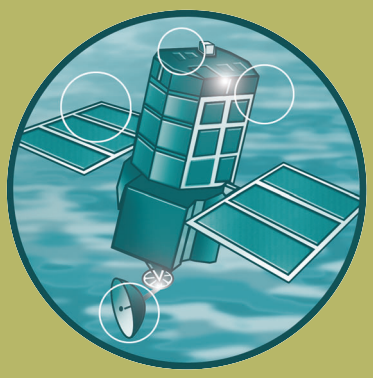
Joint Defra/EA Flood and Coastal Erosion Risk Management R&D Programme

Sustainable Flood and Coastal Erosion Risk Management

Part 1

R&D Technical Report FD2015/TR1



Environment Agency

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Department for Environment Food and Rural Affairs

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

Sustainable Flood and Coastal Erosion Risk Management

Technical Report 1

R&D Technical Report FD2015/TR1

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Statement of use

This report suggests principles and guidance to help flood and coastal erosion risk management policy makers and practitioners make better decisions that deliver greater environmental, social and economic benefits. It should be noted that it does not constitute official government policy or guidance, which will be provided through the developing work on appraisal under Making Space for Water. In the interim it is suggested that any application of the guidance within this report is only undertaken following consultation with Defra's Flood Management Division.

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Executive summary

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. This 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.

The four priority areas (adapted from Securing the Future) and their relevance to flood and coastal erosion risk management:-

Sustainable consumption and production (SCP) requires us to achieve more with less. Current patterns of consumption and production in developed countries could not be replicated world-wide: some calculations suggest that three planets' worth of resources would be needed to achieve UK levels of consumption across the globe. *Flood defence and coastal protection schemes require large volumes of primary materials – rock, shingle and sand; and also generate waste that goes to landfill sites. 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.*

Climate change and energy. The effects of a changing climate can already be seen in the global temperature record. Scientific evidence points to the release

[1] Also see http://www.sustainable-development.gov.uk

of greenhouse gases - such as carbon dioxide and methane - into the atmosphere by human activity as the primary cause of climatic change. We need to change the way we generate and use energy, and in other activities that release these gases and set an example for others to follow. *The potential impacts of climate change in the UK include sea level rise and increases in flood and drought risk. Flood and coastal erosion risks can also be increased indirectly due to accelerated deterioration of river and coastal defence assets driven by morphological responses to rainfall-runoff regimes, increased storm surge and foreshore steepening. The potential consequences in developing countries are severe including the loss of low lying island states to sea level rise and the failure to meet international development goals (Figure 1-2).*

Natural resource protection and environmental enhancement. Natural resources are vital to our existence. Our health and well-being are inextricably linked to the quality of our air, water, soils and biological resources. Our economy and key industrial sectors are directly and indirectly reliant on functioning ecosystems. There is a need for a better understanding of environmental limits, environmental enhancement and where the environment is degraded to ensure a decent environment for everyone. *Flood and coastal management can have negative impacts on the environment, but also new plans and innovative solutions present an opportunities to conserve existing valuable and threatened habitats, and in some cases to create habitats, for example by preventing coastal squeeze along substantial lengths of eroding coastlines. In deprived urban areas improved flood risk management provides opportunities for regeneration including environmental enhancement.*

Sustainable communities. Our aim is to create sustainable communities - places where people want to live and work, now and in the future. From "global to local" we aim to improve the lives of people in deprived communities and socially excluded groups who experience poor quality of life, including poor local environmental quality and poor access to services such as education, healthcare and transport*. The recent experience of New Orleans demonstrates the danger of putting vulnerable people at risk of flooding. Major components of future flood risk management will rest on risk reduction by avoiding placing vulnerable people in areas at risk and ensuring that integrated portfolios of measures are implemented in ways that are fair and equitable.*

Principles of sustainable flood and coastal erosion risk management

In order to develop a framework for sustainable flood risk management, a vision of what this 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" (Section 1 and Appendix 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)

This report 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 is 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

Topic Notes

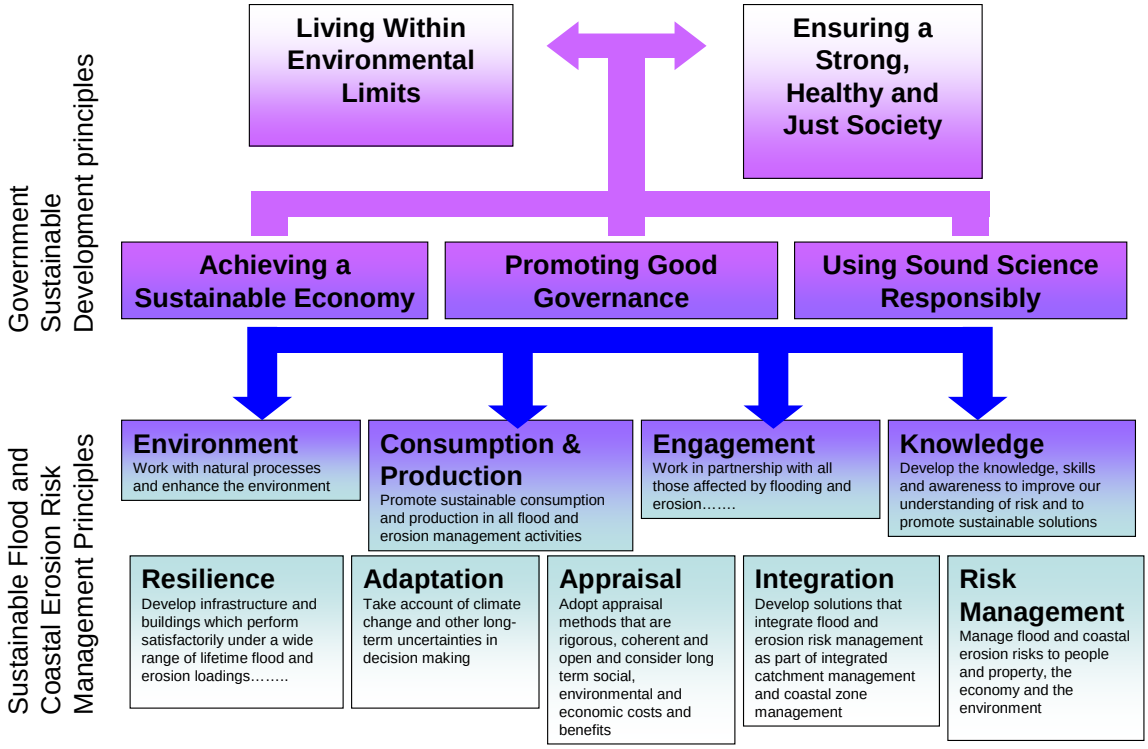
In Section 3, eleven 'Topic Notes' are provided that summarise and link to existing information and highlight key sustainability issues:-

- 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



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1. Introduction

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)[2].

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.

This strategy replaces the 1993 Strategy for Flood and Coastal Defence in England and Wales developed by the Ministry of Agriculture, Fisheries and Food and the Welsh Office that defined sustainable schemes as those that:-

"take account of the interrelationships with other defences, developments and processes within a catchment or coastal sediment cell, which avoid as far as possible tying future generations into inflexible and expensive options for defence."

The emphasis in the new strategy on managing risks as opposed to building defences and clearer alignment with the Government's Sustainable Development Strategy provides an opportunity for more sustainable flood and erosion risk management in the UK. This 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.

1.1 Taking forward Government strategy for sustainable flood risk management

In summer 2003 the Government decided to review flood and coastal erosion risk management policy for England[3]. The Government consultation paper "Making Space for Water", which was published in July 2004 proposed that:-

"*solutions for flood management and coastal erosion that work with natural processes to make more space for water should be identified and pursued wherever possible. This includes proposals for managed realignment of coasts and river corridors where appropriate*" and possibly *"establishing targets for wetland habitat creation to fulfil biodiversity commitments.*" (Defra, 2004).

[2] Also see http://www.sustainable-development.gov.uk
[3] Also see http://www.defra.gov.uk/environ/fcd/policy/strategy.htm

Following a thorough consultation process in autumn 2004, the Government outlined how the new strategy would be taken forward in England in its first response in March 2005. This set out the following actions:-

- A more holistic approach addressing the challenges and pressures affecting flood and coastal erosion risk management such as climate change and socio-economic change.
- Better management of risk by including all sources of risk (coastal erosion and tidal flooding, flooding from rivers, sewers, groundwater and overland flow) on maps, developing a better understanding of the consequences of flooding and coastal erosion and expanding flood warning, awareness and flood resilience activities.
- Effective consideration of flood risk in land use planning by encouraging the assessment of flood risk at all levels of the planning process and influencing Planning Policy Statements on flood and coastal erosion risks.
- Promoting greater use of managed realignment and rural land use solutions for managing flood risk.
- Integrating the management of coastal, fluvial and urban drainage risks by piloting different approaches to integrated urban drainage management.
- Developing a more strategic and integrated approach to managing coastal flooding and erosion with the aim of ensuring democratic input to decision making.

1.2 Alignment with the Government's Sustainable Development Strategy

The definition of sustainable development (SD) most commonly accepted is that of the World Commission on Environment and Development published in the 'Brundtland Report' in 1987:

"development which meets the needs of the present without compromising the ability of future generations to meet their own needs."

It is clear from this definition that "sustainable flood and coastal erosion risk management" should be concerned with taking a longer-term view and enhancing the environment for future generations. This leads to issues such as managing future risks and uncertainty; understanding and working with natural processes, considering the cumulative impacts of our decisions and the wise use of natural resources.

The new 2005 UK strategy of sustainable development builds on the earlier 1999 strategy "*A Better Quality of Life*", developing stronger international and societal dimensions. It sets out 5 principles for sustainable development (Figure 1-1) that provide the starting point for developing principles for sustainable flood and coastal erosion risk management (Section 2). The SD strategy also promotes four agreed priority areas that are each relevant to flood risk management.

The four priority areas (adapted from Securing the Future) and their relevance to flood and coastal erosion risk management:-

- **Sustainable consumption and production (SCP)** requires us to achieve more with less. Current patterns of consumption and production in developed countries could not be replicated world-wide: some calculations suggest that three planets' worth of resources would be needed to achieve UK levels of consumption across the globe. *Flood defence and coastal protection schemes require large volumes of primary materials – rock, shingle and sand; and also generate waste that goes to landfill sites. 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.*
- **Climate change and energy.** The effects of a changing climate can already be seen in the global temperature record. Scientific evidence points to the release of greenhouse gases - such as carbon dioxide and methane - into the atmosphere by human activity as the primary cause of climatic change. We need to change the way we generate and use energy, and in other activities that release these gases and set an example for others to follow. *The potential impacts of climate change in the UK include sea level rise and increases in flood and drought risk. Flood and coastal erosion risks can also be increased indirectly due to accelerated deterioration of river and coastal defence assets driven by morphological responses to rainfall-runoff regimes, increased storm surge and foreshore steepening. The potential consequences in developing countries are severe including the loss of low lying island states to sea level rise and the failure to meet international development goals (Figure 1-2).*
- **Natural resource protection and environmental enhancement**. Natural resources are vital to our existence. Our health and well-being are inextricably linked to the quality of our air, water, soils and biological resources. Our economy and key industrial sectors are directly and indirectly reliant on functioning ecosystems. There is a need for a better understanding of environmental limits, environmental enhancement and where the environment is degraded to ensure a decent environment for everyone. *Flood and coastal management can have negative impacts on the environment, but also new plans and innovative solutions present an opportunities to conserve existing valuable and threatened habitats, and in some cases to create habitats, for example by preventing coastal squeeze along substantial lengths of eroding coastlines. In deprived urban areas improved flood risk management provides opportunities for regeneration including environmental enhancement.*
- **Sustainable communities.** Our aim is to create sustainable communities - places where people want to live and work, now and in the future. From “global to local” we aim to improve the lives of people in deprived communities and socially excluded groups who experience poor quality of life, including poor local environmental quality and poor access to services such as education, healthcare and transport*. The recent experience of New Orleans demonstrates the danger of putting vulnerable people at risk of flooding. Major components of future flood risk management will rest on risk reduction by avoiding placing vulnerable people in areas at risk and ensuring that integrated portfolios of measures are implemented in ways that are fair and equitable.*

Figure 1-1 Five principles from the UK Government's new sustainable development strategy

Figure 1-2 International priorities and SD targets from the World Summit of Sustainable Development (WSSD) – Johannesburg 2002 (Adapted from Securing the future, Defra, 2005)

1.3 Using this report

This report provides a high level overview of sustainable flood risk management for policy makers, flood and coastal engineers, environmental scientists and planners. It provides discussion of some the key sustainability issues in the form of 'Topic Notes', example sets of sustainability indicators and examples of tools in the form of case studies that can be used for better flood risk management. It aims to support actions underway as part of the Government's new strategy for flood and coastal erosion risk management. However the Topic Notes provided are research outputs and aim to supplement rather than replace existing guidance and procedures. The distinction between existing Government policy, such as Planning and Policy Guidance notes or Flood and Coastal Defence Project Appraisal Guidance (FCDPAG) and project research outputs is made through colour coding (green for Government policy and blue for research outputs).

