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SID 5 Research Project Final Report

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Executive Summary

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

Objectives

The scientific objectives of this work were:

- To develop practical guidance for policy makers and practitioners to enable them to improve the sustainability of flood and coastal management strategies and solutions.
- To identify opportunities for flood and coastal management activities to contribute to wider Sustainable Development Activities.

Methods

The project was completed in inception, main and dissemination stages each involving literature review, expert analysis of a range of Flood and Coastal Erosion Risk Management (FCERM) issues and stakeholder consultation. A guidance document was developed, which addressed the principles and objectives of sustainable development using eleven thematic topic notes (Technical Report 1). A number of case studies were developed to provide examples of how sustainability principles were considered and implemented in different flood risk and coastal erosion policies and projects (Technical Report 2).

Outcomes

In March 2005 the Government launched a new UK sustainable development strategy - "*Securing the future*" that set out a new purpose and principles for sustainable development with priorities agreed across the UK, including the devolved administrations (HM Government, 2005)¹.

In the same month, the Government published its first response to "Making Space for Water", the consultation exercise for developing Government strategy on flood and coastal erosion risk management in England. The new strategy aims:-

To manage risks by using a range of measures that reflect both national and local priorities to:-

- reduce the threat to people and their property; and
- deliver the greatest environmental, social and economic benefit consistent with the Government's sustainable development principles.

The emphasis in the new strategy on managing risks and clear alignment with the Government's Sustainable Development Strategy provides an opportunity for more sustainable flood and erosion risk management in England and Wales. The FD2015 report aims to develop principles and guidance to help policy makers and practitioners make better decisions that deliver the greatest environmental, social and economic benefits.

Securing the future

The new 2005 UK strategy of sustainable development sets out 5 principles for sustainable development that provide the starting point for developing principles for sustainable flood and coastal erosion risk management (see Figure ES1 below). The SD strategy also promotes four agreed priority areas that are each relevant to flood risk management.

Technical Report 1 (TR1) develops nine principles of sustainable flood and coastal erosion risk management:

1. **Risk Management.** Manage flood and coastal erosion risks to people and property, the economy and the environment.
2. **Adaptation.** Take account of climate change and other long-term uncertainties in decision making.
3. **Resilience.** Develop infrastructure and buildings which perform satisfactorily under a wide range of lifetime flood and erosion loadings, without suffering permanent loss of functionality during extreme events.
4. **Integration.** Develop solutions that integrate flood and erosion risk management as part of integrated catchment management and coastal zone management.
5. **Engagement.** Work with all those affected by flooding and erosion, empowering those affected to take appropriate actions to reduce risks.
6. **Appraisal.** Adopt appraisal methods that are rigorous, coherent and open and consider long term social, environmental and economic costs and benefits.
7. **Environment.** Protect natural resources and enhance the environment where it is most

¹ Also see <http://www.sustainable-development.gov.uk>

degraded.

8. Consumption & Production. Promote sustainable consumption and production in all flood and erosion risk management activities.

9. Knowledge. Develop the knowledge, skills and awareness to improve our understanding

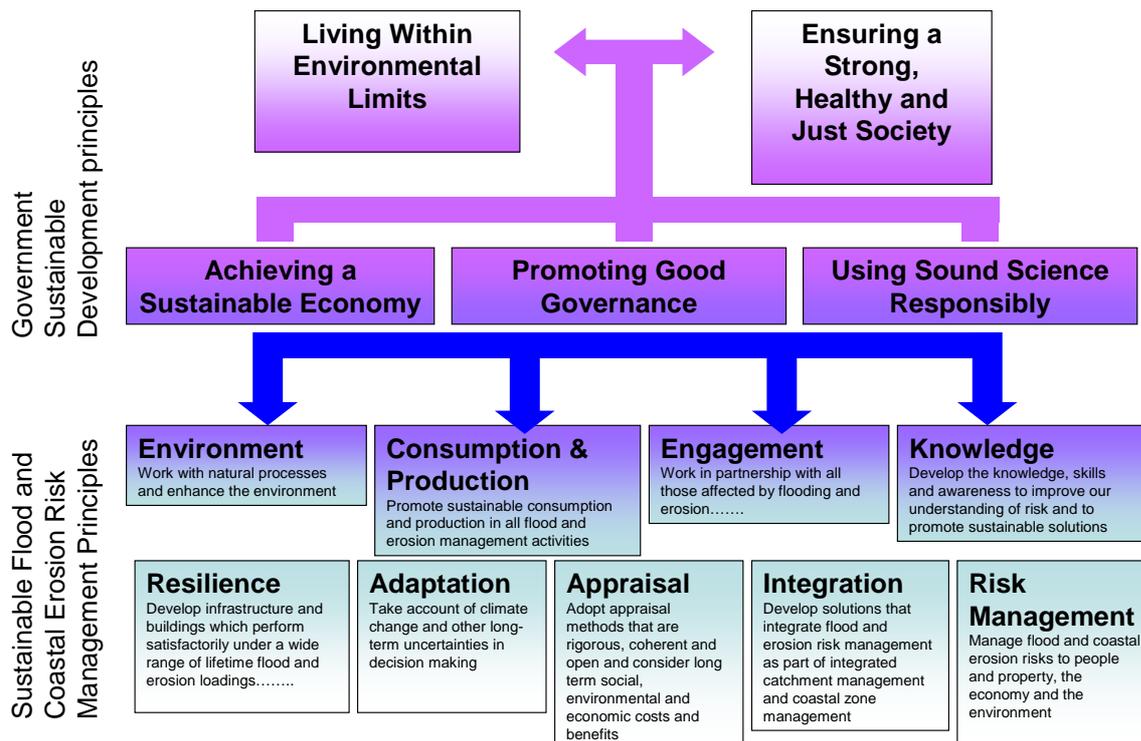
Topic Notes

In Section 3 of TR 1, eleven 'Topic Notes' are provided that summarise and link to existing information and highlight key sustainability issues:-

- Topic Note 1. Sustainability Appraisal
- Topic Note 2: Community Engagement and Sustainable Development
- Topic Note 3: Appraisal of solutions & schemes with multiple objectives
- Topic Note 4: Compulsory purchase & legal aspects of flood management
- Topic Note 5. Planning and flood risk
- Topic Note 6. Rural development and flood risk
- Topic Note 7. Adaptation and resilience
- Topic Note 8. Precautionary climate change allowances
- Topic Note 9: Wise use of materials
- Topic Note 10: Using Catchment Flood Management Plans (CFMPs)
- Topic Note 11: Using Shoreline Management Plan (SMP)

A second Technical Report describes the outputs of 7 case studies and the research Project Record provides information on the process of how the research was completed and further information for flood risk researchers.

Figure ES1 Sustainable development principles from Securing the future and the nine principles of sustainable flood and coastal erosion risk management



Project Report to Defra

8. As a guide this report should be no longer than 20 sides of A4. This report is to provide Defra with details of the outputs of the research project for internal purposes; to meet the terms of the contract; and to allow Defra to publish details of the outputs to meet Environmental Information Regulation or Freedom of Information obligations. This short report to Defra does not preclude contractors from also

seeking to publish a full, formal scientific report/paper in an appropriate scientific or other journal/publication. Indeed, Defra actively encourages such publications as part of the contract terms. The report to Defra should include:

- the scientific objectives as set out in the contract;
- the extent to which the objectives set out in the contract have been met;
- details of methods used and the results obtained, including statistical analysis (if appropriate);
- a discussion of the results and their reliability;
- the main implications of the findings;
- possible future work; and
- any action resulting from the research (e.g. IP, Knowledge Transfer).

A Framework for Sustainable Flood and Coastal Erosion Risk Management (Section 2 of TR1)

Introduction

Over the last decade Government departments and agencies involved in flood and coastal erosion risk management have developed sustainable development (SD) strategies that were nested below the overall UK SD strategy. For example, the Environment Agency, who are responsible for flood risk management on “main” rivers, flood forecasting and flood warning in England and Wales, published its Environmental Vision in 2001² and the National Assembly for Wales has a binding legal duty to pursue sustainable development in all of its activities³. The new Government SD strategy “Securing the future” provides a new agreed set of sustainable development priorities for all departments, agencies and the Devolved Administrations.

At regional and strategic levels, elements of sustainability thinking are evident in flood and coastal erosion risk management, e.g. within Project Appraisal Guidance (PAG), Planning and Policy Guidance Notes and specific technical guidance, e.g. on multi-criteria assessment, Shoreline Management Plans and taking account of climate change. The Environment Agency has a number of targets related to sustainable development in its 5-year strategy “Making it happen.”⁴. Many regional assemblies have developed their own Regional Frameworks for SD that includes flood risk management issues and indicators⁵.

Developing a framework

This section develops a clear framework for sustainable flood risk management that includes the Government’s vision for flood and coastal erosion risk management, a proposed definition of sustainable flood and erosion risk management, principles, objectives and example sustainability indicators.

