touring exhibition about the different cultures for "Living with Floods", targeted towards the non-scientific level to the broad public living in flood prone areas.

Partner No	Short Name	Contribution to Task 31 Face-to-face knowledge transfer
8	INPG	.
43	TUD	
16	**UniPad**	Task leader; development of **FLOOD*site*** Master Course package

6 Theme 6 Project Networking, Harmonisation and Assessment

6.1 Overall Objective

There are many other activities in progress on flood management across Europe; some promoted by DG research and other parts of the European Commission and others undertaken at a national level. Theme 6 will provide the basis for the linkage between **FLOOD*site*** and these external activities. The theme will also have an inward perspective to build the common view and approach within the project team and to monitor and assess progress towards the **FLOOD*site*** objectives. A key component will be develop a common language of risk and associated definitions for the application of risk management concepts to flooding.

Summary of objectives – Theme 6

6.1 Link with external research and policy development activities

6.2 Provide internal coherence within the **FLOOD*site*** consortium (e.g. through the development of a common language of risk for flood management)

6.3 Integrate review and assessment into the project activities

6.2 Approach

The DG Research has established networks within FP5 through the clustering of projects on water in the city (CITY-net) and on flood forecasting (ACTIF). Several of the **FLOOD*site*** partner organisations are connected with one or other of these FP5 clusters, which will provide a direct connection for the networking activity. Theme 6 will be implemented through two tasks:

- *Task 33 Networking and harmonisation* aimed at ensuring a common language and integration with on-going and past national and international initiative and
- *Task 34 Assessment and review* with the aim of ensuring the project deliverables and direction are scientifically sound and that project performance is satisfactory.

6.3 Task Descriptions

Task 32 Networking and harmonisation

The project networking, harmonisation and assessment component of **FLOOD*site*** will involve several activities. These will be undertaken throughout the project and will:

- Develop and communicate through the project website and otherwise the common vision for **FLOOD*site*** and its position within the broadest remit of holistic flood risk management – highlighting areas not included in **FLOOD*site*** (such as sewer and groundwater but providing a conceptual framework for future integration).
- Develop a common language of risk (including an uncertainty standard, risk terminology etc)
- Identify previous projects and results and ongoing national and international research
- Link with existing and proposed networks and clusters with significant effort devoted to integration of results from other projects.
- Establish of protocols for data sharing, including meta-data standards, formats, procedures, IPR and copyright within the **FLOOD*site*** Integrated Project.

Partner No	Short Name	Contribution to Task 32 Networking and harmonisation
1	**HRW**	Task leader – responsible for establish web-pages and a common language of risk together with data sharing protocols
2	Delft	Lead on reporting links with other national and international initiatives and provision of support on all other issues.
3	LWI	Provision of support and national knowledge on all issues.

4	IOER	Provision of support and national knowledge on all issues.
8	INPG	Provision of support and national knowledge on all issues
9	JRC-IES	Provision of support and national knowledge on all issues.
10	MU/FHRC	Provision of support and national knowledge on all issues
12	TUD	Provision of support and national knowledge on all issues
13	UPC	Provision of support and national knowledge on all issues.
22	IHE	Lead on developing **FLOOD*lab*** and Provision of support and national knowledge on all issues.

Task 33 Assessment and review

This task includes

- the technical assessment of the performance of the **FLOOD*site*** consortium
- an assessment of the utility of its outputs,
- a forum for the discussion of the later phases of the research post 18 months and
- the financial assessment of partners through the production of individual audit reports for the EC (these will be collated by under the co-ordination activities outlined in Theme 7).

The technical assessment will be achieved through the creation of a hierarchy as described in Section 7 under Project Management and is not repeated in the detailed description of work for this Task. As noted in Section 7 each management grouping will have specific responsibilities for reviewing and assessing the scientific and financial performance of the **FLOOD*site*** consortium and research.

Partner No	**Short Name**	**Contribution to Task 33 Assessment and review**
1	**HRW**	**Task leader – with a presence on the FEMT both as co-ordinator (acting as Chair) and as Theme leader. Delivery of meeting agendas, minutes and arrangement of meetings**
2	Delft	Presence on the FEMT as Theme leader and as experienced co-ordinator.
3	LWI	Presence on the FEMT as Theme leader.
4	IOER	Presence on the FEMT as Theme leader.
8	INPG	Presence on the FEMT as specialist on forecasting technologies
9	JRC-IES	
10	MU/FHRC	Project committee contribution
12	TUD	Project committee contribution
13	UPC	Project committee contribution
21	VITUKI	Project committee contribution
37	UniBo	Project committee contribution
All others	All others	Provision of financial assessment reports (audit report) and attendance at six monthly tem workshops as appropriate.

Task 34 Financial Audit

Financial Auditing will be undertaken as required by the contract conditions.

7 Theme 7 Project co-ordination

7.1 Overall objective

This Theme will contain the scientific and administrative co-ordination of the RTD work to be pursued and the overall management of the project, including administrative and financial aspects, communication with the commission, exploitation of results etc.