1.3.1 Principles of sustainable flood risk management

In Section 2, nine principles of are set out that define and explain sustainable flood and coastal erosion risk management. The process of how these were developed is explained in the research Project Record (HR Wallingford, 2005). Objectives for sustainable flood risk management and example sustainability indicators are highlighted with a complete list of example sustainability indicators included in Appendix 2.

1.3.2 Topic Notes

In Section 3, eleven Topic Notes are provided that summarise and link to existing information, such as the Defra Project Appraisal Guidance (PAG) series used by flood and coastal engineers, highlight key sustainability issues and set out a number of activities to support sustainable flood risk management:-

- 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)

Each Topic Note is relevant for different target audiences (Table 1.1). Therefore, the handbook is best approached by reading Sections 1 and 2, then individual Topic Notes of interest in Section 3 and further information from case studies or the Project Record if required.

1.3.3 Case studies

Several of the Topic Notes include summary information from case studies. Seven specific case studies are presented in Technical Report 2 (HR Wallingford, 2005a). The case studies are:-

No.	Sustainability Issues / Tools	Case Study
1	*Changes and potential loss of designated habitats – use of managed realignment and stakeholder consultation*	Humber Estuary SMP and Paull Holme Strays managed realignment scheme (within Humber Estuary)
2	Identifying and developing sustainable solutions – use of sustainability appraisal	Moray flood alleviation scheme, Morayshire, Scotland
3	Accounting for social and environmental "intangibles" in decision making – use of multi-criteria analyses	Humber Estuary SMP and River Chet flood alleviation scheme
4a	Alternatives to formal flood defences in local flood protection – use of temporary and demountable flood protection	River Severn temporary and demountable flood protection systems
4b	Integration of land and urban management. Alternatives to formal flood defences in the management of run-off – Use of SUDS	Sustainable Water Management Systems (FLOWS) project, Cambourne, Cambridgeshire.
5	Managing the conflicts between development and natural processes – Use of SMPs and associated consultation	North Norfolk SMP and associated strategies
6	Sustainable procurement and re-use of materials and waste minimisation	Brighton to Ovingdean coast protection scheme

1.3.4 Tools

A “tool” for flood risk management is broadly defined as any data, information, method or software that can improve flood risk decision making. Specific tools, such as appraisal methods, guidance material, consultation processes, software are referred within the topic notes and case studies. Tools appropriate for different levels of flood risk decision making are listed in a “compendium of flood risk tools” in Appendix 3 but this is not exhaustive and other relevant lists of tools are available on Government web pages[4].

[4] e.g. Environment Agency’s SEA toolkit http://www.environment-agency.gov.uk/aboutus/512398/830672/831980/?version=1&lang=_e and policy tools listed on the Government’s SD web site: http://www.sustainable-development.gov.uk/what/tools.htm

Table 1-1 Guidance sheets – target audiences and scale

Section	Topic	Scale	Target audience
2.0	Framework for sustainable flood risk management	All scales	All
3.1	Topic Note 1. Sustainability Appraisal	All scales	Policy Makers and Practitioners
3.2	Topic Note 2: Community Engagement and Sustainable Development	Local & community Regional & strategic	Policy Makers and Practitioners
3.3	Topic Note 3: Appraisal of solutions & schemes with multiple objectives	All scales	Policy Makers and Practitioners
3.4	Topic Note 4: Compulsory purchase & legal aspects of flood management	National & policy	Policy Makers and Practitioners
3.5	Topic Note 5. Planning & flood risk	Local & community Regional & strategic	Policy Makers and Practitioners
3.6	Topic Note 6. Rural Development	Local & community Regional & strategic	Policy Makers and Practitioners Land Managers
3.7	Topic Note 7. Adaptation and resilience	All scales	Policy Makers and Practitioners Local planners
3.8	Topic Note 8. Precautionary climate change allowances	All scales	Policy Makers and Practitioners Local planners Regional planners
3.9	Topic Note 9: Wise use of materials	Local & community	Policy Makers and Practitioners Design and Construction Engineers
3.10	Topic Note 10: Using CFMPs to deliver sustainable flood management	Regional & strategic	Policy Makers and Practitioners
3.11	Topic Note 11: Using SMP2 processes to deliver sustainable flood risk and coastal erosion management	Regional & strategic	Policy Makers and Practitioners

2. A Framework for Sustainable Flood and Coastal Erosion Risk Management

2.1 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 2001[5] and the National Assembly for Wales has a binding legal duty to pursue sustainable development in all of its activities[6]. 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."[7]. Many regional assemblies have developed their own Regional Frameworks for SD that includes flood risk management issues and indicators[8].

2.2 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.

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[5] http://www.environment-agency.gov.uk/aboutus/275292/234823/615862/379055/351167/?lang=_e

[6] http://www.wales.gov.uk/themessustainabledev/index.htm

[7] http://www.environment-agency.gov.uk/aboutus/286233/783258/353470/?version=1&lang=_e

[8] 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

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).

- 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 FLOODsite[9] 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 Consortium[10] that is directing fundamental research approaches to meeting the needs of end users and practitioners.

[9] Information on the FloodSITE project can be found on the project web pages:- http://www.floodsite.net/

[10] Information on the FRMRC project can be found on the project web pages:- – http://www.floodrisk.org.uk

2.3 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.
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- 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 FLOOD*site* 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.*

2.4 Principles

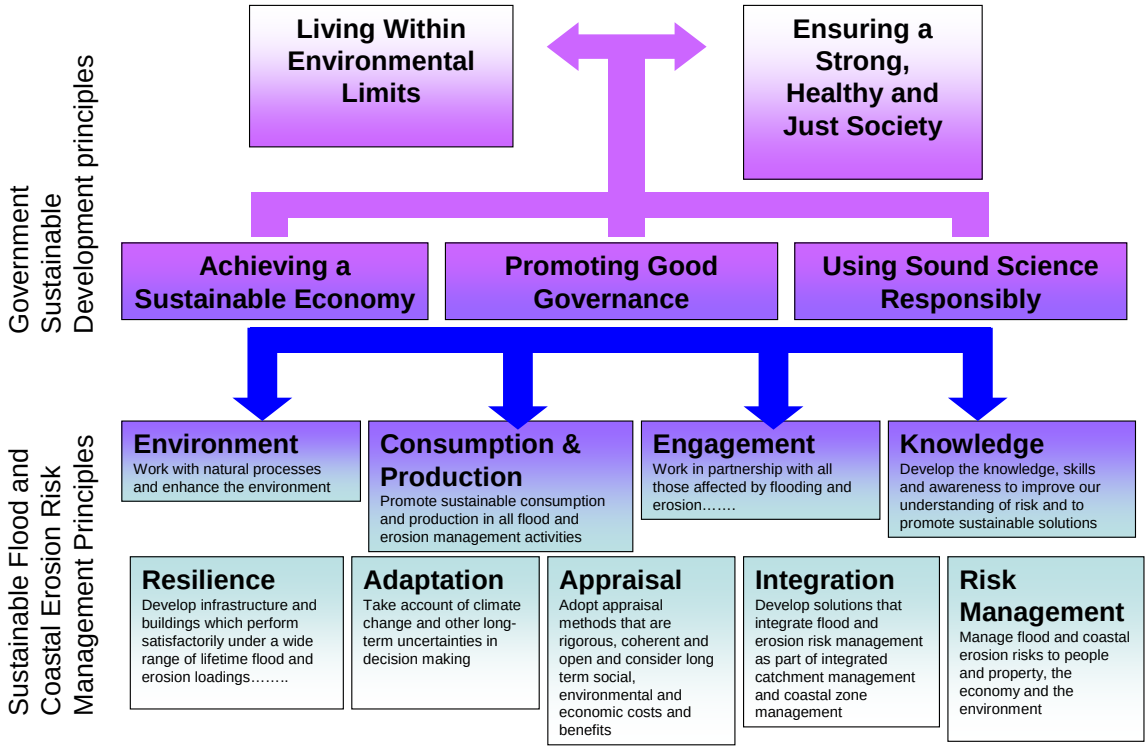
The nine principles of sustainable flood and coastal erosion risk management are summarised in Box 2 and explained in detail in this section of the handbook with reference to Government's SD strategy "Securing the future" (Defra, 2005) and response to the Government consultation document "Making Space 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 2-1 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.

2.4.1 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 2-2[11]. 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.

[11] 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 2-2 The flooding system

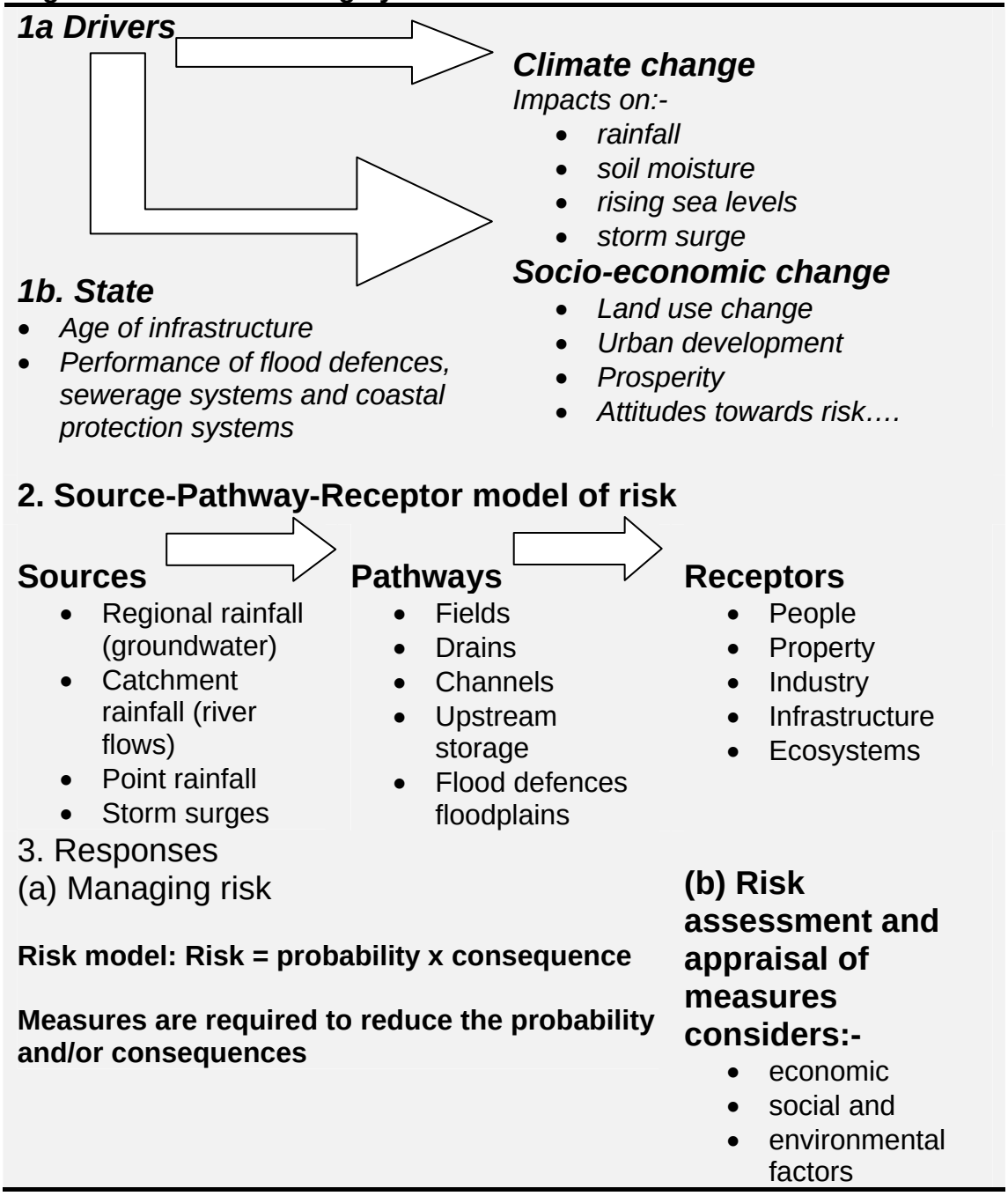
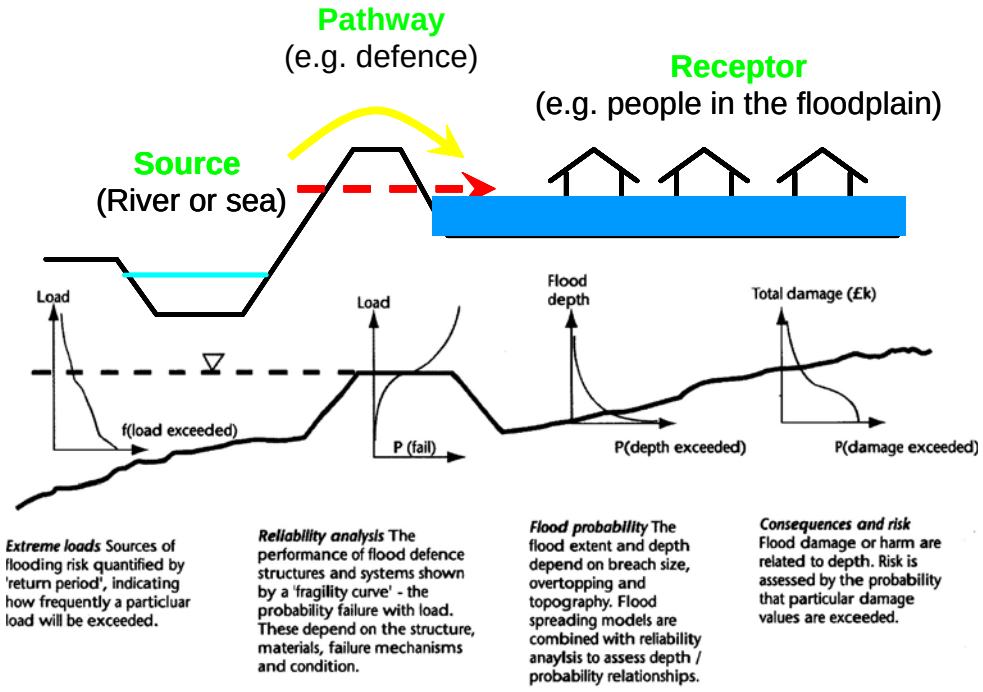


Figure 2-3 Source / Pathway or Barrier / Receptor assessment framework for the assessment of flood risk (Sayers and Meadowcroft, 2005)



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.