Vision → Definition → Principles → Objectives → Indicators.

A vision of what ‘sustainable flood and erosion risk management’ means is required to determine the ‘direction of travel’ of future policy, strategy and plans. The Government’s vision and aims were stated in the response to “Making space for water” (Defra, 2005b, summarised in Appendix 1). The following sections develop this vision by proposing a definition and distilling it into nine principles of sustainable flood risk management that, in turn, can be used to develop objectives, indicators and approaches for better flood and coastal risk management.

Key influences in the development of a vision for “sustainable flood and coastal erosion risk management” and the implementation of sustainability principles include:-

- The Government’s current strategy for Sustainable Development and the establishment of many of the key principles of sustainable development within UK Government policy (and some in law). For example, in 1999, the Quality of Life report defined ten Guiding Principles, which have been adopted in Government department strategies (e.g., Defra 2002). “Securing the future” promotes five principles and four priority areas that should influence all Government strategies (Defra, 2005).

²<http://www.environment-agency.gov.uk/aboutus/275292/234823/615862/379055/351167/?lang=e>

³<http://www.wales.gov.uk/themessustainabledev/index.htm>

⁴<http://www.environment-agency.gov.uk/aboutus/286233/783258/353470/?version=1&lang=e>

⁵ In South East http://www.southeast-ra.gov.uk/our_work/planning/sus_dev/download.html ; and East Midlands http://www.emra.gov.uk/publications/sust_dev.asp

- The consultation exercise, Making Space for Water, which emphasised the need to *“take further account of environmental and social factors as well as economic damage”* and solutions that *“work with natural processes to provide more space for water.”* The new strategy aims to ensure that land use policy reduces (*“where possible”*) and certainly does not add to, the overall level of flood risk. It promotes the *“sequential approach”* to planning, avoiding areas at greatest risk, flood resilience and the importance of raising awareness and improving our understanding of risk.
- The recent Foresight report ‘Future Flooding’ provided new insights into flood and coastal erosion risks throughout the UK during the 21st century based on a systems approach to analysis of future scenarios of climate change and socio-economic development. It showed that, if current flood defence strategies, technologies and investment levels are maintained, risks are likely to increase seriously under all climate/socio-economic futures. This finding established the need for new policies capable of adapting to an uncertain future. It concluded that early implementation of integrated portfolios of structural and non-structural measures can prevent flood and coastal erosion risks from rising above current levels, through a programme of incrementally increased annual investment in flood risk management that is both affordable and cost effective (Office of Science and Technology, 2004).
- UK and European research and international comparisons of sustainable flood risk management including research completed by Scottish National Technical Advisory Group (NTAG) on flooding, the European FLOODsite⁶ project on flood risk management that has aimed to develop and agreed *“language of risk”* for flood risk work throughout Europe, and the Flood Risk Management Research Consortium⁷ that is directing fundamental research approaches to meeting the needs of end users and practitioners.

⁶ Information on the FloodSITE project can be found on the project web pages:- <http://www.floodsite.net/>

⁷ Information on the FRMRC project can be found on the project web pages:-
– <http://www.floodrisk.org.uk>

Vision

The Government set out its vision for flood risk management in Defra, 2005b. The aims of the new strategy and “headline” statement on sustainable development are summarised in Box 1.

Box 1 Vision and aim of sustainable flood risk management (Defra, 2005b)

Vision: the future as a result of this strategy:

- The concept of sustainable development will be firmly rooted in all flood risk management and coastal erosion decisions and operations. Full account will be taken of the social, environmental and economic pillars of sustainable development, and our arrangements will be transparent enough to allow our customers and stakeholders to perceive that this is the case.
- Account will also continue to be taken of long-term drivers such as climate change. Decisions will reflect the uncertainty surrounding a number of key drivers and will where appropriate take a precautionary approach. Decisions will be based on the best available evidence and science.
- Flood and coastal erosion risk management will be clearly embedded across a range of Government policies, including planning, urban and rural development, agriculture, transport, and nature conservation and conservation of the historic environment. Other relevant Government policies will also be reflected in the policies and operations of flood and coastal erosion risk management.
- There will be a mix of policies designed to minimise the creation of new risks (by the way development policy is implemented in areas of flood risk), to manage risk and to increase resistance and resilience. There will be a clear understanding and acceptance of the respective roles of the state, central and local government, other organisations and agencies, and of individuals. The public will be more aware of flood and coastal erosion risks and empowered to take suitable action themselves where appropriate.
- There will be increased use of co-funding with other bodies and other schemes so as to secure sustainable and cost-effective management of flood and coastal erosion while at the same time securing a greater overall contribution to sustainable development than would have been possible without co-operation.
- The true costs of providing, and not providing, flood and coastal defences and other measures will be reflected to a greater extent than at present in individual and commercial decision-making. Expenditure will be focused so as to achieve value for money, and will be prioritised to deliver maximum benefits in line with this strategy.
- There will be local participation in decision-making, in particular through the preparation of Catchment Flood Management Plans and Shoreline Management Plans, within a context of national standards and nationwide information on flood risks and prioritisation.
- There will be a holistic approach to the assessment of options through a strong and continuing commitment to Catchment Flood Management Plans and Shoreline Management Plans, within a broader planning matrix which will include River Basin Management Plans prepared under the Water Framework Directive and Integrated Coastal Zone Management.
- There will be transparent and measurable targets and performance indicators, in terms of managing risks to people, property and the environment, to ensure those responsible for delivering the strategy can be held to account. These measures will drive performance forward and enable the identification and dissemination of good practice solutions.
- The results of the strategy will be seen on the ground in the form of more flood and coastal erosion solutions working with natural processes. This will be achieved by making more space for water in the environment through, for example, appropriate use of realignment to widen river corridors and areas of inter-tidal habitat, and of multi-functional wetlands that provide wildlife and recreational resource and reduce coastal squeeze on habitats like saltmarsh.

(Further information is provided in Appendix 1).

Aim

To manage the risks from flooding and coastal erosion by employing an integrated portfolio of approaches which reflect both national and local priorities, so as:

- to reduce the threat to people and their property; and
- to deliver the greatest environmental, social and economic benefit, consistent with the Government's sustainable development principles.

To secure efficient and reliable funding mechanisms that deliver the levels of investment required to achieve the vision of this strategy. (Defra, 2005b)

There has been considerable interest in sustainable flood risk management in Europe with important contributions being made by stakeholders, researchers and practitioners throughout the UK. However, there are few alternative definitions or discussions of sustainable flood and coastal risk management in the research literature. The European FLOODsite project reviewed a number of definitions of sustainability and adopted the following working definition of sustainable flood risk management adapted from Samuels (2000) that is routed in the previous UK Government SD strategy “A Better Quality of Life”:-

Sustainable flood risk management involves:

- ensuring quality of life by reducing flood damages but being prepared for floods
- mitigating the impact of risk management measures on ecological systems at a variety of spatial and temporal scales
- the wise use of resources in providing, maintaining and operating infrastructure and risk management measures
- maintaining appropriate economic activity (agricultural, industrial, commercial, residential) on the flood plain.

(Gouldby and Samuels, 2005).

The Scottish National Technical Advisory Group (NTAG) on flooding proposed the following concise high-level definition or 'vision' of sustainable flood management in 2004:

"Sustainable flood management provides the maximum possible social and economic resilience* against flooding, by protecting and working with the environment, in a way which is fair and affordable both now and in the future."

(* 'resilience' means: 'able to recover quickly and easily'. The Executive uses it to deliver the 'four As': **Awareness + Avoidance + Alleviation + Assistance.**) (NTAG, 2004 (35)).

This report has favoured the development of principles rather than an exact definition of sustainable flood and coastal erosion risk management. However, the NTAG definition is succinct and robust when tested against the principles of "Securing the future." With appropriate modifications to emphasise the issues of risk management, coastal erosion and clarify the meaning of 'fairness', it provides a good definition that is particularly relevant to current debates in the UK and internationally.

Report definition of sustainable flood and coastal erosion risk management[#]

Sustainable flood and coastal erosion risk management* provides the maximum possible social and economic resilience* against flooding and coastal erosion, by protecting communities, natural resources and enhancing the environment, in a way which is fair and affordable both now and in the future.

* In this definition:

- ***risk management*** means adopting an integrated portfolio of approaches to manage the probability and the consequences of flooding and reflect both national and local priorities to gain the greatest environmental, social and economic benefit
- ***'resilience'*** means: 'able to recover quickly and easily' and encompasses delivery of the 'four As': ***Awareness + Avoidance + Alleviation + Assistance,***
- ***'fair'*** means transparent, accountable and equitable as between stakeholders and generations."

[#] For brevity sustainable flood and coastal risk management is shortened to sustainable flood risk management or SFRM in the remainder of this report.