Summary objective – Theme 7

7.1 To ensure effective and efficient overall management of the project, including administrative and financial aspects, communication with the commission, exploitation of results etc.

7.2 General approach

The primary purpose of the project management task is to ensure that the project achieves its objectives. At the start of the project a detailed Project Management Plan will be drawn up, to enable monitoring of progress and will form the basis of an integrated Quality Plan for the project. A project secretariat will be established for the duration of the Integrated Project, located at the offices of the co-ordinator HR Wallingford. The overall coordinator will be assisted by a deputy coordinator, with the intention that one of the other should be available on most days during the project to deal with any urgent management or technical issues.

The activities under Theme 7 will be undertaken as a single Task. This task is outlined below with further detail provided in Section 7 on Project Management.

7.3 Task 35 Project co-ordination

The key activities under Task 35 will be to:

- Ensure the overall progress of the project according to the contract signed with the European Commission
- Prepare and monitor the use of the Project Quality Plan
- Monitor the project for deviation from programme or cost profiles, establish causes, consequences and implement remedial actions as necessary
- Prepare the rolling 18-month detailed implementation programme, updated annually during the life-time of the project
- Maintain a regular and effective interface with the European Commission.
- Prepare and submit scientific progress, administrative and financial reports to the EC
- Establish a pre-project consortium agreement.
- Establish appropriate mechanisms to protect the IPR generated in the project and the post-project exploitation agreement

The Quality Plan will be negotiated and agreed with all partners. It will initially be based upon the established procedures at HR Wallingford and will cover:

- communication of technical and contractual information
- validation of data
- traceability of project data and results
- security of confidential information
- approval of results and outputs to be placed in the public domain
- archiving of project information

Partner No	Short Name	Contribution to Task 35 Project co-ordination
1	**HRW**	**Project Co-ordinating – providing Co-ordinator, Deputy and administrative support.**
2	WL | Delft	Presence on the FEMT as Theme leader and as co-ordinator of IRMA-SPONGE.

It is intended that, for the sake of clarity, that the independent Financial Audit activities and costs incurred in the project will be identified separately within the project account (see Task 34).

8 Major Milestones over full project duration

For convenience the major milestones are summarised here as those planned to be achieved within each 12-month project review period. In the spirit of the Integrated Project instrument, the content and milestones in the later part of the project are subject to annual review and confirmation. In the development of the project proposal, many detailed milestones and deliverables were identified in the course of each work package. It is agreed with the EC officer that these should be use for internal project control purposes and that the milestones in this section of the Description of Work should represent major steps in the project, aggregated from the results of the individual research tasks.

Year 1

1 Establish project image, web presence and data procedures
2 Report on the language of risk
3 Review of dissemination methods and raising public awareness

Year 2

1 Report and software for improved characterisation of flash flood catchments
2 Next generation techniques and guidance for estimating coastal and river extremes, accounting for trends and uncertainties and incorporating paleo-flood as well as contemporary data sources
3 Report on the hydraulic loading of flood defence structures using new information on extremes
4 Report on flood impact evaluation methods used in Germany, the Netherlands, U.K. and the Czech Republic
5 Reports on risk perception and community behaviour in face of flood risks for each country

Year 3

1 Best practice guide outlining defence types, failure modes (including 'indicators' processes) as well as methodologies of analysis (i.e. limit state functions and models of failure modes)
2 Reports on framework model on loss of life and modelling damage reduction by flood warning
3 Report on MCA method for assessment of pre-flood measures
4 Methodology for reliability analysis, including time dependent processes such as deterioration and progress failure.
5 Review of measures, policy instruments and strategies for different flooding situations and evaluation of different strategies for flood mitigation with respect of sustainability criteria
6 Improved methods for flash flood forecasting in small basins
7 Guidance on the emergency repair of dike failures

Year 4

1 Method to define comprehensive and sustainable for use with future planning scenarios and the FRMA procedure
2 Methods to identify in real-time safe evacuation routes in flash-flood catchments, lowland rivers and coastal plains
3 Technical report outlining a conceptual integrated framework for long-term planning together with a functional design of DSS, with a working release of the prototype DSS (scientifically fully functional but not tested or provided in packaged software).
4 Technical report outlining a conceptual integrated framework for flood event management planning together with a functional design of DSS, with a working release of the DSS (scientifically fully functional but not tested or provided in packaged software).

5 Technical report outlining a conceptual integrated framework for propagating of uncertainty through complex models proved through the development of a non-decision specific DSS.
6 Guidelines for the development of a European Flood Hazard Atlas, with examples

Year 5

1 **FLOOD*lab*** web-based tool demonstrator completed
2 Educational and Professional Development training material prepared
3 Integrated Report on Lessons from the Case Studies
4 Final integrated scientific report on the whole project

9 Plan for using and disseminating knowledge

The **FLOOD*site*** project will develop and prove concepts and approaches to the feasibility and prototype level, testing out the methodologies within the context of the case study areas. These have been chosen to represent different types of flood risk issue and process from the mitigation of flash-flood risks on small basins, through major trans-national lowland rivers to estuaries and coastal sites. The sites cover climatic types from northern European maritime to Continental and Mediterranean.