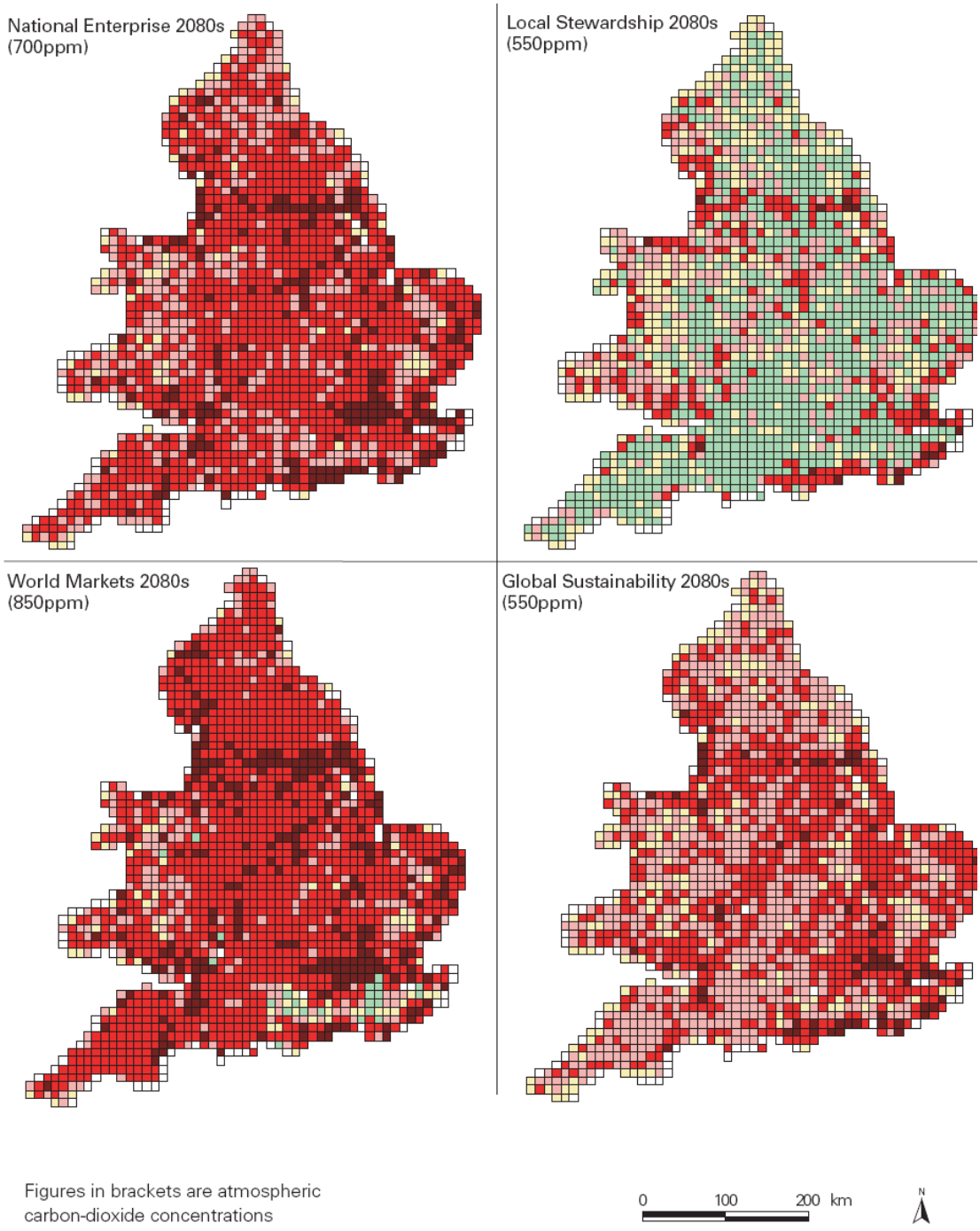
The most significant outcome of the Foresight FCD project is the acceptance of its findings by Government and the all other major stakeholder organisations, which has been effectively universal and complete. Twenty months after the launch of the Future Flooding reports, the Action Plan published on the 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/environ/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 2-4 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.



2.4.2 Adaptation

Principle 2: <u>Adaptation.</u> 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

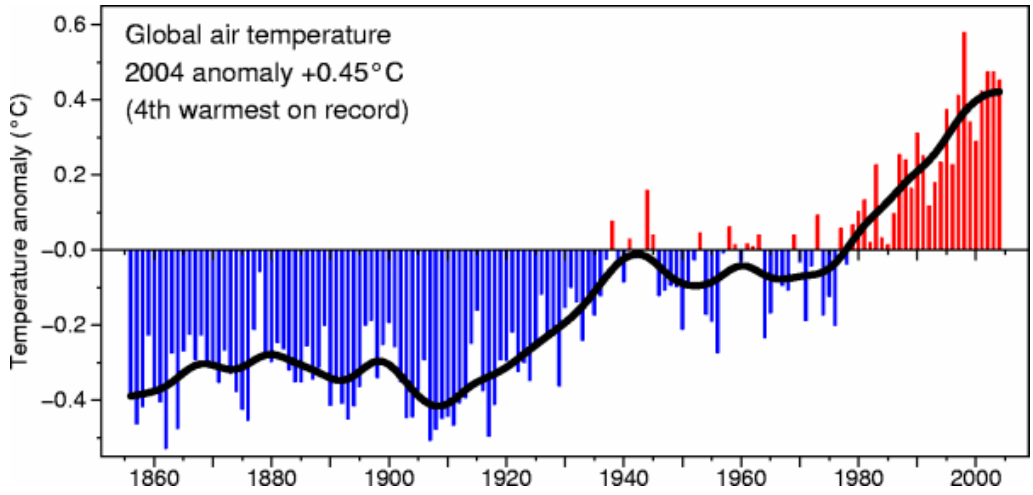
principle in the form of precautionary allowances for climate change in a range of plans and schemes (Topic Note 8) and considering future scenarios in strategic plans (Topic Notes 11 and 12 on CFMPs and SMPs respectively).

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 2-5 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/

2.4.3 Resilience

Principle 3: <u>Resilience.</u> 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.

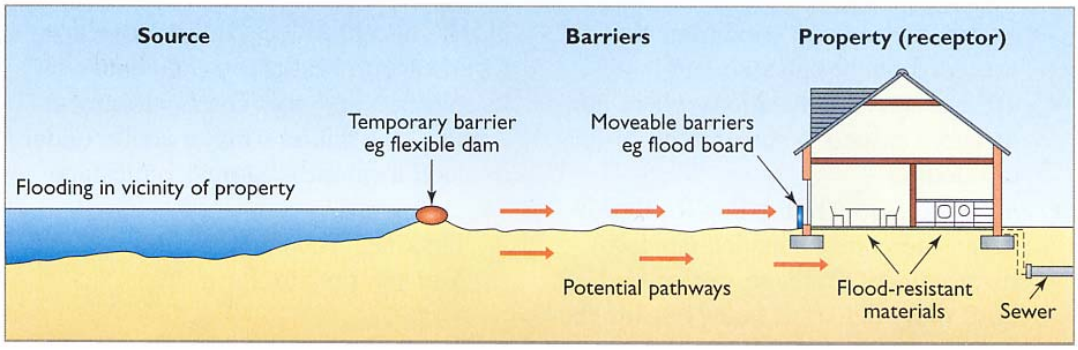
Planning of new development should consider flood risk and the integrated management of catchments and coastal cells early and at all scales of the planning process. Adoption the "sequential approach" to planning (Topic Note 5) means that hazardous flood risk areas should be avoided. However, it is not 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 2-6 Flood resistance and resilience measures

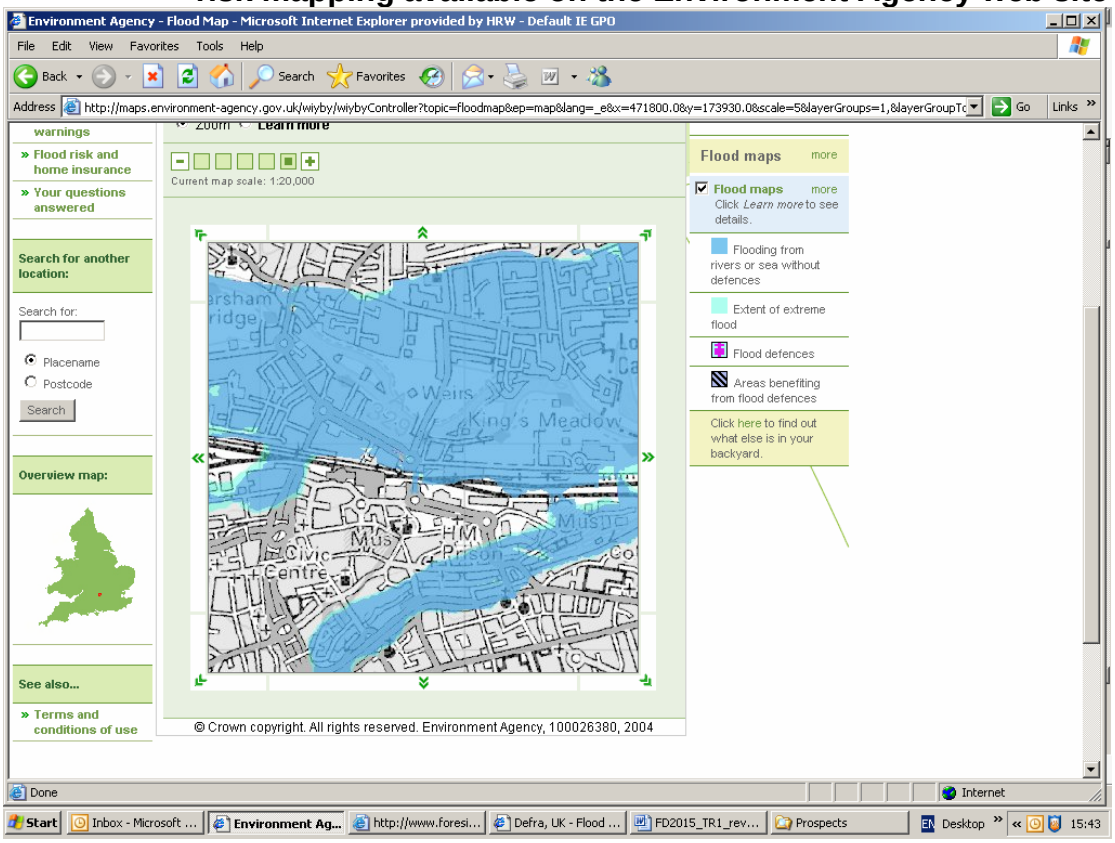


Taking a wider view, resilience of the whole flood risk system, including environmental and social aspects, requires consideration of:-

- 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 2-7 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/environ/fcd/policy/strategy/techdocs.htm

2.4.4 Integration

Principle 4: <u>Integration</u>. 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/environ/fcd/policy/strategy/techdocs.htm

2.4.5 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

2.4.6 Appraisal

Principle 6: <u>Appraisal</u>. 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/environ/fcd/policy/strategy/techdocs.htm

2.4.7 Environment

Principle 7: <u>Environment.</u> 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/environ/fcd/policy/strategy/techdocs.htm

2.4.8 Sustainable consumption and production

Principle 8: <u>Consumption & Production.</u> 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 though out the life cycle
- Average distance between site and source material per ton construction material (Ecopoints estimator)
- CO_2 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

2.4.9 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/environ/fcd/research/default.htm
- The Flood Risk Management Research Consortium (FMRMC) http://www.floodrisk.org.uk/
- The FLOOD*site* 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/

2.5 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
	Sub-catchment	Strategic planning for sub-catchments and coastal process units
Local and Community	Scheme or local solution	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	Review & monitor using selected indicators

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.