Principles

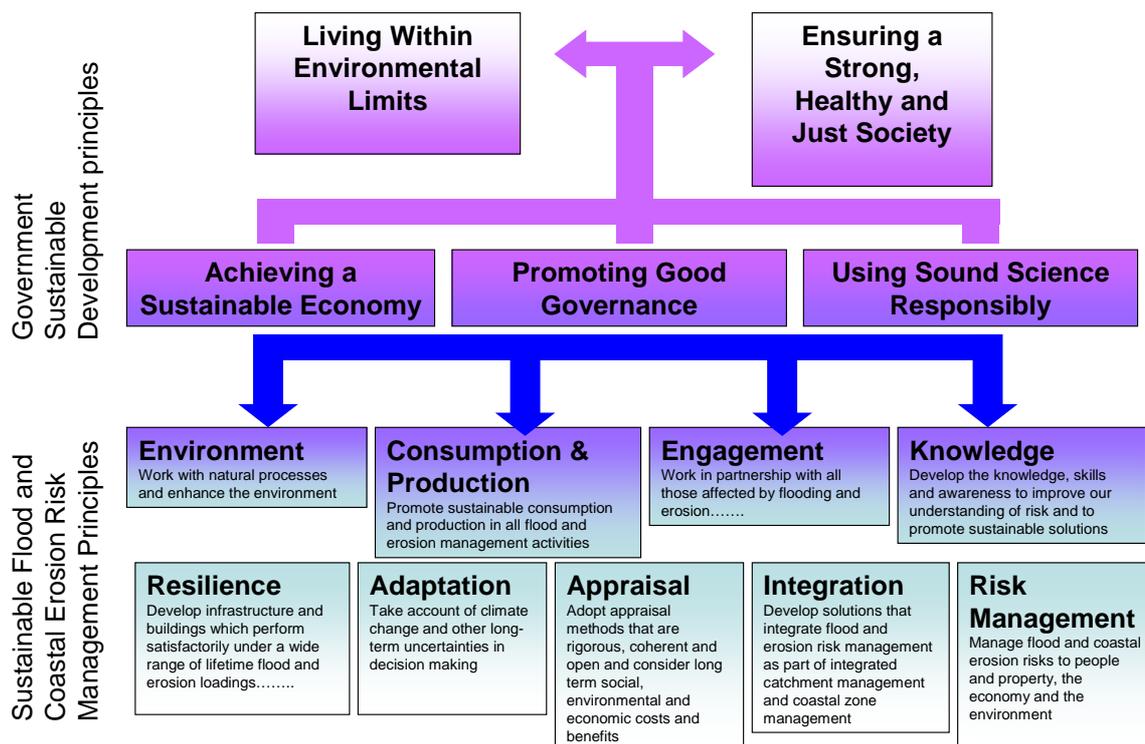
The nine principles of sustainable flood and coastal erosion risk management are summarised in Box 2 and explained in detail in this section of the handbook with reference to Government's SD strategy "Securing the future" (Defra, 2005) and response to the Government consultation document "Making Space for Water" (Defra, 2005b).

Box 2 The 9 principles of sustainable flood and coastal erosion risk management.

1. **Risk Management.** Manage flood and coastal erosion risks to people and property, the economy and the environment.
2. **Adaptation.** Take account of climate change and other long-term uncertainties in decision making.
3. **Resilience.** Develop infrastructure and buildings which perform satisfactorily under a wide range of lifetime flood and erosion loadings, without suffering permanent loss of functionality during extreme events.
4. **Integration.** Develop solutions that integrate flood and erosion risk management as part of integrated catchment management and coastal zone management.
5. **Engagement.** Work with all those affected by flooding and erosion, empowering those affected to take appropriate actions to reduce risks.
6. **Appraisal.** Adopt appraisal methods that are rigorous, coherent and open and consider long term social, environmental and economic costs and benefits.
7. **Environment.** Protect natural resources and enhance the environment where it is most degraded.
8. **Consumption & Production.** Promote sustainable consumption and production in all flood and erosion risk management activities.
9. **Knowledge.** Develop the knowledge, skills and awareness to improve our understanding of risk and to promote sustainable solutions

As shown in Figure 2-1 these principles are directly related to the five principles defined in “Securing the future” but are tailored specifically for sustainable flood risk management. The first row of four principles are general sustainability principles, such as “working with natural processes” and “engaging stakeholders,” whereas the second row relate more specifically to some of the problems and issues in flood and coastal erosion risk management discussed in “Making space for water.”

Figure 0-1 Sustainable development principles from Securing the future and the nine principles of sustainable flood and coastal erosion risk management



The following sections describe the principles in more detail in conjunction with specific Topic Notes in Section 3 provide a gateway to links, case studies and further information on sustainable flood risk management.

Risk Management

Principle 1: Risk Management. Manage the risks to people and property, the environment and the economy.

Objectives:

- To understand the probability and consequences of flooding (to people, property, environment and economy) and how this can be modified
- To consider a wide range of options either to reduce the probability of a flood or coastal erosion, or the consequences of such events for people, properties and the environment.
- To promote sustainable flood risk management solutions that are based on integrated portfolios of measures that optimise flood risk reduction across the entire geographical, socio-economic and institutional extent of the flood system in question
- To adopt a holistic approach to assessing flood risks and measures to reduce them, based on recognition that the flooding system includes the sources, pathways and receptors of flooding
- To accept that sustainable flood risk management stems from and requires integrated analysis of the hydrological, geographical, geomorphological, societal, behavioural, economic, institutional and governance aspects of the flood system
- To take account of the full range of risks over the whole life cycle of the option or portfolio of measures adopted
- To provide flood warnings wherever feasible and promote effective action following warnings
- To provide all interested parties with the best available information as to the locations and degree of flood and coastal erosion risks including groundwater, urban drainage and overland flow risks
- To promote the adoption of SUDS to reduce runoff at source where this can be shown to reduce risks
- To work to prevent inappropriate development in areas at significant risk
- To reduce the health and safety risks during and after construction of flood risk schemes

Example Indicators:

- Expected flood damage
 - Risk Assessment for Strategic Planning (RASP) Annual Average Damage (AAD) per capita
 - No. of properties in the floodplain
- Measures related to risks to people
 - No. of properties with flood warning (existing Key Performance Indicator (KPI))
 - Percent of people taking effective action (KPI)
 - No. of properties with flood proofing products
 - No. of people in the floodplain
 - No. of vulnerable people located in the floodplain (elderly & infirm as defined in the Social Flood Vulnerability Index)
 - No of deaths related to flooding
 - No. of people suffering long term health affects e.g. stress due to flooding
- Others
 - Environmental consequences of flooding
 - Travel interruptions
 - Lost production and sales
 - Percent of schemes with measures aimed to reduce consequences of flooding
 - No. of properties compulsory purchased to be removed from floodplain

Flood and coastal erosion risks are related to the **probability** of a flood or erosion event occurring and the **consequences** of events.

Risk = probability x consequences

In the past, flood management focused on the construction and maintenance of defences that aimed to reduce the probability of flooding and protect land from flooding and erosion. However, the risks can be managed by focusing on both components of the risk equation – probability and consequences, and this is reflected in both Government’s aims for flood risk management and the report’s definition of sustainable flood risk management.

This is particularly the case where traditional defences schemes or even “softer” engineering solutions cannot be justified on economic grounds and for reasons of fairness other solutions need to be developed that reduce the consequences of flooding. These alternative solutions may include improved flood warning and awareness, insurance schemes or grants to flood proof homes.

A “risk-based” approach, including the development of a clear understanding of flooding and erosion systems, is essential for good flood risk management. Significant advances have been achieved in understanding the concepts that underpin a risk-based approach to flood management (Environment Agency 2002, Sayers *et al.*, 2002). For example, the Source-Pathway-Receptor (SPR) and Drivers-Pressures-State-Impact-Response (DPSIR) conceptual models are widely used to assess and inform the management of environmental risks across Government. It has now been adopted to describe the flooding system (Figures 2-2, 2-3) and forms central part of the framework for sustainable flood risk management.

An example of a conceptual model of the flooding system is shown in Figure 2-2⁸. This describes the flooding problem in terms of:-

- **Drivers.** Any phenomenon that can change the level of risk in the flooding system through its impacts on the sources, pathways and receptors of flooding and coastal erosion.
- **State.** The current state of flood, coastal defence and sewerage assets that has a major influence on the performance of these assets during flood events.
- **Sources of flooding.** Meteorologically related phenomena (for example; prolonged frontal precipitation, short duration-high intensity rainfall events, marine storm surges) that can cause flooding.
- **Pathways.** Physical pathways by which floods are conveyed to receptors and the barriers designed to redirect away from flood vulnerable areas and/or store flood water in flood suitable areas.
- **Receptors.** People, property and infrastructure that are at risk of flooding or erosion.
- **Responses.** Measures to manage risks at acceptable levels through structural and non-structural actions to reduce the probability and/or consequences of flooding and erosion.