Exploitation of the project results will follow primarily through the subsequent development and production of professional standard software to encapsulate the project results. Several of the project partners have experience of producing and supporting in practice software systems in the water environment. The use of the project knowledge in such systems will be covered in the project Consortium Agreement. The sales of such software are unlikely to be large, given the mainly public-sector nature of the user base (flood defences are provided as a public good), and implementation is likely to be tailored to the corporate information systems architecture of the major clients. Thus a further software development phase is envisaged after the completion of the **FLOOD*site*** project, the design of which will make full use of the results of the FP5 research action HARMON-IT.

Therefore Theme 5 of **FLOOD*site*** aims to disseminate the project knowledge and procedures into the community of users. In this context we understand the "users" to be the professionals involved in the assessment of flooding risk, the preparation and implementation of policies, strategies, designs and operational systems for flood risk mitigation. The users in this sense do not include the ultimate beneficiaries of these activities, i.e. the public and businesses which receive protection from flooding. The case studies are all important to the relevant users in the countries where they are located.

In particular, new knowledge and understanding from the project will be disseminated in several ways. As outlined in Theme 5, dissemination is envisaged to occur to three different communities:

- the general public as the end beneficiaries of flood risk management and mitigation activities,
- professional communities involved in the assessment and management of flood risk as users of the knowledge, and
- the teaching and research community who propagate knowledge, particularly to the young

A multi-media approach will adopted to communicate the **FLOOD*site*** added knowledge to each of these stakeholder groups. In particular knowledge will be communicated and transferred through three principal media formats, including:

- text-based knowledge transfer including the traditional routes of publication of peer reviewed research papers, books and reports
- web-based and other distance learning forms knowledge transfer
- face-to-face knowledge transfer

The main dissemination activities are indicated in the box below.

The **FLOOD*site*** dissemination activities are focused in Theme 5 and will include:

- **FLOOD*Lab*** a web-based modelling laboratory (including role-plays and games) for flood modelling and management and tools for visualisation of flood data and results.
- an integrated tool-based E-learning platform
- the organisation of professional development and training as short courses and workshops
- incorporation into undergraduate and post-graduate education courses
- preparation of guidelines based upon the project findings
- preparation of peer-reviewed scientific papers.

The integrated use of pilot study sites through the development of the **FLOOD*site*** science and methodologies (see Theme 4) will also support the transfer and uptake of knowledge.

10 Gender Action Plan

The professional skills required for this project have for many years attracted more men than women participants thus senior researcher in the field are predominantly men. The leadership of the **FLOOD*site*** project is therefore likely to be male dominated. The **FLOOD*site*** project consortium, however, recognises that it has an opportunity to redress the current imbalance by specific efforts to attract women into the project activities and by targeting training and opportunities for experience to less senior women participants. The sector presently lacks networks specifically for women scientists but should these develop during the course of the project, the leading researchers will make every effort to link with those organisations.

The co-ordinating institution, HR Wallingford, already exercises an equal opportunity policy and the partner universities, which form the majority of the **FLOOD*site*** consortium, are expected to accord high priority to equity issues and gender-aware policies.

The project will adopt a positive discrimination in favour of women in a number of ways, whilst ensuring that the quality of staff is maintained at a high level, that each candidate is appropriately qualified for the task he/she undertakes, and that the regulations of partner institutes are recognised.

Positive discrimination will include:

- Prioritising the appointment of women in the event of a choice of equally qualified and suitable male and female candidates presenting for a post.
- Presenting a positive female dimension of the project in publications and on the web-site, for example, this may affect the choice of illustrations and language.
- Making special efforts to attract women participants in seminars conferences and workshops relating to the project. This may include offering services such as childcare needed by working parents with responsibility for children.
- Investigating specific needs for gender balance among researchers, as for instance in Sub-theme 1.3, in Theme 2 and in Theme 6. Ideally this should include analysis of the changing societal dynamics in the event of flood.
- Incorporating in-service training where possible to increase the capacities of women participants, where those are perceived to be lesser than among their male counterparts (or *vice versa*).
- Ensuring a family-friendly working culture, particularly in relation to hours worked and travelling arrangements.
- Ensuring a role for the women researchers of the project in the interface with end users.
- Ensuring that dissemination of the project outcomes reached men and women equitably and that the technology used is not “gender-exclusive” in its nature.

11 Raising public participation and awareness

FLOOD*site* contains a number of mechanisms aimed at improving public participation and awareness. These include

- participation in the research itself (through survey proposed in Sub-theme 1.3, contingency planning methodologies in Theme 2 and activity engagement in the pilot sites through Theme 4)
- innovative dissemination approaches to be developed under Theme 5 including a **FLOOD*Lab***, a web-based modelling laboratory including role-plays and games for flood modelling and management and tools for visualisation of flood data and results,
- E-learning and face-to-face courses

The Plan for raising public awareness is an integral part of the project work and will be developed and implemented during the project.