3. Topic Notes

3.1 Topic Note 1. Sustainability Appraisal

3.1.1 Sustainability Principles

Sustainability Appraisal (SA) provides a methodical and transparent approach to evaluating to what extent a proposal (whether a policy, plan or scheme) meets sustainability objectives (Section 2). The ethos and principles underpinning sustainable development are still evolving. However, some principles are established within UK Government policy (and some in law). In 2005, the UK Government launched its new strategy for sustainable development, *Securing The Future*, that developed an agreed set of 5 sustainability principles to be taken forward in strategies by the UK Government, Scottish Executive, Welsh Assembly Government and the Northern Ireland Administration (Section 1) Both the wording and the spirit of these principles have met with broad consensus and acceptance, because they were devised to address the range of issues that are known to arise whenever there is an imbalance in the nature/society system (such as unfairness, economic inefficiencies, irreversible environmental damage, poor risk management, etc.). Several of these principles cross-cut the conventional "three pillars" of sustainability:

Sustainability Appraisal (SA) provides a method for evaluating to what extent a proposal meets sustainability objectives.

- **Environment** – the effective, long-term conservation, management and enhancement of a healthy natural environment;
- **Economy** – maintenance of prosperity as the means to enhance quality of life;
- **Community/Society** – the fair distribution of impacts and benefits, and inclusiveness in meeting social needs and deciding priorities.

For a policy to be sustainable, it must respect all five [sustainability] principles…..some policies….. Any trade-offs should be made in an explicit and transparent way. (Securing the Future, 2005)

The principles, then, provide a pragmatic yet robust set of aims. Tensions in the past have arisen where the "three pillars" are treated sequentially, or traded off against one another. The new Government policy makes its clear that all five of the principles, and indeed each of the "three pillars" must be respected equally. Sustainability Appraisal for flood and coastal risk management should, therefore, reflect each of these guiding principles, within the regulatory and legislative context.

Flood and coastal risk management needs to move away from a primary emphasis on economic damages towards a broader inclusion of environmental and social factors.

Principles of sustainable flood and coastal risk management

With regard to the principles of sustainable flood and coastal risk management developed in Section 2, all nine specific principles are relevant to SA and Principle 5 (see over) specifically addresses the need for improved appraisal methods at the policy, "regional & strategic" and "local & community" levels.

The sustainability of flood and coastal risk management policy itself is an issue at present, particularly in the context of climate change and post-industrial socio-economic development. The primary emphasis for the UK's national strategic guidance is on risk management (MAFF Strategy, 1993; *Response to Making Space for Water*, 2005; PPG25 and others; Foresight Future Flooding, 2004), which historically has focused on economic damages, and been decided at a comparatively local level. The current emphasis is shifting to a broader inclusion of environmental and social factors, recognising the need to manage risks, in the short *and* long-term, on a larger landscape scale, reflecting coastal cells and river catchments.

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?

Mechanisms for larger spatial coverage and longer timescales for flood risk management planning are developing. Strategic environmental assessment (SEA) can be applied across the development planning hierarchy of policies, plans and schemes, whilst Environmental Impact Assessments (EIAs) should be undertaken for site-specific projects. However, appraisal of sustainable development needs to extend the environmental impact focus of SEA and EIA, integrating conservation and management of the environment, community well-being and economic growth within a fuller Sustainability Appraisal.

SA goes beyond the requirements of SEA, which focuses only on environmental impact, although it should remain compliant with the SEA Directive.

The Government's Integrated Policy Appraisal (IPA) tool has recently been applied to flood and coastal risk management (Defra, 2004), evaluating the social, economic and environmental impacts of management policy, along with its distributive implications.[12] This is an extension of the NADNAC approach (National Assessment of Defence Needs and Costs), which is still under consultation. It is intended to extend economic concerns (tangible costs and benefits) with a broader sustainability basis. It includes cross-cutting criteria in addition to the 'three pillars' of sustainability, and the questions it has formulated are broadly analogous to national level indicators for Sustainability Appraisal.

In summary, sustainable flood risk management depends on the integrated planning and implementation of optimal action (in accordance with the principles of sustainable development), and also on a mechanism for knowing what that optimum is. At the highest policy level, this mechanism is the IPA; SA is the mechanism at the multiple operational levels.

At the highest policy level, Integrated Policy Appraisal (IPA) fulfils the role of SA.

3.1.2 Why consider Sustainability Appraisal?

The revision of the UK strategy for flood and coastal risk management in England *(Making Space for Water***,** Defra, 2004) is driven by the recognition that many aspects of current practice are not sustainable. Current approaches will result in further escalation in both costs and risks (Foresight Future Flooding, 2004) because of trends in development pressure and coastal squeeze[13]. Today's improved understanding of hydrology, landscape and the nature/society system, and available technologies (including those for communication and education) can be better combined with engineering approaches to provide solutions that are appropriate and robust in a dynamic changing world.

SA is an integral part of determining sustainable solutions.

Making more space for water relies first on more integrated and wide-ranging forms of Sustainability Appraisal, and then on consistent and widespread positive action across society. This guidance sheet describes the former; the guidance sheet on community engagement describes good practice that can help towards the latter, an essential component of sustainable development.

SA should demonstrably and transparently influence flood and coastal risk management planning.

[12] http://www.defra.gov.uk/environ/fcd/policy/ForumMtgs/28Nov2003/fmssf09.htm
[13] A combination of society's activities and sea-level rise, aggravated by projected climate change-induced changes in rainfall and storminess.

Sustainability Appraisal should demonstrably and transparently influence the objectives and policies of flood and coastal risk management planning. The Scottish Executive has reported on a methodology for assessing the degree of effectiveness of a participatory process influencing integrated/sustainable coastal management (Scottish Executive Social Research, 2002).

The SEA Directive, Water Framework Directive and the Aarhus Convention all act as drivers for sustainability within flood and coastal risk management.

3.1.3 Where does Sustainability Appraisal fit within the different scales of flood and coastal risk management?

Sustainability Appraisal is framed in a changing legislative and regulatory context. International drivers of sustainability within flood and coastal risk management are the EU's Strategic Environmental Assessment (SEA) Directive, affecting all types of planning; the Water Framework Directive, shaping integrated, systemic catchment-scale water resource planning; and the Aarhus Convention, ensuring rights to participation and protection from environmental problems.

The vision and principles of sustainable development have been adopted globally and nationally, but they can only be manifest at a more local scale. For SA to be effective at all, it *must* be an iterative process, revisiting both local and regional actions and the higher-level concerns. It must be tailored to the local circumstances, whatever the high-level guidance. In flood and coastal risk management, there are numerous examples of tensions between local and national strategic aims. Sustainability Appraisal is not a tool that makes those tensions disappear, but it makes them more transparent, and gives an indication of the time and spatial scales that need to be considered in their management.

Effective SA must be an iterative process, identifying local, regional, national and international issues.

3.1.4 What are the main elements that constitute Sustainability Appraisal?

In addition to the spatial and legislative **scales** mentioned above, SA also incorporates both a **process** element (*how* planning and implementation takes place), and some impact measurement or metric (i.e. the sustainability **indicators** for a given proposal). Sustainability indicators in this context are statements or measures of the probable future effects of a proposal, and in the process of integrated planning and sustainability optimisation they can be used both as evaluation tools (defining a baseline) and boundary criteria (setting thresholds or limits for adverse impacts).

SA should consider three main issues:
1. ***scale***
2. ***process***
3. ***indicators***

Sustainability Appraisal should embrace and include the consideration of:

SCALE	• Incorporate concerns at all levels: global, national, regional and local;
PROCESS	• Be an integral part of the planned proposal right from the early stages of planning through to implementation and monitoring; • Consider the long-term social, environmental, and economic effects on the area when the proposal is implemented *and* as it develops in the future;
INDICATORS (see Box 5)	• Provide an audit trail across the 'three pillars' of sustainability, so that the process of optimising the benefits can be transparent and responsive.

3.1.5 When should Sustainability Appraisal be undertaken?

As stated earlier, SA should be an integral part of the planned proposal right from the early stages of planning through to implementation and monitoring.

SA should be undertaken in parallel with the planning process, not posthumously, to enable an iterative process.

As part of this it is necessary to consider the long-term social, environmental, and economic effects on the area when the proposal is implemented *and* as it develops in the future. Foresight Future Flooding (2004) emphasised the fact that some effective and sustainable flood risk management actions have long lead-in times. If these actions are included as alternative options in a Sustainability Appraisal, then the time horizon for planning and the period over which the impacts are being appraised needs to be appropriately defined.

3.1.6 When are Sustainability Appraisals mandatory?

Under the Planning and Compulsory Purchase Act 2004, Sustainability Appraisals are mandatory for regional and local development planning (ODPM, 2004). These Appraisals should meet the requirements of the SEA Directive in full, but widen the Directive's approach to include social and economic as well as environmental issues. Effectively, the SEA (in the form of an Environmental Report) will form one part of the Sustainability Appraisal.

Sustainability Appraisals for flood and coastal risk management planning are not mandatory but are considered to be good practice by Defra. This is particularly the case for SMPs, CFMPs and flood risk management strategies that help to set the framework for future planning and can have significant environmental implications. The SEA must be carried out during the preparation of the plan or programme and before its adoption or submission to a legislative procedure.

Box 1: When is an SEA mandatory?

The European Union Directive 2001/42/EC makes an SEA mandatory for plans and programmes that:-

- Are prepared for agriculture, forestry, fisheries, energy, industry, transport, waste management, water management, telecommunications, tourism, town and country planning or land use and which set the framework for future development consent for projects listed in Annexes I and II to Directive 85/337/EEC (the "Environmental Impact Assessment (EIA) Directive)"; or
- In view of the likely effect on sites, have been determined to require an assessment pursuant to Article 6 or 7 of Directive 92/43/EEC (the "Habitats Directive")

Environmental assessment is only required for:-

- Plans and programmes within the core scope set out in the paragraph above that determine the use of small areas at local level;
- Minor modifications to plans and programmes within this core scope;
- Any other plans and programmes outside this core scope that set the framework for future development consent of projects;
- Where they are likely to have significant environmental effects.

A screening process is needed to determine whether such plans or programmes are likely to have significant environmental effects and hence whether an SEA is required. Screening can be by means of case-by-case examination or by specifying types of plans and programmes, or by combining both these approaches. Annex II of the Directive lists criteria for determining the likely significance of the environmental effects of plans or programmes, and these must be taken into account when screening.

The Directive does not apply to:-

- Plans and programmes the sole purpose of which is to serve national defence or civil emergency;
- Financial or budget plans and programmes;
- Plans and programmes co-financed under the respective programming periods for Council Regulations EC 1260/1999 and EC 1257/1999 (programming periods end in 2006 or 2007)

3.1.7 Who is responsible for Sustainability Appraisal?

The production of a SA is the responsibility of those making the policy or plan or proposing the scheme or project. The responsibilities associated with flood and coastal risk management are split between Defra, who have policy responsibility in England and Wales and the operating authorities - the Environment Agency, local authorities and Inland Drainage Boards. These organisations are different from those with responsibility for development planning. Where strategies, plans, projects, etc. overlap, the responsibilities will stretch across both groups.

SA is the responsibility of those making the proposal.

Table 3-1 Sustainability Appraisals to accompany Flood and Coastal Risk Management

Sustainability Appraisal of:	Carried out by:
National policy and strategies	Government departments – principally Defra and the Welsh Assembly Government
Catchment scale strategies, i.e. large-scale planning for river catchments (CFMPs) and coastal sediment cells (SMPs)	Environment Agency in partnership with other Flood and Coastal Defence Authorities
Sub-catchment scale strategies, i.e. strategic planning flood and coastal risk management systems for river sub-catchments and coastal process units	Environment Agency in partnership with other Flood and Coastal Defence Authorities
Projects and schemes	Operating Authorities

Table 3-2 Sustainability Appraisals to accompany Development Planning

Sustainability Appraisal of:	Carried out by:
National policy and strategies	Government departments – principally ODPM and the National Assembly for Wales
Regional Spatial Strategies	Regional Assemblies and Regional Development Authorities
Local Development Frameworks	Local Planning Authorities and Unitary Authorities

3.1.8 Who should be consulted for Sustainability Appraisal?

Although the organisations listed above have responsibility for undertaking SA, the various components of SA are best handled in a partnership approach with appropriate stakeholder engagement.

SA is best undertaken as a partnership approach with appropriate stakeholder engagement.

"SA is most likely to be effective if undertaken by a group of people who can:

- Consider and respond to local circumstances
- Take a balanced and objective view
- Understand the issues
- Draw on good practice elsewhere
- Evaluate the full range of sustainability issues" (ODPM, 2004)

A major part of SA at any level is a scoping exercise to find the optimal way to meet simultaneously the requirements of existing legislation and policies and other existing appraisals (such as SEA and/or the related Environmental, Social and Health Impact Assessments).

The last five years have seen major developments in the mechanisms for regional integrated and environmental planning, in particular, Catchment Flood Management Planning and Shoreline Management Planning (through Defra and the Environment Agency, with local authorities as major consultees), and Strategic Environmental Assessment. In England, the Countryside Agency, English Heritage, English Nature and the Environment Agency (and in Wales the Countryside Council for Wales) have been designated the "authorities with environmental responsibility" in relation to the SEA Directive, and they must be consulted as part of any SEA process (see Box 2).