⁸ This is a combination of two widely used risk models – SPR and Driver-Pressure-State-Impact-Response (DPSIR) that works well for flood risk.

Figure 0-2 The flooding system

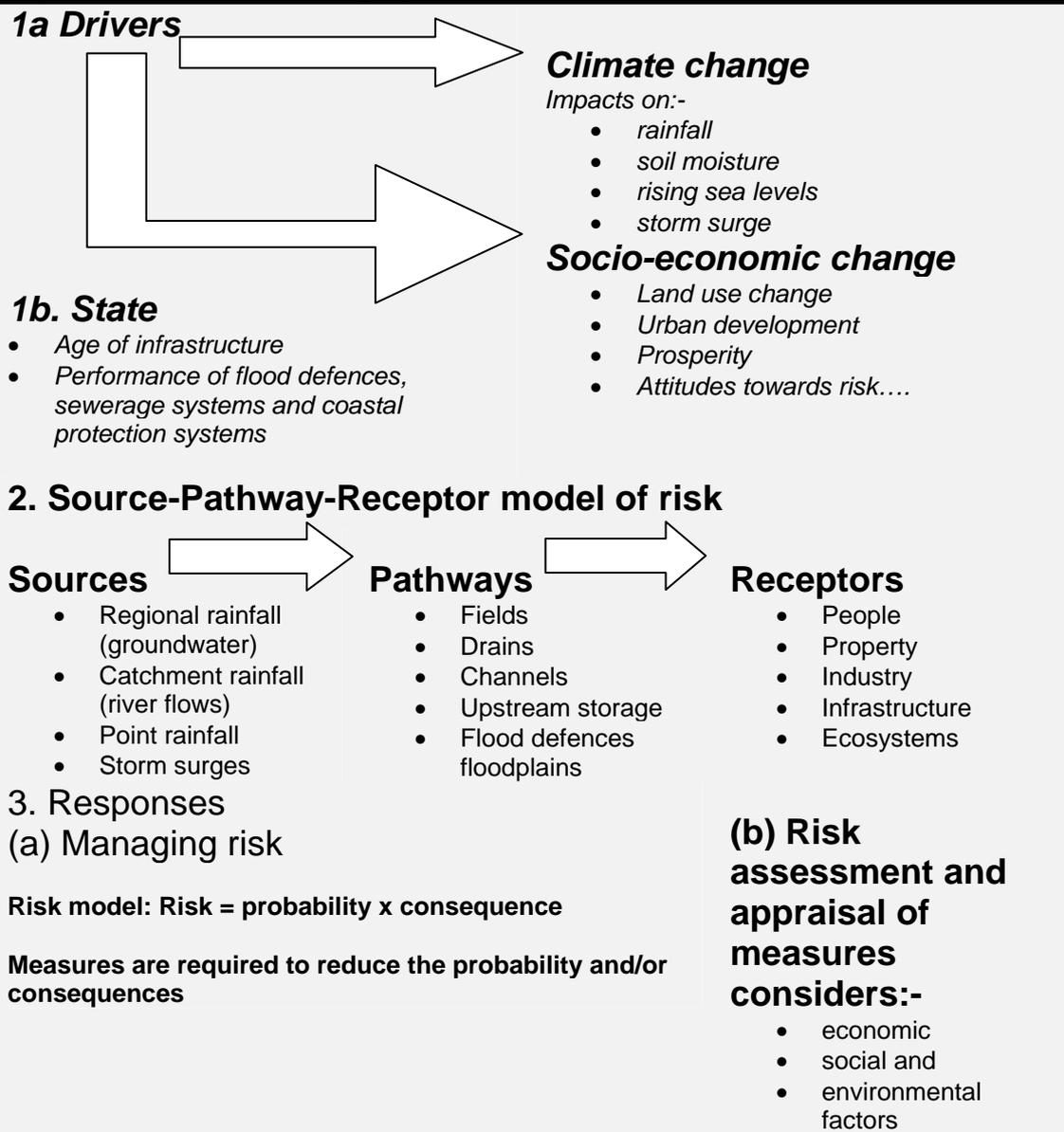
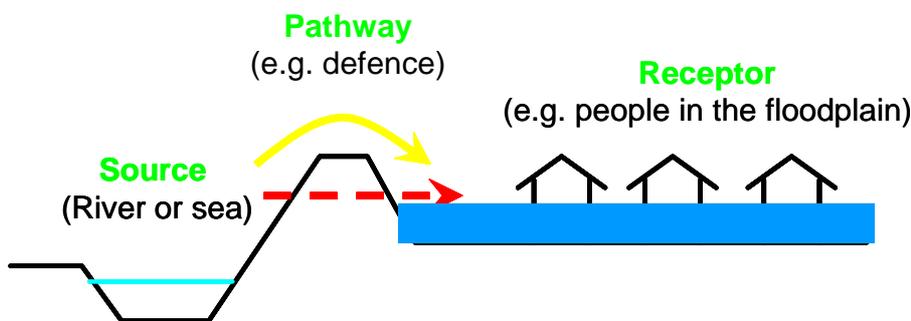
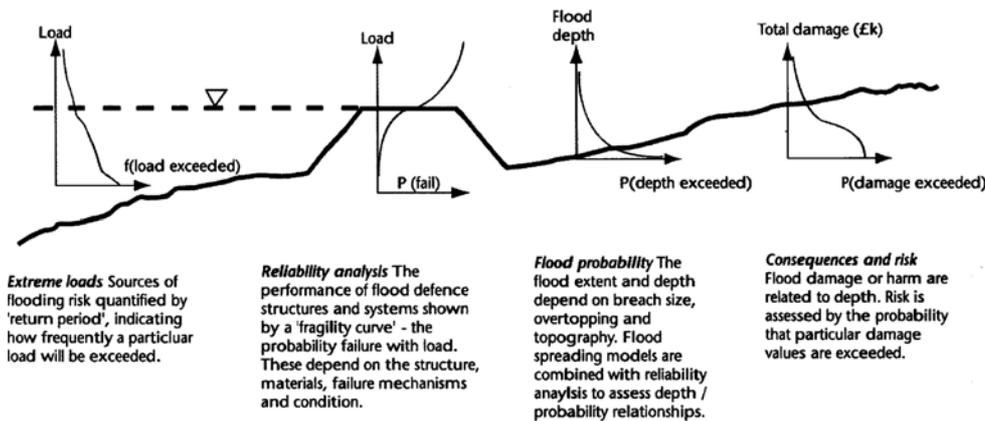


Figure 0-3 Source / Pathway or Barrier / Receptor assessment framework for the assessment of flood risk (Sayers and Meadowcroft, 2005)





Adopting a risk based approach, rather than one that simply tries to reduce the chance of flooding, means considering a wider range of management measures that influence sources of flooding, pathways and receptors. For example, influencing "pathways" by providing more physical space for flood conveyance and storage; reducing the consequences of flooding by preventing development in the floodplain and making property, infrastructure and communities more resilient.

The Foresight Future flooding project provided a national assessment of flood risk that considered all the physical and organisational systems that influence or are affected by flooding (OST, 2004). It adopted a similar model of the flooding system and explored future risks and responses under four different climate and socio-economic scenarios (Figure 2-4). This approach led to the consideration of a wide range of responses that were grouped under five response themes for managing flood risk:-

- Managing the Rural Landscape
- Managing the Urban Fabric
- Managing Flood Events
- Managing Flood Losses
- Engineering (rivers, estuaries & coasts)

There were 26 groups of responses under these headings (Appendix 3). In simple terms the first two themes are all about "Making space for water", i.e. physical space for storage and conveyance in the rural and urban landscape. Managing flood events focuses on reducing the consequences of flooding through raising awareness, forecasting and warning and a range of different measures to avoid risk. Managing flood losses includes better land use planning, building codes and insurance and Engineering includes "hard" and "soft" engineering approaches to alter flood pathways.

The most significant outcome of the Foresight FCD project is the acceptance of its findings by Government and the all other major stakeholder organisations, which has been effectively universal and complete. Twenty months after the launch of the Future Flooding reports, the Action Plan published on the OST Foresight website attests to how successful Foresight FCD has been in making the difficult transition from advice to uptake and demonstrates that UK stakeholders not only accept the case for sustainable flood and coastal risk management but, that more importantly they are minded to deliver it.



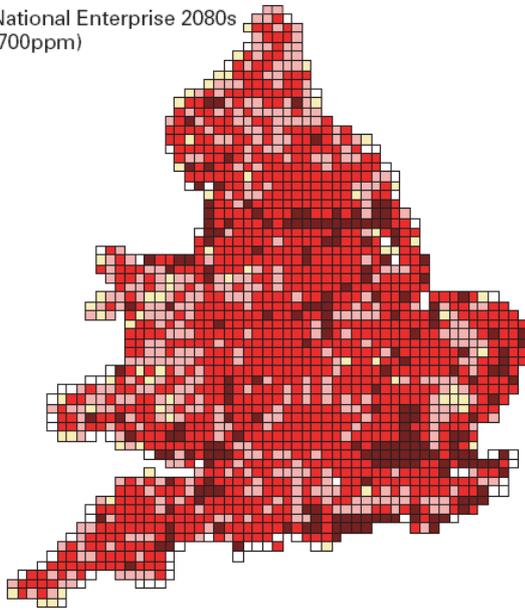
Further information

- All the objectives under the Risk Management principle relate to taking a "risk-based" approach of flood risk. These are developed further in the Topic Notes 3, 5, 7, 8 10 and 11 on appraisal, planning, resilience, climate change and strategic planning.
- Making Space for Water: Developing a New Government Strategy for Flood & Coastal Erosion Risk Management: Background and Technical Documents.
<http://www.defra.gov.uk/enviro/fcd/policy/strategy/techdocs.htm>
- The Foresight Future Flooding project. Final outputs.
http://www.foresight.gov.uk/Previous_Projects/Flood_and_Coastal_Defence/Reports_and_Publications/Project_Outputs/Outputs.htm
- The Foresight Future Flooding project. Action Plan.
http://www.foresight.gov.uk/Previous_Projects/Flood_and_Coastal_Defence/Reports_and_Publications/Action_Plan/Action_Plan.html

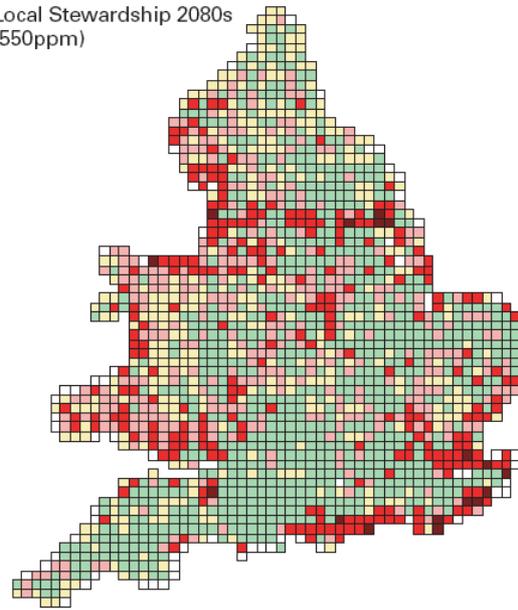
Figure 0-4 An example of the “best available information as to the locations and degree of flood and coastal erosion risks” from the Foresight project (OST, 2004).

The distribution of average annual damage from flooding across England and Wales in the 2080s. The maps represent changes in risk by the 2080s for the four future scenarios. Darker shades of red signify progressively greater increases in damage. Green signifies a reduction.

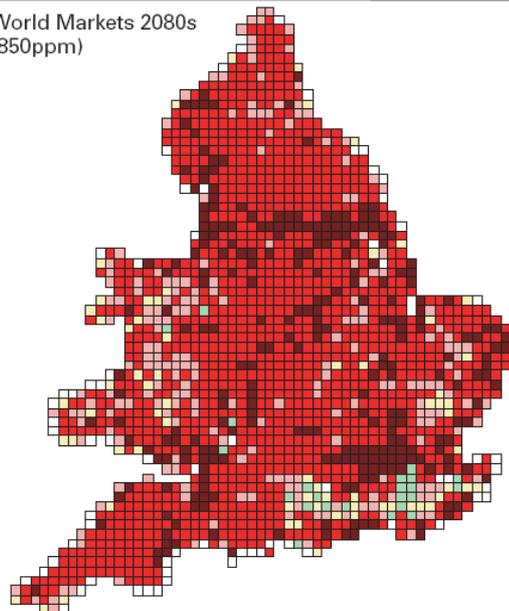
National Enterprise 2080s
(700ppm)



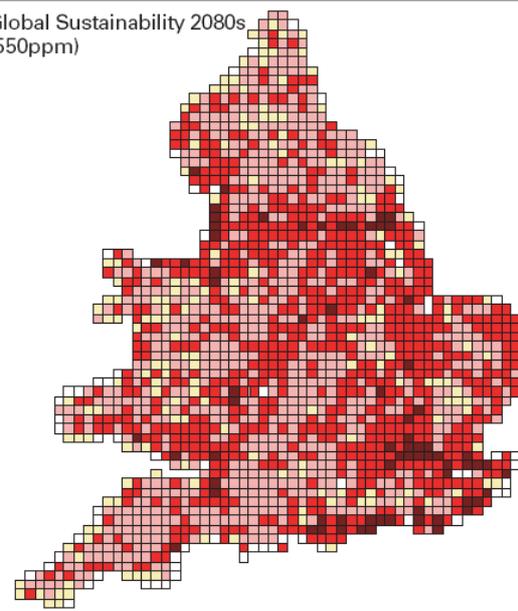
Local Stewardship 2080s
(550ppm)



World Markets 2080s
(850ppm)



Global Sustainability 2080s
(550ppm)



Figures in brackets are atmospheric carbon-dioxide concentrations



Adaptation

Principle 2: Adaptation. Take account of climate change and other long-term uncertainties in decision making.

Objectives:

- Promotion of adaptive flood defence systems and integrated approaches to flood risk management
- Adoption of the precautionary principle
- Ensure a fair balance between reducing risks for present and future generations
- Consider social and economic uncertainties
- Reduce greenhouse gas emissions (as per sustainable production and consumption).

Example Indicators:

- Ability to adapt
 - Proportion of the coastline and fluvial floodplain with space for adaptation
 - Proportion of flood and coastal defences suitable, including having available space, for adaptation
 - Costs of adaptation of existing flood and coastal defence schemes
 - % schemes accounting for socio-economic changes
- Ability of assets to perform under increased loadings related to climate change
 - Condition of flood defence and erosion management assets and their performance under higher rates of warming
 - Average time horizon that existing defences meet their of standard of protection
 - % schemes with built in precautionary allowances
- International and national GGE and Carbon Emissions targets (see Principle 7)

“Climate change and energy” is a priority theme in the Government’s SD strategy. Sustainable flood risk management must contribute to climate change mitigation (Principle 8 – Sustainable production and consumption) and adapt by taking account of long term climate change and other uncertainties.

There is strong evidence that global temperatures are increasing in a way that is consistent with global models of climate change (Figure 2-6). However there is considerable uncertainty regarding the potential impacts of a warmer climate on flood risk. The Foresight project combined future socio-economic change scenarios with climate change scenarios to estimate future flood risk (see Figure 2-4 above) and produced wide ranging estimates of future flood damage.

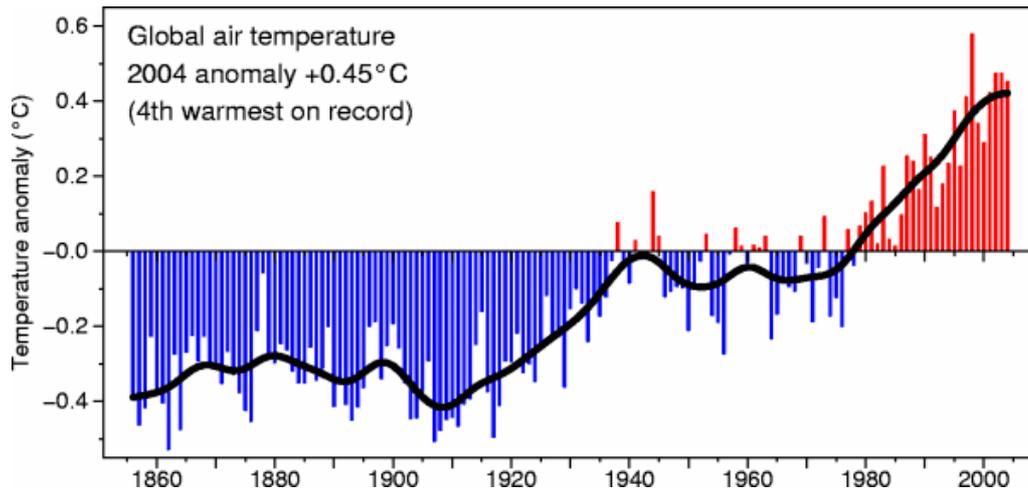
Climate change adaptation can be achieved by developing a good understanding of the uncertainties regarding possible future changes, adopting the precautionary principle in the form of precautionary allowances for climate change in a range of plans and schemes (Topic Note 8) and considering future scenarios in strategic plans (Topic Notes 11 and 12 on CFMPs and SMPs respectively).

As more information becomes available from climate change models, further impacts research is required to determine the likely changes in risk under future scenarios and this then needs to be implemented by providing practical guidance to flood risk managers and planners for dealing with climate change.