Box 2 The Environment Agency's Role in relation to the SEA Directive

Under the SEA regulations, it is the role of the Environment Agency in consultation with English Nature, the Countryside Agency, and English Heritage (and with Countryside Council for Wales), to screen for significant environmental effects on:

- Water quality and resources,
- Soil, waste and contaminated land
- Air quality and climatic factors
- Biodiversity (especially aquatic ecosystems)
- Material assets
- Cultural heritage and landscape (where they relate to aquatic environment).

The Agency Management System (AMS) guidance on SEA includes general principles that are resonant with this Topic Note:

1 Criteria in SEA screening overlap or interact (true also for SA): it is important to consider the relationships and any cumulative effects.
2 Wider consultation is often advisable to 'develop a more complete *and persuasive* view'.
3 There is a decision-making hierarchy and process, and issues should be appraised in terms of this. Attention needs to be paid to the strategic 'nesting' of issues.
4 Sustainability includes action in the context of uncertainty, so issues like the reversibility of effects and adaptability of actions need to be considered explicitly – risk screening (precautionary principle).

The meaningful engagement of a wider range of stakeholders, including the general public, is a fundamental and essential aspect of sustainable development, an objective of the planning mechanisms mentioned above, and a requirement under the terms of the Aarhus Convention and the Water Framework Directive, both of which have a strong bearing on flood and coastal risk management. Engagement contributes to risk management by enabling consensus building regarding the appropriate level of risk and management of

uncertainty, which is part of the precautionary approach, itself a component of sustainability. Further information on community engagement is provided in Topic Note 2.

Stakeholder engagement is a fundamental and essential aspect of sustainable development.

Box 3 Good Practice in Consultation

The Environment Agency and Government departments follow the Cabinet Office's current Guide to Good Practice in Consultation[14]. The guidance can be summarised in its six basic criteria:

1. Consult widely throughout the process, allowing a minimum of 12 weeks for written consultation at least once during the development of the policy.
2. Be clear about what your proposals are, who may be affected, what questions are being asked and the timescale for responses.
3. Ensure that your consultation is clear, concise and widely accessible.
4. Give feedback regarding the responses received and how the consultation process influenced the policy.
5. Monitor your department's effectiveness at consultation, including through the use of a designated consultation co-ordinator.
6. Ensure your consultation follows better regulation best practice, including carrying out a Regulatory Impact Assessment if appropriate.

Sustainability Appraisal engagement should at least comply with these criteria.

3.1.9 How do you undertake Sustainability Appraisal?

Within the UK, guidance on SA is currently being prepared and disseminated in the context of local and regional development planning. A Consultation Paper was issued in 2004 (ODPM, 2004), which has since been reviewed through its application to a number of pilot studies. Details of this review are provided in Box 6.

There are 5 stages of SA that can be applied in all contexts.

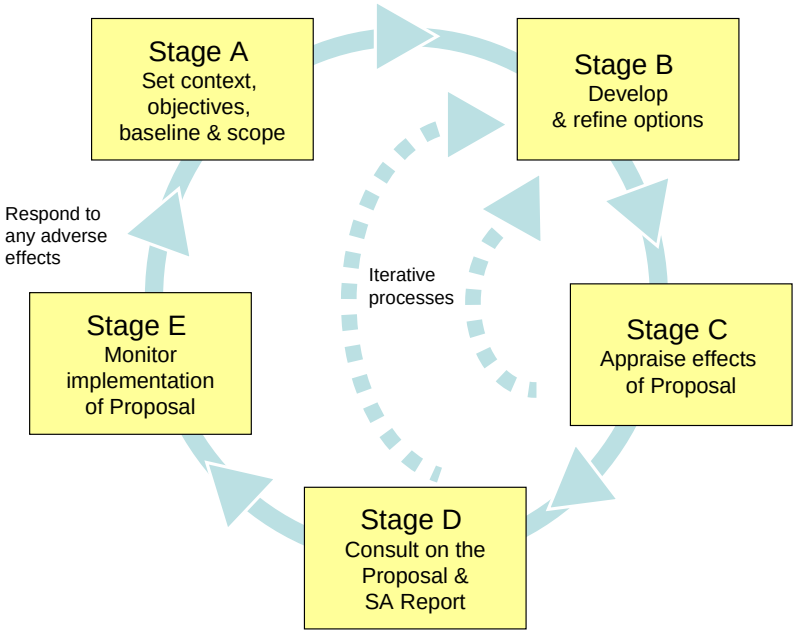
The following stages of SA (also illustrated in Figure 3-1) are defined within the Consultation Paper (ODPM, 2004).

Stage A: Setting the context and objectives, establishing the baseline and deciding on the scope
Stage B: Developing and refining options
Stage C: Appraising the effects of the plan
Stage D: Consulting on the plan and the SA report
Stage E: Monitoring implementation of the plan

[14] http://www.cabinetoffice.gov.uk/regulation/consultation/documents/pdf/code.pdf

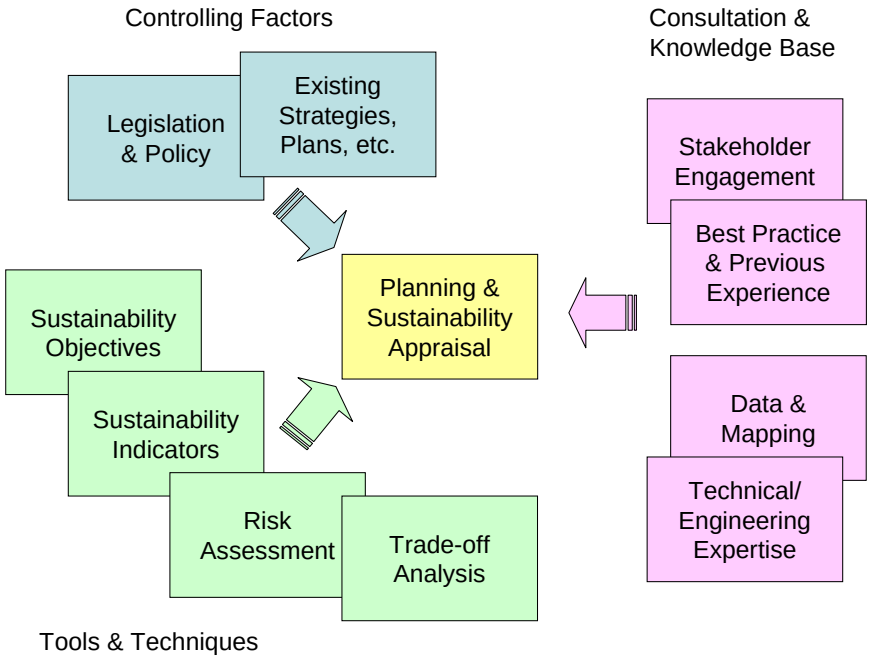
These stages can be applied equally in other contexts and mirror the planning process itself. Key components of the SA process are listed in Box 4. A checklist for SA is provided at the end of this Topic Note.

Figure 3-1 The five stages of Sustainability Appraisal



In order to undertake these stages, SA needs to consider controlling factors, as discussed earlier, and draw on a number of knowledge bases and tools and techniques, as illustrated in Figure 3-2.

Figure 3-2 Factors contributing or influencing planning and Sustainability Appraisal



Box 4 Key components of the SA process

- Involving the public and authorities with social, environmental and economic responsibilities early in the assessment process, in order that all parties have the opportunity to understand the issues, and to arrive at a balanced and objective view;
- Collecting baseline information that addresses the full range of sustainability issues;
- Identifying reasonable proposals and predicting their significant likely effects;
- Scoping good practice elsewhere, along with evolving guidance and regulatory constraints;
- Monitoring the actual effects of the proposal (whether policy, plan or scheme) during its implementation;
- Ensuring changing local circumstances are taken into consideration and, where necessary, responses are directed appropriately (as part of adaptive learning).

SA should reflect local and national issues

In flood and coastal risk management, the risks to a local community are in significant part associated with catchment scale actions (see the Source-Pathway-Receptor model, as described in Section 2). The UK's institutional environment for regional planning is very complex, and flood and coastal erosion

risk management sits rather uneasily across many sectors, with many scales of decision-making, and is governed by regulations and guidance with many different degrees of statutory weight. The crux for integrated SA is how to ensure that the aggregation of local or project-scale assessments results in a sustainable outcome, and then also contributes to stated national and supra-national sustainable development objectives.

Coordination of SA at different spatial scales and decision-making levels should be sought, where possible

Controlling factors (such as legislation, policies, existing strategies, etc.) may be relatively remote in terms of physical distance or decision-making hierarchy from the proposal being appraised. In such cases, it is important to be conscious of the need for 'tiering' between appraisals undertaken at different levels and at different spatial scales.

Managing these transitions demands:

- Common engagement of some key stakeholders at multiple levels from policy through to scheme – the Environment Agency is important in this role;
- A common set of guiding principles, probably agreed and refined iteratively as SA becomes a more established tool;
- Clarity at all levels with regard to the integration between appraisal and decision-making processes;
- Attention to the timing of engagement, because a rolling, multi-level approach will be more effective than many sequential, small-scale initiatives;
- Novel approaches to balancing conflicting stakeholder issues, in particular those that arise where national aims cause local tensions, and to managing stakeholder expectations. Communication, engagement and education guidance such as that developed for Local Agenda 21 and the multi-agency Quality of Life Capital[15] are valuable operational tools.

[15] http://www.countryside.gov.uk/LAR/Landscape/Quality/index.asp

Box 5 Selecting Indicators for SA

At a practical level, Sustainability Appraisal relies on quantifiable indicators that are conceptually easy to grasp, unambiguous to measure, and that robustly capture the underlying objectives of sustainable development (see the UK Government strategy document, *A Better Quality of Life* (1999) and the consultation draft, *Taking it On* (2004)). Suites of indicators have been developed for the macro scale, such as the UK Government's Quality of Life Counts[16] and Scotland's *Meeting the Needs* (Scottish Executive Environment Group, 2002) indicators at national level, and the UN's Millennium Development Goals[17] globally. These must be borne in mind, as they provide a generic framework for the specific context of flood and coastal risk management, from policy through to the scheme and at operations and management levels.

Partial appraisal tools (such as EIA and social impact assessment) and the matrices of indicators can be used as the 'building blocks' for SA. Local objectives and indicators should be developed in consultation with the local community and key stakeholders. National indicators were derived following a large-scale process of engagement and consultation. Achieving consensus on a set of indicators can be a time-consuming and often costly process, so drawing on good practice already established in the partial appraisals developed to date is cost-effective, and also builds on existing community goodwill.

Objectives and indicators should be revisited and, if necessary, redefined as baseline data are collated. During the process of appraisal, the indicators should direct the collection of baseline information, while the baseline information in turn should indicate which sustainability issues are areas of priority concern. There may be external objectives for consideration beyond the SA process, arising from multiple sources. Examples of these are targets for conservation and management of the environment, for example, or for social inclusion, as defined in Community Strategies, Local Agenda 21 action plans, and the sustainable development strategies mentioned above.

3.1.10 How is existing related guidance still applicable?

The existing Flood and Coastal Defence Project Appraisal Guidance (FCDPAG) forms the basis of current flood and coastal erosion risk management planning. Some guidance themes are of particular significance for Sustainability Appraisal:

Existing FCDPAG notes have direct relevance to SA.

- PAG2 *Strategic Planning & Appraisal* outlines the integration of flood and coastal erosion risk management strategy with other planning initiatives and strategies. The process of SA relies on scoping the different plans, and PAG2 recognises that there is generally a need to be adaptive, taking a case-by case approach to this scoping activity. It also discusses the time-

[16] http://www.sustainable-development.gov.uk/indicators/national/index.htm
[17] http://www.un.org/millenniumgoals/

frame for strategic thinking. Sustainability Appraisal may need to extend this, considering multiple time frames explicitly.

- PAG5 *Environmental Appraisal* contains the policy definition of 'Sustainable Flood and Coastal Defence Schemes', and recognises that the ongoing development of interconnected planning initiatives and a portfolio of environmental and social measures are all essential to long-term sustainability.

Existing guidance on EIA is still relevant in the context of SA.

There is extensive impact assessment experience at the project level for flood and coastal zone management, where for several years, procedures have been formalised for economic and environmental impact assessments (see Environmental Impact Assessment Regulations 1999 (No. 293) and 2000 (No. 2867); and the ODPM guidance[18] giving up-to-date sources of information about EIA).

A more pragmatic assessment has tended to be used for social impacts via local democracy channels (e.g., the Local Flood Defence Committees, Local Agenda 21). Tools linking economic, environmental and community assessment are emerging now, and range from simple matrices or lists of guidelines (e.g., Moray Sustainability Appraisal 2002 – see Box 7) through to more complex Integrated Catchment Zone Management (ICZM) participatory planning and analytical approaches, including multi-criteria analysis. Protocols for community consultation and engagement are very well established and have been robustly validated. Further information on community engagement is provided in Topic Note 2.