Adaptive flood defences are designed to cope with a range of possible future situations (with an appropriately high benefit to cost ratio). Adaptive flood risk management solutions can be modified cost effectively, with optimum reuse of physical resources, without coming up against overriding constraints. The most common categories of overriding constraints are space (generally related to the need to widen or relocate a defence) and “buildability”, related to the ease with which a defence can be raised or reconfigured given its present structural configuration.

The costs of flood risk management schemes can increase significantly by adding more conveyance and storage to a system. Therefore it is important that there is an economic justification (including social and environmental factors) for building adaptable flood defence systems (See Topic Notes 3, 7 and 8 on appraisals, adaptation and climate change). In general terms non-structural measures are easier to adapt than structural measures and therefore an adaptive policy should include a wider portfolio of measures to manage flood risks.

Figure 0-5 Combined global land and marine surface temperature record from 1856 to 2004 (Source: Climate Research Unit, University of East Anglia).



The above global time series was compiled jointly by the Climate Research Unit and the UK Met Office Hadley Centre and shows that 2004 was the fourth warmest year on record, exceeded only by 1998, 2002 and 2003. The 1990s were the warmest decade in the series. The warmest year of the entire series has been 1998, with a temperature of 0.58°C above the 1961-90 mean. Nine of the ten warmest years in the series have now occurred in the past ten years (1995-2004) (Jones and Moberg, 2003; Jones *et al.*, 1999).



Further information

- Topic Note 7 provides further information on Adaptation and Resilience.
- Topic Note 9 provides information the use of precautionary climate change allowances
- Case study 4a Use of temporary and demountable flood defences
- The UK Climate Change Impacts Programme. <http://www.ukcip.org.uk/>

Resilience

Principle 3: Resilience. Adopt solutions which perform satisfactorily under a wide range of lifetime flood and erosion loadings, without suffering permanent loss of functionality or character during extreme events.

Objectives:

- Promotion of resilient buildings and flood defence systems
- “Repairability” of damaged infrastructure (including defence assets) and buildings
- Adoption of performance-based asset management, with appropriate monitoring and maintenance
- Work with natural systems that exhibit resilience
- Ensure communities are able to respond, cope and recover during and after significant flooding and erosion events

Example Indicators:

For resilience of assets:

- Condition of flood defence and erosion management assets
- Resilience to higher rates of climate change – i.e. their performance under higher than expected loadings

For systems as a whole:

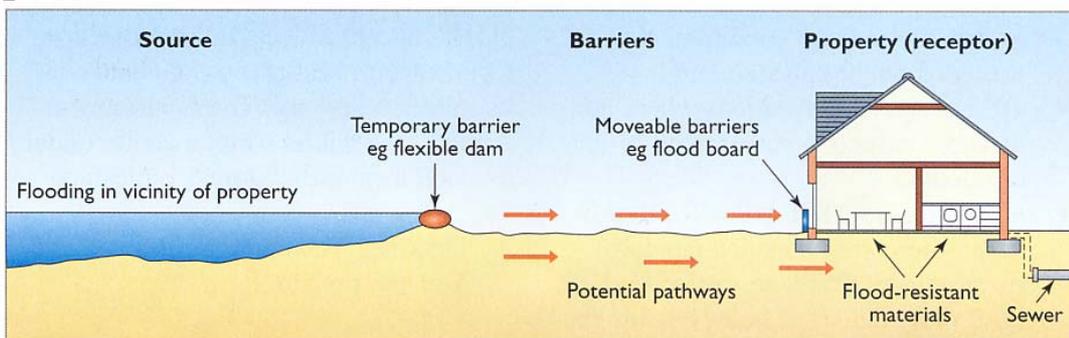
- Graduality – the percentage increase in Annual Economic Damages for a flood system for a given increase in loading above a “design” value (de Bruijn, 2004)
- Recovery rate - rates of physical, social, and, economic recovery (de Bruijn, 2004)

Flood risk management systems are typically designed for a specific level of service, such as protection against the 1% or 1 in 100 year return period flood, but their design should also consider the “residual risk” and how the systems perform in extreme events.

Planning of new development should consider flood risk and the integrated management of catchments and coastal cells early and at all scales of the planning process. Adoption the “sequential approach” to planning (Topic Note 5) means that hazardous flood risk areas should be avoided. However, it is not always possible to prevent flooding and therefore, in some cases, alternative measures need to be considered (Appendix 3), including flood resistance and flood resilience measures:-

- Flood resistance measures are those that aim to keep floodwater outside the outer walls of a building. They can consist of flood-boards to doorways and other openings or other protective measures. To be effective, all possible water entry points must be considered such as airbricks, drains and other service connections.
- Flood resilience measures are those that consider the form of construction and the materials used with a view to minimising damage when something is flooded. The aim is then to ensure that reoccupation of the building or use of the facility can take place as soon as possible after flooding with disruption minimised. This will include, for example, the use of water resistant materials in floors and walls and the siting of electrical cables and appliances so that all vulnerable installations are at a raised level.

Figure 0-6 Flood resistance and resilience measures

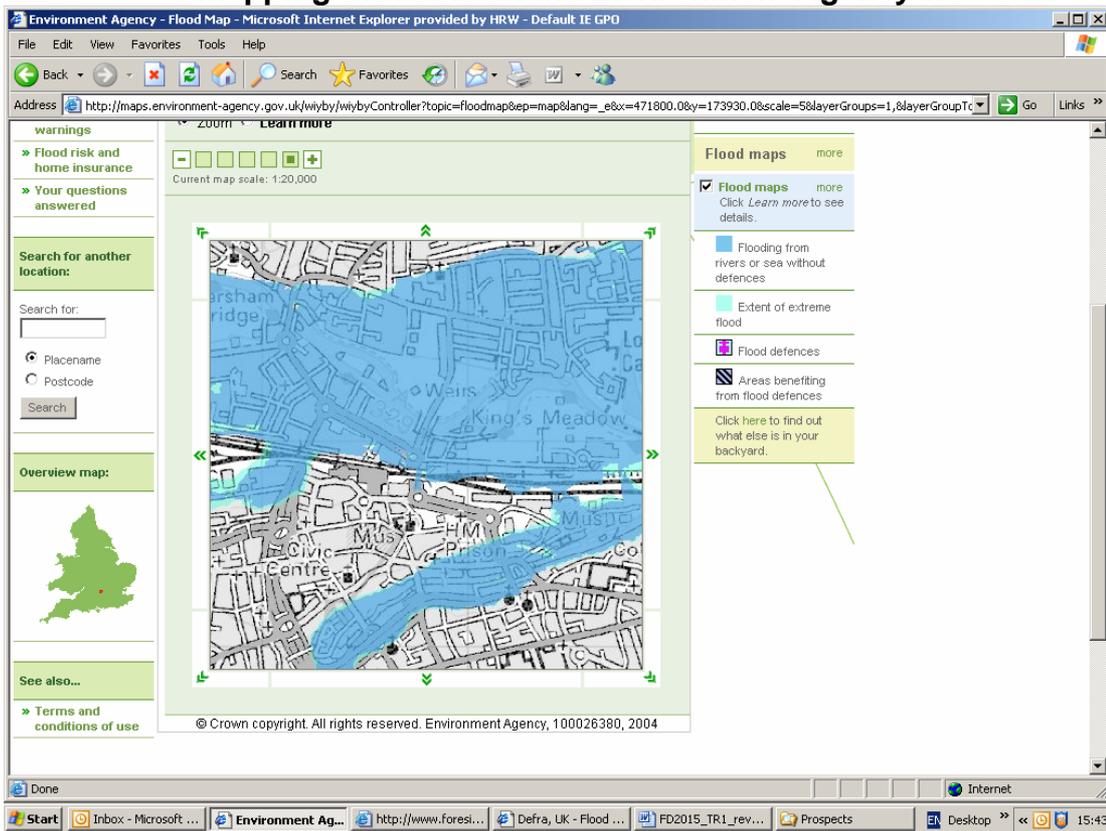


Taking a wider view, resilience of the whole flood risk system, including environmental and social aspects, requires consideration of:-

- How sensitive systems are to increases in loading above nominal design events.
- How natural systems and communities respond, cope and recover from flooding
- Access to information on flood risk, including risks from sewer, groundwater and overland flooding (Figure 2-7)
- Flood forecasting and warning, its effectiveness and role in different types of flooding situation
- Strategies for reducing the consequences of flooding, including flood insurance, community flood fighting, etc....
- Providing assistance during flood events

Overall resilience strategies are based on the concept of minimising the consequences of flooding or “learning to live” with the floods in addition to or instead of reducing flood hazard.

Figure 0-7 Providing access to flood risk information. An example of flood risk mapping available on the Environment Agency web site



Further information

- Topic Note 7 provides further information on Adaptation and Resilience.
- Case study 4a Use of temporary and demountable flood defences
- Making Space for Water: Developing a New Government Strategy for Flood & Coastal Erosion Risk Management: Background and Technical Documents.
<http://www.defra.gov.uk/enviro/fcd/policy/strategy/techdocs.htm>

Integration

Principle 4: Integration. Develop solutions that integrate flood and erosion risk management as part of integrated catchment management and coastal zone management.

Objectives:

- To take a strategic approach that increases the integration of plans and increases the effectiveness of flood risk, water resources and environmental planning.
- To promote the inclusion of water and coastal management into land use planning
- To take account of wider social and environmental policies, including increasing biodiversity and economic regeneration, in planning for flood and coastal defence
- To build strong inclusive partnerships between the stakeholders in catchment and coastal zone management
- To seek to adopt multi-functional options where possible

Example Indicators:

- No. of schemes implemented with multiple objectives and funding streams
- The contribution of flood and coastal erosion risk management to national biodiversity targets (measured as area, no. of sites or funding?)
- No. of plans relating to different catchments (The smaller number of plans indicating greater integration)
- No. of strategies and plans (CFMPs, SMPs and coastal defence strategy plans) in which local and regional development plan social, environmental and economic policies are incorporated
- Development and adoption of methods to recognise and account for the land use and environmental benefits of flood and coastal defence schemes that do not appear in current benefit appraisal methods, which are restricted to considering only flood defence benefits

Integrated water resource management plans were an international target following the World Summit of SD in Johannesburg, 2002. In England and Wales, a range of strategic water plans are developed for flood risk management, drainage area planning, water resources, water level management and shortly River Basin Management Plans that are required under the Water Framework Directive (WFD). Greater integration is required, in particular between water management and the planning system so that flood risks are considered at all levels of the planning system.

Making Space for Water highlighted the important role of land use planning, rural land management and integrated urban drainage management in managing flood risks (Defra, 2005).

The key issues related to planning and flood risk, as described in Topic Note 6 are:

1. Consider flood risk early and at all scales of development planning.
2. Undertake planning based on a “sequential approach”.
3. Understand the components that in combination generate the flood risk.
4. Recognise the differences between and the issues related to reducing flood risk compared to managing flood risk.
5. Ensure transparency and community engagement, as appropriate, as part of the decision-making process.



Further information

- Topic Note 5 provides more information on Planning and Flood Risk
- Case study 4b Integration of land and flood management – the FLOWS project
- Making Space for Water: Developing a New Government Strategy for Flood & Coastal Erosion Risk Management: Background and Technical Documents.
<http://www.defra.gov.uk/enviro/fcd/policy/strategy/techdocs.htm>

Engagement

Principle 5: Engagement. Work with all those affected by flooding and erosion (includes victims, beneficiaries, tax-payers and other stakeholders)

Objectives:

- To provide better information on risks to communities at risk of flooding or coastal erosion
- To support stakeholder engagement through information and technical tools
- To build enduring and inclusive partnerships with other stakeholders
- Promotion of innovative approaches to stakeholder consultation
- Increase community awareness and responsibility
- Promote measures to reduce the consequences of flooding for local communities (flood proofing, flood plans, social resilience)

Example Indicators:

- Measures of stakeholder satisfaction at the end of and flood risk management process and within processes
- Success in keeping stakeholders involved throughout the projects and plans e.g. CFMPs (percent retention)
- Allocated staff time and / or funding of organisations to stakeholder engagement processes
- Existence of policy or project statements on stakeholder engagement
- Staff sent or participation in stakeholder engagement training
- Existence of outreach activities

'Securing the future' promotes community action to improve local environments by "taking everyday actions that can make a difference". Community groups can contribute to flood risk management as well as recycling, carbon reduction and other environmental initiatives by maintaining private drainage systems, raising awareness of flood issues and organising protection of individual properties from flooding.

Better stakeholder engagement is required at all levels of flood and coastal management, from the development of policy, strategic plans and local and community initiatives. The response to Making Space for Water made a commitment to greater stakeholder involvement at all levels of flood risk management. This includes the provision of better information to increase awareness of flood risk, the potential impacts of climate change and the approach to appraisal of flood risk management solutions. At the strategic planning level the production of CFMP and SMPs now involve a greater level of consultation and engagement than in previous strategies.

In order to ensure good stakeholder engagement it is important that no group is seen to be seriously disadvantaged by the manner in which flood and coastal management is carried out. This poses a particular challenge on eroding coastlines where it is either not appropriate or not cost-beneficial to provide protection. Topic Note 4 suggests some ways in which communities thereby affected could be dealt with in a manner that is both fair to them and to society as a whole.



Further information

- Topic Note 2 Stakeholder Engagement
- Topic Note 4 Helping those disadvantaged by flood and coastal erosion risk management policies and strategies
- Topic Note 10 CFMPs
- Topic Note 11 SMPs
- Case Study 5 North Norfolk SMP
- Making Space for Water: Developing a New Government Strategy for Flood & Coastal Erosion Risk Management: Background and Technical Documents. Paper 4 on Stakeholder Engagement. <http://www.defra.gov.uk/environ/fcd/policy/strategy/techdocs.htm>
- Securing the future web pages: Sustainable development at the community level: <http://www.sustainable-development.gov.uk/delivery/global-local/community.htm>

Appraisal

Principle 6: Appraisal. Adopt appraisal methods that are rigorous, coherent and transparent and consider long term social, environmental and economic costs and benefits.

Objectives:

- To take account of all-important societal objectives including equity.
- To adopt a rigorous, logical framework by which to compare alternative courses of action.
- To do so through a process that is itself fair and promotes stakeholder engagement.
- To apply methods that increase understanding of the nature of the choices that must be made and encourage the invention of new and better flood and coastal defence options.
- To take account of full life cycle costs in making decisions
 - To develop clear procedures that are open and transparent, with clear lines of accountability.
- Provide information on flood and erosion risks in a simple form is accessible and can be understood by all?

Example Indicators:

- Stakeholder satisfaction (see Principle 4);
- Application on MCA methods that consider social and environmental factors (W2)
- Existence and demonstration of an auditable evaluation process (M)

The Government's SD strategy, *Securing the Future*, states that *"for a policy to be sustainable, it must respect all five [sustainability] principles.....some policies....will place more emphasis on certain principles than others. Any trade-offs should be made in an explicit and transparent way"*. (Defra, 2005).

In flood risk management the project appraisal process must ensure that proposed programmes and projects are fully assessed against the economic, social and environmental pillars of SD in a logical framework. In *Making Space for Water*, there was a commitment to ensure this balanced approach and to consider a wider range of options so that projects with flood risk management and environmental benefits are identified and considered in the options appraisal process.

A range of tools are available for flood risk managers, including Government's Integrated Policy Appraisal (IPA) methodology, Sustainability Appraisal and Multi-Criteria Analysis (MCA). New guidance on appraisal methods is being developed by Defra and the Environment Agency for roll-out in 2007.



Further information

- Topic Note 2 Sustainability Appraisal
- Topic Note 3 Appraisal of schemes with multiple objectives
- Case Study 2. Sustainability Appraisal – Moray Firth
- Case Study 3. Accounting for social and environmental "intangibles" in decision making
- *Making Space for Water: Developing a New Government Strategy for Flood & Coastal Erosion Risk Management: Background and Technical Documents. Paper 3 on appraisal methods.*
<http://www.defra.gov.uk/enviro/fcd/policy/strategy/techdocs.htm>

Environment

Principle 7: Environment. Protecting our natural resources and enhancing the environment where it is most degraded

Objectives:

- Recognise the heavily modified nature of drainage systems, catchments and coastal zones
- Reduce the impacts on natural systems, including water quality, biodiversity and landscape.
- Develop innovative solutions that enhance modified systems or create new habitats.
- Prevent inappropriate development in the floodplain
- Promote managed realignment in coastal and fluvial systems
- To meet the requirements of the Water Framework Directive

Example Indicators:

- Area of habitat created to support Biodiversity Action Plans (BAPs)
- Number of schemes, area or length of river realignments
- Number of schemes, area or length of coastal realignment
- No of new development with SUDS (Existing indicator in regional sustainable development frameworks)
- Improved ecological status of 'heavily modified water bodies' affected by flood defences

Natural resource protection & environmental enhancement is one of the four priority areas of the Government's SD strategy. Rivers and coastlines in England and Wales are heavily modified with a history development in the floodplain and along the coastline. In many areas river defences and drainage system assets are very old and can be in a poor state of repair. So this principle is about enhancing and modifying these existing systems to create more drainage capacity, "room for rivers" and rising seas while creating new habitats rather than returning rivers and coast to an original natural condition.

Greater use of rural and land use management solutions to flooding was promoted in Making Space for Water alongside a commitment to continue providing finance for land and property purchase required for managed realignment and research into the effectiveness of land management solutions. The Environment Agency have now established national minimum targets for wetland habitat creation so as to ensure flood risk and coastal protection solutions are consistent with biodiversity needs. Managed realignment and the set-back of defences should always be considered as options and the environment and social costs and benefits considered in options appraisal process.