The ODPM's (2003) Practical guidance on applying the SEA Directive identifies the sorts of plans and programmes that the scoping phase of the SA should consider:

- Plans at various geographical levels
- Local authority plans from other sectors (e.g. Local Transport Plans, Community Strategies)
- Agency plans and programmes (e.g. Regional Development Agency strategies, Environment Agency River Basin Management Plans and Water Resources Plans)

The boundary constraints on SA can come from various sources. Because of the longer history of environmental impact assessment, objectives for the conservation and management of the environment tend to be the most systematically defined. Key sources are:

- Planning Policy Guidance (PPG) Notes and other Government policy initiatives;

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http://www.odpm.gov.uk/stellent/groups/odpm_control/documents/contentservertemplate/odpm_index.hcst?n=4132&l=2

- National and local strategies on air quality, energy, climate change, and so on;
- Biodiversity Action Plans, including species and habitat action plans;
- European Directives;
- International commitments, e.g. the Kyoto Protocol.

Further research is needed of sustainability objectives, indicators and metrics; communication and adaptive learning procedures; and examples of good practice.

3.1.11 Future Activities to support Sustainability Appraisal

There are two aspects of Sustainability Appraisal that need to be developed further:

- The development of objectives, indicators and metrics (see Box 5); and
- A traceable and iterative process of communication and adaptive learning.

This latter concept is already accepted at a policy level, although the means for recognising and facilitating it are still rather incipient (see the recently drafted Environment Agency Social Policy[19]).

In addition, a series of examples of good practice would prove beneficial for those undertaking development planning (see Box 6) and flood and coastal risk management planning (see Box 7).

Box 6 Pilot Studies for Regional and Local Development Planning

ODPM commissioned a review of a series of pilot studies to test the process of undertaking Sustainability Appraisal, as described in The Consultation Paper 'Sustainability Appraisal of Regional Spatial Strategies and Local Development Frameworks' (ODPM, 2004).

The primary objective of the research was to consider the overall Sustainability Appraisal methodology for Local Development Documents and revisions to Regional Spatial Strategies using evidence obtained from the pilot studies. The secondary objective was to provide examples of good practice in SA that could be referred to in the guidance and provided in full on the ODPM website.

The results of the study determined that none of the pilot sites had completed the SA process in full. Therefore, it was concluded that it would be inappropriate to include material from the pilots in the guidance itself. Instead, it would be more useful to include and build up a library of examples on a dedicated website. Further information can be found in the Sustainability Appraisal Pilot Studies: Executive Summary found at http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_039889.hcsp.

[19] http://www.environment-agency.gov.uk/science/922300/923624/927396/?version=1&lang=_e

Box 7 The Moray Flood Alleviation Scheme

The Moray Flood Alleviation Scheme[20] is one of the first applications of a SA for flood risk management. As an example of good guidance, the SA of his scheme is discussed in case study 2. In addition to the indicators developed in consultation for the 'three pillars' of sustainability, the guidelines include a section on project development (i.e. design and construction of sustainable solutions), consisting of four points:

- Take a long-term perspective to impacts, benefits and constraints *(Does the scheme represent a certain long-term solution?)*
- Apply the precautionary principle and analysis of risks *(Does the scheme create new problems or transfer existing ones?)*
- Take a holistic and integrated approach to scheme development *(What are the consequences of intervention in the built environment?)*
- Use best possible scientific information and anticipate need for dedicated collection *(Is Best Practice being applied?)*

For the Moray scheme sustainability indicators were compiled into a project guidance document that became central to the flood risk management scheme. The sustainability indicator set was compiled to ensure achievement on a large number of sustainability objectives, grouped into four categories.

- Project development – generic indicators that could apply to any project
- 'Environment'
- 'Economy'
- 'Community'

The last three groups were specific to the scheme and therefore it is the process, rather than the specific indicators, that provides a useful example for other projects.

The indicators were used as part of an assessment process to explore the opportunities that could be realised through the development of the flood alleviation scheme. The process brought together people from different disciplines which in itself helped to generate ideas towards sustainable development.

Sustainability Appraisal checklist (see also guidelines from EA):

1. Is there an assessment of the likely significant effects on the following:
    a. biodiversity,
    b. fauna and flora,
    c. soil,

[20] http://www.morayflooding.org/schemes/general/general.htm

d. water,
e. air,
f. climate factors,
g. population,
h. human health,
i. built assets, and
j. cultural heritage and landscape?

2. Is there an assessment of the likely significant effects on the wider sustainability issues of the following:
    a. employment,
    b. housing,
    c. transport,
    d. community cohesion, and
    e. education?
3. Is there an assessment of the likely duration of effects (whether short, medium or long-term), interactions and cumulative effects?
4. Does the appraisal scope and use existing accepted standards, regulations and thresholds?
5. Does the appraisal explore and evaluate mitigation measures for negative and positive impacts?
6. Is all reporting and documentation clear and accessible to all those who may wish to refer to it (including reference to rationale, methodology and information sources)?
7. Has the appraisal included stakeholder consultation and was this used to give early, effective and, where appropriate, ongoing opportunities for stakeholders to form and express their opinions, whether these stakeholders be:
    a. Relevant authorities
    b. Non-governmental organisations
    c. Community groups or members of the public?
8. Has the decision-making taken into account stakeholder inputs and have reasons been given for the outcome?
9. Have monitoring measures been identified and are these clear, practicable and linked to the indicators and objectives used in the appraisal?

3.1.12 Where to get more information

The following are key websites for up to date information on Sustainability Appraisal and related assessments and appraisals.

Cabinet Office
Code of Practice on Consultation:-
http://www.cabinetoffice.gov.uk/regulation/consultation/documents/pdf/code.pdf

Department of the Environment, Food and Rural Affairs (Defra)
Sustainable Development (general):-
http://www.sustainable-development.gov.uk/index.htm
Indicators of Sustainable Development:-
http://www.sustainable-development.gov.uk/indicators/national/index.htm
National Scale Assessments:-
http://www.defra.gov.uk/environ/fcd/policy/naarmaps.htm
Strategic Environmental Assessments:-
http://www.defra.gov.uk/environ/fcd/policy/sea.htm
Environmental Impact Assessments:-
http://www.defra.gov.uk/environ/fcd/consult/eiacons.htm
Flood and Coastal Defence Project Appraisal Guidance:-
http://www.defra.gov.uk/environ/fcd/pubs/pagn/default.htm
Water Framework Directive:-
http://www.defra.gov.uk/environment/water/wfd/?lang=_e

Environment Agency
Sustainability Appraisal and Integrated Appraisal:-
http://www.environment-agency.gov.uk/aboutus/512398/830672/831980/832188/?lang=_e
Strategic Environmental Assessments:-
http://www.environment-agency.gov.uk/aboutus/512398/830672/?version=1&lang=_e
Social Policy:-
http://www.environment-agency.gov.uk/science/922300/923624/927396/?version=1&lang=_e
Water Framework Directive:-
http://www.environment-agency.gov.uk/business/444217/444663/955573/?version=1&lang=_e

Strategic Environmental Assessment Information Service
http://www.sea-info.net/index.htm

The Countryside Agency
Quality of Life Assessment Toolkit:-
http://www.countryside.gov.uk/LAR/Landscape/Quality/toolkit.asp

The Office of the Deputy Prime Minister (ODPM)
Sustainability Appraisal and Strategic Environmental Assessment:-
http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/divisionhomepage/037789.hcsp

Sustainability Appraisal Pilot Studies:-
http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_039889.hcsp
Environmental Impact Assessment:-
http://www.odpm.gov.uk/stellent/groups/odpm_control/documents/contentservertemplate/odpm_index.hcst?n=4132&l=2
Sustainable Communities:-
http://www.odpm.gov.uk/stellent/groups/odpm_communities/documents/sectionhomepage/odpm_communities_page.hcsp

United Nations
Millenium Development Goals:-
http://www.un.org/millenniumgoals/

WFD United Kingdom Technical Advisory Group (UKTAG)
http://www.wfduk.org/

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Short, M., Jones, C., Carter, J., Baker, M. and Wood, C. (2004) Current practice in the strategic environmental assessment of development plans in England. *Regional Studies* **38** 177-190.

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3.2 Topic Note 2: Community Engagement and Sustainable Development

3.2.1 Introduction

The involvement of individuals in society's decision-making processes is one of the fundamental tenets and characteristics of democratic systems (Guimaraes, 2001; UNDP, 1996; European Commission, 2003). The sustainability agenda is strongly associated with the recognition that fair, open and transparent participation by people is needed in the decisions and processes that affect them.

Fair, open and transparent participation by people is needed in the decisions and processes that affect them.

The UK government's sustainable development ethos has been articulated at national policy level (Securing the Future, 2005) in which two of the five Guiding Principles (*"Ensuring a Strong, Healthy and Just Society", "Promoting Good Governance")* are formal recognition of the importance of community engagement issues, and it has also been defined at regional and local level where there is emphasis on participation across multiple sectors of action, and at all stages from policy definition right through to local-level practice.

Communities are more likely to accept difficult decisions when they understand the larger-scale issues.

The reasons why community engagement is an essential component of sustainability are many:

- ***Knowledge*** about local issues is needed for the aggregate or strategic perspective. Much of today's problem with *un*sustainability has arisen because the overall (incremental) or longer-term implications of local-level changes were not explicitly considered. Remote decision-making has a greater risk of being problematic in terms of sustainability.

- ***Pragmatism*** – difficult local decisions have been shown to be more palatable and manageable when the communities have a better understanding of the larger-scale issues that affect those decisions and feel that they have been involved in optimising the decisions (e.g., Tippett *et al..*, 2005; Ledoux *et al..*, 2004). It should be recognised that not everybody will be pleased all of the time and the management of the tensions is best served by helping communities to understand why and how as well as what decisions have been made.

- ***Fairness*** and equity – if decisions have impacts (either positive or negative), the nature and distribution of those impacts needs to be known. Recent research by the Environment Agency[21] indicates that the burden of negative

[21] http://www.environment-agency.gov.uk/news/641569. (EA staff only otherwise a report can be obtained from the Environment Agency R&D Dissemination Centre, email: publications@wrcplc.co.uk.

impacts is not yet shared fairly. At the very least, progress in this direction requires communication between the decision-makers and the people who will benefit or lose out as a result of the decision, but a deeper sustainability would require the distribution of impacts and perhaps the decision itself to be agreed by the communities.

Local knowledge is required as well as that of experts for decision-making where there is an uncertain future.

- ***The precautionary principle*** in the context of complex decision-making and an uncertain future requires multiple knowledge inputs, including lay or local knowledge as well as input from specialists, and also effective mechanisms for the output of useful knowledge to society.

The move towards increasingly participatory decision-making manifests itself very clearly in flood risk management, where land, water resources and community planning interface. The complex regulatory and planning landscape in which flood and coastal risk management decision-makers operate means that the requirement for community involvement in the process of flood and coastal risk management comes from many directions. Participatory engagement has, therefore, evolved simultaneously in different institutions, with different mechanisms and objectives. This complexity should by no means be assumed to be a problem. The challenge is to ensure that the layers of participation and engagement adequately and sufficiently capture the necessary inputs from key stakeholders and the wider public, and yet minimise redundancies and overlap.

The multiple processes of engagement in social and environmental decision-making that have emerged in the last decade or two mean that now there is a very substantial case resource from which good practice guidelines can be derived, underpinned by both firm theoretical and practical/experiential considerations of sustainability. This Topic Note summarises key points from that experience and literature.

3.2.2 Sustainability Principles of Flood Risk Management

This topic links most directly with the following principles of sustainable flood risk management:

Principle 1: Risk management – manage the risks to people and property, the environment and the economy.

The consequences of flooding or erosion events can only be assessed and determined by direct consideration of the people affected. Warning systems must be developed, explained and promoted, all of which require direct engagement with the people at risk. The information about the spatial patterns and the degree of flood or erosion risk needs to be both collected and disseminated by means of community engagement. Involvement at the appropriate scale and with the appropriate institutions or agents is a prerequisite for the risk management aims associated with development controls and land use planning.

Adaptation – take account of climate change and other long-term uncertainties in decision making.

The precautionary principle has been mentioned above. In addition to responsive scientific research and monitoring of the risk situation, the precautionary approach requires a broad input of different types of knowledge as a means of hedging against uncertainty.

Engagement – work with all those affected by flooding and erosion.

This note will describe how to support stakeholder engagement and promote community-level awareness through information and technical tools, in a range of consultative and partnership approaches.

Appraisal – adopt appraisal methods that are rigorous, coherent and transparent.

Alongside sustainability appraisal of actions (projects and programmes, see Topic Note 3), it is necessary to take account of societal objectives at the conceptual and policy level through deliberative and responsive engagement.

Knowledge – develop the knowledge, skills and awareness to promote sustainable solutions.

Awareness-raising is a community outreach activity by policy-makers and practitioners in flood risk management. It is as important to ensure the transfer of knowledge back from affected communities too; the development of good practice guidance and adaptive learning requires communication from an engaged community.

3.2.3 How does Community Engagement fit in with the new strategy for flood and coastal risk management?

Making Space for Water (Defra, 2004) explicitly recognises that the UK's future flood and coastal risk management relies on consistent and widespread social engagement alongside the planned technical and economic investment. This Topic Note describes good practice in this context.

Community engagement is an integral part of future flood risk management.

Community engagement will be an integral part of all five of the key themes explored in the *Making Space for Water* consultation:

1. Risk management will address **social values** beyond the conventionally determined economic values, requiring the progressive development of new valuation techniques which involve participatory initiatives, such as multi-criteria analysis (Defra, 2002).