Further information

- Topic Note 3 Appraisal
- Topic Note 6 Rural development
- Topic Note 9 Wise use of materials
- Case Study 1 Managed Realignment and Stakeholder Consultation Humber Estuary SMP
- Case Study 3 Accounting for social and environmental "intangibles" Humber Estuary SMP
- Making Space for Water: Developing a New Government Strategy for Flood & Coastal Erosion Risk Management: Background and Technical Documents. Paper on the WFD.
<http://www.defra.gov.uk/enviro/fcd/policy/strategy/techdocs.htm>

Sustainable consumption and production

Principle 8: Consumption & Production. Promote sustainable consumption and production in all flood and erosion risk management activities.

Objectives:

- To minimise the use of non-renewable resources
- To use renewable resources from sustainable production
- To promote the use of re-used and recycled material
- To minimise the amount of waste
- To reduce the energy from non-renewable sources used in transport and construction
- To reduce greenhouse gas emissions
- To make efficient use of capital assets

Example Indicators

- Proportion of re-used, secondary or recycled materials used in flood defence schemes
- Proportion of hazardous waste materials produced through out the life cycle
- Average distance between site and source material per ton construction material (Ecopoints estimator)
- CO₂ emission and/or other environmental impacts caused by the used means of transport per ton construction material (Ecopoints estimator)
- % Greenfield development footprint in the indicative floodplain

Securing the future highlights that *“the largest and fastest growing pressures on the global environment come from areas such as household energy and water consumption, food consumption, transport and tourism. While past environmental policy focused mainly on pollution from domestic production activities, we now need a wider focus across the whole life cycles of goods, services and materials, including impacts outside the UK. There would be little value in reducing environmental impacts within the UK if the result were merely to displace those impacts overseas.”*

Structural flood and coastal defence measures are significant consumers of steel and concrete as well as natural materials. These measures consume natural resources and energy in their production, and therefore, flood and coastal managers must consider “whole life costs” with the overall aim of reducing the ecological and carbon “footprints” of plans and schemes. This means considering the source of materials, impacts of transport in terms of carbon emissions and fate of waste from flood and coastal protection schemes.



Further information

- Topic Note 9. Wise use of materials
- Case study 6. Sustainable procurement and re-use of materials – Brighton to Ovingdean

Knowledge

Principle 9: Knowledge. Develop the knowledge, skills and awareness to promote sustainable solutions

Objectives:

- Raise awareness of key SD issues amongst all those affected by flooding and erosion
- Ensure that planners, engineers and scientists are trained in principles of sustainable development
- Promote Continued Professional Development
- Dissemination of best practice and guidance
- To increase and improve education on flood and coastal issues in universities, colleges and schools
- To improve the communication of flood and coastal erosion risks, through better Public Relations, marketing and the mass media

Example Indicators:

- Register of Continued Professional Development (CPD) involving training in sustainable flood and erosion risk management
- Awareness measures including awareness amongst different stakeholder groups, include vulnerable groups at risk from flooding, as well as the general public, and practitioners.
- Uptake of R&D in flood risk management projects

“Using Sound Science Responsibly” is one of the five principles of SD in “Securing the future”. This principle aims to make sure that Government policy is developed and implemented on the basis of strong scientific evidence, whilst taking into account scientific uncertainty (through the precautionary principle) as well as public attitudes and values. Research in areas such as flood and coastal erosion processes, the impacts of climate change, risk and uncertainty, environmental and social consequences is required to underpin changes in policy and flood risk management strategies. The programme of work required to develop Making Space for Water includes new research in integrated urban flood risk management and the effectiveness of rural land management techniques for managing flood risk.

As well influencing policy, research findings need to be disseminated much more widely and effectively to different groups. Improvements in the understanding of sustainable flood risk management must be matched by better education, communication and effective media coverage. This is required to ensure that different stakeholders understand the key issues and take effective action to reduce flood and coastal erosion risks.



Further information

- Topic Note 8. Precautionary climate change allowances.
- Defra/Environment Agency Flood Risk research programme <http://www.defra.gov.uk/enviro/fcd/research/default.htm>
- The Flood Risk Management Research Consortium (FMRMC) <http://www.floodrisk.org.uk/>
- The FLOODsite project is a major European project on flood risk management <http://www.floodsite.net/>
- Foresight Future Flooding project www.foresight.gov.uk
- Professional chartered institutions provide a range of guidance of SD, e.g. the Institute of Civil Engineers <http://www.ice.org.uk/> and Chartered Institute of Water and Environmental Managers <http://www.ciwem.org/>
- CEEQUAL is an awards scheme assessing the environmental quality of civil engineering projects - a civil engineering equivalent to BREEAM for buildings. It is being promoted by ICE, BRE, CIRIA and a group of committed industry organisations. <http://www.ceequal.com/>

Tools

For each level of flood and coastal risk assessment tools and guidance are required for each stage of the planning process including: **defining** risks; **developing** potential policies or solutions; **comparing** alternative options and **selecting** options.

Tools for sustainable flood risk flood management

Scale	Units	Policies and plans (examples only)
National and policy	National	Government policy and funding for flood risk management, the Water Framework Directive and regulation.
Regional and strategic	Catchment or Coastal Cell	Large scale and long term planning CFMPs SMPs and RBMPs
Local and Community	Sub-catchment Scheme or local solution	Strategic planning for sub-catchments and coastal process units Schemes, plans and actions related to individual projects

Step	Sustainability considerations
Defining the problem	Problem formulation using a clear risk model e.g. Source-Pathway-Receptor Understanding the current state of the system and performance of the existing flood risk management solutions Developing and agreeing sustainability indicators Engaging stakeholders
Developing scenarios	Developing future scenarios & risk assessment Engaging stakeholders
Comparing strategic options	Sustainability Appraisal Options appraisal using multi-criteria analysis and considering a range of future scenarios Cost Benefit Analysis Engaging stakeholders
Selecting options for each cell	Selection of options based on score, robustness across scenarios, effectiveness etc.. Engaging stakeholders
Implementing flood risk management solutions	Final plan Operation of flood risk management Engaging stakeholders
Monitoring performance including sustainability indicators	Review & monitor using selected indicators Engaging stakeholders

The eleven Topic Notes in Section 3 and the 7 case studies described in Part 2 of the handbook make reference to and illustrate several important tools, such as Sustainability Appraisal (Topic Note 1 & Case Study 2), existing Project Appraisal Guidance (Topic Notes 3 & 9) and the Ecopoints Estimator (Topic Note 10 & case study 6). A long list of potential tools and related guidelines is included in Appendix 4 and information on these is described in the accompanying Project Record for the benefit of other researchers.

References to published material

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

FD2015 Outputs

Summary

http://www.defra.gov.uk/science/Project_Data/DocumentLibrary/FD2015/FD2015_6132_TSM.pdf

Technical Report 1

http://www.defra.gov.uk/science/Project_Data/DocumentLibrary/FD2015/FD2015_6140_TRP.pdf

Technical Report 2

http://www.defra.gov.uk/science/Project_Data/DocumentLibrary/FD2015/FD2015_6141_TRP.pdf

Related projects linking to outputs of FD2015

FD2320 Flood risk assessment guidance for new development

http://www.defra.gov.uk/science/Project_Data/DocumentLibrary/FD2320/FD2320_3364_TRP.pdf

Selected references from TR1 bibliography relating to the project

Department of the Environment, Food and Rural Affairs (2002) *Directing the Flow – Priorities for Future Water Policy*, Defra, London, at <http://www.defra.gov.uk/environment/water/strategy/>

Department of the Environment, Food and Rural Affairs (2004) *Taking It On – developing a UK sustainable development strategy together*, Defra, London.

Department of the Environment, Food and Rural Affairs (2005) *Making space for water: taking forward a new Government strategy for flood and coastal erosion risk management in England (First Government response to the autumn 2004 consultation exercise)*, Defra, London, at <http://www.defra.gov.uk/corporate/consult/waterspace/>

HR Wallingford (2005b) *Flood Risk Assessment Guidance for New Development, Phase 2 Framework and Guidance for Assessing and Managing Flood Risk for New Development – Full Documentation and Tools*, Defra/Environment Agency R&D Technical Report FD2320/TR2 Final Draft, March 2005, at http://www.hrwallingford.co.uk/projects/flood_risk_assessment/index.html

NTAG (2004) *Sustainable Flood Management Sub-Group Report*, 23 September 2004. National Technical Advisory Group on Flooding Issues, The Scottish Executive. Downloadable from <http://www.scotland.gov.uk/about/ERADEN/ACEU-AQT/00016919/NTAG.asp>

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http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_030110.pdf

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OST (2004) *Foresight. Future Flooding. Scientific Summary: Volume 1 – Future Risks and their Drivers*, Office of Science and Technology, London, at

http://www.foresight.gov.uk/Previous_Projects/Flood_and_Coastal_Defence/Reports_and_Publications/Future_Flooding_Scientific_Summary_Volume_1.html