2. Continuing to strengthen the sustainable approach to managing risks from flood and coastal erosion clearly demands community involvement from the most basic level. There is a need for **consensus** in obtaining the land area required for accommodation space for more nature-friendly and dynamic management approaches (such as coastal realignment and floodplain functional restoration).

3. The moves towards greater integration of landscape scale decision-making in development planning and flood and coastal risk management highlight the junctures of **democratic representation** and evolving governance structures.

4. In coastal zones, the governance and planning structures are potentially more complex than for inland waterways. Particularly on the east coast of England, sea-level rise is already evident as a significant driver of change, forcing a more radical assessment of coastline management (Milligan and O'Riordan, 2005). The established **partnership approach** between communities and decision-makers has been consolidated most effectively over the last decade since the first round of Shoreline Management Planning, but there is still a need for further development and consistency.

5. **Public awareness** is recognised as a crux issue. The Foresight project, *Future Flooding,* categorised different types of response to flood risk, and ranked them in terms of a suite of sustainability implications. Many of the responses that will be needed as part of a long-term strategy for sustainable flood and coastal risk management that is resilient in the face of possible future socio-economic and climate-change scenarios can only be successfully implemented with wide-spread awareness of the processes and risk factors affecting flooding and erosion, and with extensive public engagement in the prioritisation of decisions and adaptive behavioural or spatial/land use changes that ensue.

The guidance provided in this note outlines generic participatory approaches that can be used for community engagement in both the flood and coastal risk management planning stages and response stages.

3.2.4 Where does Community Engagement fit within the different scales of flood and coastal risk management?

Planning and management actions need to consider problems on a bigger scale and with a longer timeframe than achieved in the past.

Tensions between local and national strategic aims can be managed and reduced by effective and honest deliberation.

Flood and coastal risk management currently finds itself in a changing context; as a result of evolving legislation, planning and management actions need to consider the problems on a bigger scale and with a longer timeframe (see Topic Note 3 for the need to track and consider the regulatory context). In this context, all stakeholders including the general public have increased access to processes of strategic planning at the level of central government departments (examples include *Making Space for Water* and the current PPG25 consultation processes). This note does not directly address this scale of engagement, because cross-departmental guidance has already been adopted.

It is when a set of national strategic aims and policies has been agreed that participatory engagement is most needed, operating at the level of local communities, and for some purposes, at the level of individual members of communities. Although engagement happens at the local level, it must incorporate concerns at all levels from the global (e.g., sea-level rise) through to the national, regional and local. Tensions between local and national strategic aims can be managed and reduced by effective and honest deliberation.

Community engagement is a process not a one-off event.

Unlike some other aspects of flood risk management, the community engagement component must be conceived as a ***process*** rather than a one-off task or event. If this process perspective is missing, then whatever community discourse there is risks falling short of the sustainability principles.

3.2.5 Who is responsible for Community Engagement?

Engaging the wider public in environmental decision-making that affects them is:

- A fundamental and essential aspect of sustainable development,
- An objective of several planning mechanisms that affect flood and coastal risk management, and
- A requirement under the terms of the Aarhus Convention to which the UK is a signatory, ensuring rights to public participation and protection from environmental problems.

There are several mechanisms for regional integrated and environmental planning in England and Wales. Community engagement in environmental and social decision-making operates at different stages in these planning processes, with several different aims, ranging from simple information exchange through to power-sharing in the decision-making process.

For flood and coastal risk management specifically, community engagement is primarily the responsibility of:

- **The Environment Agency** - through many channels; most significantly here through its flood risk management remit; through the implementation of the Water Framework Directive with regard to catchment-scale planning; and through its ongoing social policy development framework (Warburton *et al.*., 2005).

- **Other public bodies**, in particular the Countryside Agency, English Heritage and English Nature - the "authorities with environmental responsibility". Each of these organisations recognises the need for the meaningful engagement of a wide range of stakeholders and has established procedures for doing so.

- **Local government** – both through democratically elected representatives and through direct public engagement under the terms of various pieces of local government legislation. Specific guidance on public participation is available for many local authority activities; most important in this context are development planning and social inclusion/community planning.

- **Partnerships** such as coastal forums and shoreline management planning groups typically comprise a combination of external experts, government or operating authority representatives, democratically appointed representatives and other local community and interest-group representatives. Whilst not all have legal obligations to engage the wider public or the power to shape outputs directly, virtually all are intended to be effective mechanisms for community engagement. The coastal partnerships have evolved both in terms of their make-up and their activities. Most large-scale flood alleviation schemes now operate with analogous partnership forums. These models of engagement are needed in the wider context of inland flood risk management and the more integrated management of the socio-environmental system.

- **Operating authorities** in flood and coastal risk management, who have increasingly well defined and articulated corporate social responsibility aims, which include community outreach and communication activities.

Other decision-making processes involving the local public have less direct impact on flood and coastal risk management, but sustainability appraisal should nevertheless ensure that these more extended networks are identified and consulted or informed as necessary in the process so that conflicts can be minimised.

Table 3-3 Community Engagement Responsibilities for Flood and Coastal Risk Management

Engagement regarding:	Carried out by:
National policy and strategies	Government departments – principally Defra and the Welsh Assembly Government
Catchment scale strategies, i.e. large-scale planning for river catchments (CFMPs) and coastal sediment cells (SMPs)	Environment Agency in partnership with other Flood and Coastal Defence Authorities, (in the case of coastal areas through coastal management partnerships)
Sub-catchment scale strategies, i.e. strategic planning flood and coastal risk management systems for river sub-catchments and coastal process units	Environment Agency in partnership with other Flood and Coastal Defence Authorities through local coastal and estuary management partnerships and flood forums
Projects and schemes	Operating Authorities

Community engagement should be initiated early on in the planning process and continue throughout, including the implementation and monitoring stages.

Table 3-4 Community Engagement Responsibilities for Development Planning

Engagement regarding:	Carried out by:
National policy and strategies	Government departments – principally ODPM and the National Assembly for Wales
Regional Spatial Strategies	Regional Assemblies and Regional Development Authorities
Local Development Frameworks	Local Planning Authorities and Unitary Authorities

3.2.6 When should Community Engagement be undertaken?

The timing and duration of the community engagement process is as important as its mechanisms and procedures. Communities become most involved in discursive planning processes most readily at times of crisis and change, and given tight resourcing, the conventional model of community engagement to date has taken the form of consultation when a management intervention is at a comparatively advanced stage of planning: people become involved as a reaction to what they may perceive as an interference in their community. The trend towards more continuous and proactive public engagement needs to be strengthened, and local inputs need to be reflected in the development of larger-scale strategic aims.

Experience shows that stronger, longer-term partnership engagements are effective in part because they bring expert knowledge to the affected public, allowing deeper understanding and contextualisation. This access to specialised knowledge and technical specialists does not instantaneously resolve uncertainty; people take time to learn about the multiple technical aspects and potential impacts of the management intervention actions. Involving the public must happen early in the planning process, to give them a real opportunity to understand the often complex issues and to arrive at a balanced and objective view.

3.2.7 How do you undertake Community Engagement?

Community engagement is best undertaken via a portfolio of actions that ensure:

Community engagement should involve a portfolio of actions.

1. There are effective channels both for continuous 'background' communication *and* for more 'in-depth' engagement (e.g., in response to high-risk or high-conflict situations);

2. The public can provide information to those undertaking the planning *and* vice versa.

Managing such a portfolio demands:

- **Tiering and nesting** of the communication efforts undertaken at different levels, from local to national (e.g., technical flood warning systems supported by ongoing national information campaigns and local level community evaluatory feed-back on experience of the systems);

- Attention to the **timing** of engagement, because a rolling, multi-level approach will be more effective than many sequential, small-scale initiatives;

- Internal **coherence** within key agencies, and progress towards explicit and transparent links between them.

- Attention to the **accessibility** of information for communities, as opposed government, public sector or technical specialists in flood and coastal risk management and development planning, including the use of plain English, the avoidance of jargon and the supply of background information regarding planning processes and responsibilities.

All community engagement should fulfil the same fundamental requirements.

Fundamental requirements for community engagement are that it should be:

- An **integral** part of any planned proposal, right from the earliest stages of planning through to implementation and monitoring;

- **Transparent** – all should know who is included, what specific issues are being addressed and the limits or scope of the process;

- **Traceable** (documented) process of communication;

- **Accountable** - show clear lines of accountability, and be consistent and coherent with democratic structures (note the ongoing review of PPG25 that recognises the importance of modern more fluid governing structures);

- **Responsive** - if an informed community agrees something that is aligned with strategic aims, it should be done; if there are tensions, then the strategic aims should be revisited in the light of community impacts, just as the community discourse should be informed more fully of the strategic needs and tensions.

Fore*sight*'s *Future Flooding* (2004) emphasised the fact that some effective and sustainable flood and coastal risk management actions have long lead-in times or rely
critically on messages about risk and behaviour being progressively reinforced in the public mind. Current styles of engagement tend to be reactive and project-oriented, leading to contact with stakeholders that is intermittent in space and time. There is, therefore, a need to develop a more robust process of constructive engagement. The portfolio approach outlined above shows how reactive, specific projects can be embedded in a broader context of ongoing discursive engagement.

Community engagement will facilitate progress in planning integration and congruence in the many planning timelines that are required in sustainable flood risk management.

The broader development planning process is still couched in traditional procedures, although societal governance is changing in a very wide range of social, environmental and economic planning contexts, as recognised in the new PPG25 consultation (ODPM, 2004a). Sustainable flood and coastal risk management requires development planning to become more accessible and coherent with the procedures of other planning and decision-making forums. Communication, engagement and education guidance such as that developed for Local Agenda 21and the multi-agency Quality of Life Capital[22] are valuable operational tools that can be extended to explicitly address flood-related issues. The Environment Agency's new Social Policy[23] and guidance for social appraisal outlines important criteria for the engagement process itself as well as the scope within which participatory decisions can be made. This guidance and the social appraisal framework developed by Warburton *et al.*. (2005) address the need for new tools for supporting effective stakeholder involvement, and bring social science insights into decision-making that takes into account environmental inequalities, social diversity and a more inclusive process.

[22] http://www.countryside.gov.uk/LAR/Landscape/Quality/index.asp
[23] http://www.environment-agency.gov.uk/science/922300/923624/927396/?version=1&lang=_e

3.2.8 Where can you find further guidance?

Substantial guidance regarding community engagement is available. The following are examples of existing guidance. Examples of community engagement are given in Box 2.

For application at all levels of planning:

- Cabinet Office Guide to Good Practice in Consultation (see Box 1)
- National standards for community engagement in Scotland[24]

Primarily relevant at the regional or catchment-scale level of planning:

- EA Consultation and Stakeholder Awareness toolkit
- Building Trust with Communities programme
- Defra Strategy for Sustainable Development Education
- ODPM's Local Strategic Partnership Evaluations - Community Engagement (Richings *et al..,* 2004)
- Audit Commission Effective Partnership working (Audit Commission, 2002)

More relevant at the local scale of planning:

- Community involvement in town and country planning: National Planning Forum good practice note (National Planning Forum, 2005)
- PPG25 paragraphs 63 to 67 (DTLR, 2001)
- Stakeholder dialogue – A good practice guide for users (Pound, 2004)

Box 1 Good Practice in Consultation

The Environment Agency and Government departments follow the Cabinet Office's current Guide to Good Practice in Consultation[25]. The guidance can be summarised in its six basic criteria:

1. Consult widely throughout the process, allowing a minimum of 12 weeks for written consultation at least once during the development of the policy.
2. Be clear about what your proposals are, who may be affected, what questions are being asked and the timescale for responses.
3. Ensure that your consultation is clear, concise and widely accessible.
4. Give feedback regarding the responses received and how the consultation process influenced the policy.
5. Monitor your department's effectiveness at consultation, including through the use of a designated consultation co-ordinator.
6. Ensure your consultation follows better regulation best practice, including carrying out a Regulatory Impact Assessment if appropriate.

[24] http://www.communitiesscotland.gov.uk/stellent/groups/public/documents/webpages/scrcs_006693.hcsp

[25] http://www.cabinetoffice.gov.uk/regulation/consultation/documents/pdf/code.pdf

Box 2 Examples of Community Engagement

The *Broadland Flood Alleviation Project*[26] has been an innovative public/private partnership at a multi-scheme (sub-catchment) scale, with closer working between consultant, contractor, the EA and the public than in most flood and coastal risk management projects to date. It has been the object of ongoing social and policy research (Tyndall Centre and CSERGE), and its consultation and engagement process has been documented and evaluated.

Defra's *Managed Realignment Review* (Halcrow *et al.*., 2002) outlines experiences and stakeholder evaluations of participation in managed realignment decision-making and implementation. The Paull/Thorngumbald site in the Humber and the saltmarsh recreation at Brancaster summarise the lessons that key stakeholders identified for the very local scale.

Stakeholder Dialogue – a good practice guide for users (Pound, 2004) includes a case study *Making the most of the Islands*, which outlines the experiences of planning for an Area of Outstanding Natural Beauty (AONB) in the Scilly Isles. While flood risk management was not the primary focus of this case study, its insights into longer-term planning, cross-agency input, societal prioritisation of concerns and aims, and responsive decision-making make this an excellent summary and starting point for community discourse at the local and regional level.

Living with a changing coast[27], the Tyndall Centre's project exploring changing governance for more effective and sustainable coastal management, has involved very extensive public engagement, with Defra support. Its discourse addresses national policy and strategic planning (what might need to be changed), and explores how local concerns can be meshed within this larger framework.

Box 3 The benefits of stakeholder engagement as part of the Humber SMP

The Humber Estuary SMP is described as case study in TR2 is a good example of sustainable flood risk management because a number of barriers preventing managed realignment in the Humber estuary were overcome through the process of early and sustained consultation, particularly with respect to financial compensation, and technical studies, to provide an understanding of the processes and effects of options (short and long-term).

Managed realignment in the Humber reduced flood risk and provided biodiversity and amenity benefits

[26] http://www.bfap.org/

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Sustainable flood risk management should promote the adoption of multi-functional options

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3.3 Topic Note 3: Appraisal of solutions & schemes with multiple objectives

This note provides guidance on the appraisal of strategies and schemes with multiple objectives. It cross-references recent research and examples of Multi-Criteria Analysis (MCA) and suggests other activities to promote the adoption of multi-functional options. To this end the guidance covers a wide range of topics including the need for greater stakeholder engagement, negotiation, possible changes to funding, accountability and equity. It argues for clear transparent procedures rather than prescriptive rules for scheme appraisal.

3.3.1 The issue

The adoption of sustainable flood and coastal erosion risk management should be expected to promote the adoption of multi-functional options. For example, artificial wash lands can provide flood storage while also accommodating wetlands that deliver ecological benefits and reduce pollutants, while buffer strips on agricultural land reduce not only the quantity of surface runoff but also the concentration of pollutants in that runoff. In so far as there are economies of scope, it will be more efficient to adopt such options than to seek a separate option to deal with each problem.

In “Directing the Flow”, Defra (2003) emphasised the importance both of integrating flood risk management with other aspects of integrated catchment management and also of considering those wider benefits when appraising a flood risk management schemes. The Environment Agency now has explicit targets for creating priority habitats as part of more sustainable flood risk management and the Government’s Environmental Stewardship Scheme includes flood risk management as a secondary objective (Topic Note 6). However, different bodies/departments may be responsible for, and/or a different funding stream tied to, each of the different functions.

The question is whether there are barriers to the adoption of such multi-functional or multi-objective options. Appraisal, funding and implementation are linked so that another option may be adopted rather the multi-functional, multi-objective option because:

- The appraisal is too narrow since only some of the objectives are included in the appraisal.
- The multi-functional option is rejected in the appraisal, or later, because it is too difficult or takes too long to implement.
- The multi-functional option is rejected in the appraisal, or later, because there is a gap in the powers to act or fund some aspect of that multi-functional option.

As catchment or coastal zone perspectives are increasingly taken as the framework in which to consider flood and coastal defence issues (Technical Support Unit 2004), there should be expected to be increased use of multi-functional options.

3.3.2 Appraisal

Defra (2002) re-emphasised that it will seek to ensure that 'the selection and appraisal of options for flood management schemes allow sufficiently for multiple benefits, including those for water resources, water quality, sewer systems, environmental protection and enhancement..'. FCD PAG3 (S2.7) asserts that all benefits and costs should be included.

Selection and appraisal of options should allow…for multiple benefits, including those for water resources, water quality, sewer systems, environmental protection and enhancement. (Defra, 2002)

The issue is whether all the relative advantages and disadvantages of the different options can be included within a particular appraisal framework. In particular, one important category of objectives is that referring to the relations between people: justice, democracy, freedom and equity are all examples of objectives which refer to the relations between people. These also generally carry moral and ethical connotations so there are claims as to what these relations ought to be. These objectives refer not only to the nature of outcomes of decisions but also to the process through which those decisions are made. The requirement that decisions are made on the basis of openness, participation and accountability (CEC 2001) is a reference to the process through which decisions are to be made.

These objectives referring to the relationships between people cannot be included in a benefit-cost analysis which considers only the total quantity of individual consumption relative to the resources required to provide that consumption. Deliberative Multi-Criteria Analysis (Green 2003) offers a way in which other objectives can be included, and the relative importance that should be given to the achievement of different, including relational, objectives can be debated, argued and negotiated by the stakeholders.

However, satisfying those relational objectives often has resource implications and there is no simple technical way in which the advantages of achieving such an objective can be compared to the resource costs. This has to be decided upon a case to case basis. Here, the stakeholders include people in other parts of the country. For example, the additional cost of a fairer flood defence scheme in, say, Sussex over the cheapest option may mean that there are now insufficient resources to undertake a scheme in, say, Yorkshire.

It is necessary to build strong partnerships with the other stakeholders

Ecological objectives will also need to be considered. In some case statutory protection means that ecological objectives must be fulfilled. In other cases, the ecology must take its place in the balance with other objectives

3.3.3 Implementation

With multi-functional options, the necessary powers and the funding streams are likely to reside with a number of different organisations. Hence, it is necessary to build and maintain strong and long lasting partnerships with the other stakeholders including local authorities, government agencies and NGOs: co-operation and co-ordination are easier when they are done on a continuing basis. Building up these relationships over the catchment or coastal zone is desirable and a strategic approach is more likely to identify a range of situations where each of the different stakeholders can gain through co-operation and co-ordination. Conversely, in a single decision, there will often be losers as well as winners; this makes reaching an agreement less likely.

3.3.4 Funding

The purposes for which public bodies can spend money are defined in the relevant Acts. For a public body to spend money for other purposes, it would be acting *ultra vives*, illegally. The tighter these purposes are defined, the greater the accountability of that body. But, the tighter these purposes are defined, the less scope there is for innovation and adaptability. Consequently, a multi-functional option will typically require funding from different organisations. A pilot project is currently being undertaken on the Laver and Skell catchment (Defra 2004) to explore how to bring together funding streams from different sources in order to fund multi-functional projects. It is not currently proposed to change the current organisation of funding. However, there may be options, or necessary elements of multi-functional options which cannot currently be funded. It is difficult, for example, to see where funding for managed realignment along rivers in urban areas can be obtained if 'planning blight' is not to be caused.

FCD PAG3 (S2.7) then offers some principles as to how the costs should be shared between the different parties.

3.3.5 Evaluation and learning

The subject of performance evaluation is discussed in Topic Note 4 and applied particularly to defence assets. Here, it is worth noting that the validity of appraisal processes can only be checked with hindsight. As was stated in MAFF (1999):

> "… the only way of measuring the effectiveness of decision making is by monitoring and evaluating outcomes (in the context of the driving forces that precipitate these outcomes) and assessing the performance of policies, plans and schemes against their original aims and objectives."

Indeed, it is very appropriate that those risk management activities in which the government has invested significant sums of public money should be subject to particular monitoring and evaluation scrutiny. This scrutiny will help to demonstrate that each investment is achieving value for money (e.g. Best Value) and to ensure that lessons learnt are captured and effectively disseminated. The lessons learned can then (a) inform the future management of the scheme and (b) inform practitioners involved in the design or implementation of similar schemes in future.

3.3.6 Link with sustainability principles

This topic clearly links with a number of sustainability principles. The most relevant, “Integration” and “Appraisal” are summarised below:-

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

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

3.3.7 Level or location in framework

Multi-functional options emerge as a result of taking a wider perspective than simply seeking to address a local flood or erosion problem. It follows from taking a systems perspective of the catchment or coastal zone as appropriate, and also from understanding of the wider concerns of the other stakeholders be these economic and social regeneration, or Biodiversity Action Plans. As the River Basin Management Plans are developed, there can be expected to be increased attention being focused upon the identification of multi-functional options.

This government and the EU place great emphasis upon stakeholder engagement in public decision making as one aspect of better governance (UNDP 1996;.CEC 2003). Those stakeholders include both those who have the responsibility of taking action that will affect the risks of flooding and coastal erosion, and those who are affected by any action or inaction. Multi-functional solutions will involve a larger number of stakeholders than will single purpose solutions and also naturally emerge from taking a systems view of the catchment or coastal zone.

Stakeholders with responsibility for managing flood and coastal erosion risks include::

- The Regional Assemblies in preparing the Regional Spatial Strategies – these are likely to be crucial to delivering sustainable water management as a whole (RTPI 2004).
- Local authorities in preparing the Local Development Frameworks.
- The Environment Agency in preparing the River Basin Management Plans, Catchment Flood Management Plans, Shoreline Management Plans.
- The Environment Agency, Local Authorities and Internal Drainage Boards who undertake flood defence works.
- Coastal defence authorities.
- Consultants acting for these organisations.

Those affected by flooding or coastal erosion include:

- Those who live or work on flood plains and on the coast.
- The Wastewater companies and Highway Authorities.
- The general taxpayer who pays for flood and coastal defence schemes..
- The Statutory consultees
- A great variety of NGOs and interest groups.

Delivering multi-functional options may also require the involvement of other stakeholders.

3.3.8 Activities to support sustainable flood management

3.3.8.1 Stakeholder engagement

There are two groups of overlapping stakeholders:

- Those who have the powers or funds to implement works; and
- Those who are affected by either flooding or erosion, or by the possible works.

Delivering multi-functional options requires the development of effective means of building partnerships with the first group of stakeholders; establishing legitimacy requires working with the second group as well to decide what the option adopted should be.

3.3.8.2 Appraisal

The objective of appraisal is to help us to make ‘better’ choices where ‘better’ involves both outcome and process. It is a learning process so that design is appraisal led and one increasingly in which the stakeholders are centrally engaged. Appraisal techniques are intended to help in this learning process by enabling understanding of what the choice involves and aiding in the invention or discovery of new options. Appraisal tools have a crucial role to play in this process and there are a number of different support requirements. Tools based upon Checkland’s soft system methodology (Checkland and Scholes 1990) may be able to contribute to sharing the understandings of the different stakeholders; and Deliberative Multi-Criteria Analysis (Green 2003) to the understanding of what the choice involves; and conflict resolution techniques (Handmer et al. 1991) to the select of the option to be adopted.

Box 1 Appraisal using Multi-Criteria Analysis

Case study 3 examines to what degree the recently developed MCA-based approach has the potential for delivering more sustainable outcomes to decision making.

The case study shows that the greatest strengths of the MCA technique is seen in providing:

- The ability to consider impacts and benefits over a broader scale than those reflected in monetary terms.
- An analytical tool for assessing the sensitivities of a system to differing options, which could be tuned, through the selection of categories, the scoring system and subsequent weighting, to promote decisions towards agreed sustainability targets.
- An analytical tool for reassessing the inherent conflicts produced through the selection of options and allowing development of subsequent, more sympathetic options within the appraisal process.
- MCA presents a strong potential for assessing and delivering sustainable solutions. The approach taken by Defra/Environment Agency research project FD2013 has taken significant strides in achieving this.

3.3.8.3 Integrated decision making

Delivering 'joined up government' means working across institutional boundaries and fashioning ways in which each institution can see the interests of the other stakeholders. By definition, an institution operates under formal or informally prescribed rules. Those rules may define its objectives, procedures or actions. Defining those actions it must, may or must not undertake provides the greatest degree of transparency but is least inductive to adaptation and learning. A shift to stakeholder involvement in procedures for taking decisions may increase adaptability and maintain accountability.

Implementation involves either one institution undertaking the action or seeking to influence another institution or the public to take specific action or to avoid taking some action. A useful first step would be to draw up an 'institutional map' showing which stakeholder has what powers and funding to undertake each activity and the chains of responsibility. In particular, this may identify areas where currently no institution has the necessary powers or funding. Where implementation involves seeking to change the behaviour of others, then a review of the comparative effectiveness of different means of inducing those changes will be helpful. Those inducements include regulations, funding or charging, voluntary agreements and social pressure.

3.3.8.4 Funding

Funding is a primary means of accountability and the purposes for which monies may be used tends to be tightly defined for that reason. There is a danger that this can restrict innovation and adaptation and also that the allocation of funding between functional areas may not meet local needs. For example, it might be

that introducing source control in one area might be a highly effective means of flood risk management but that the sums available for such works were very limited whereas as the monies available to carry out other forms of works were ample.

3.3.9 Directions

Government guidance	• FCDPAG series http://www.defra.gov.uk/environ/fcd/pubs/pagn/default.htm • Action for Sustainability 2003 Implementing Action for Sustainability: An Integrated Appraisal Toolkit for the North West (http://www.nwra.gov.uk) • SDIG (Sustainable Development in Government) 2003 Integrated Policy Appraisal Pilot Assessment (www.sustainable-development.gov.uk) • Consultation of Government flood risk management strategy http://www.defra.gov.uk/environ/fcd/policy/strategy.htm
Tools	• Defra, Environment Agency MCA research project (FD2014 'Evaluating a Multi Criteria Analysis Methodology for Application to Flood Management and Coastal Defence Appraisals'.)
Indicators	Will be numbered according to draft indicator worksheet. 1.
Case study	• Case Study 3
Ongoing research & initiatives	• FRMRC http://www.floodrisk.org.uk • Defra and Environment Agency joint programme http://www.defra.gov.uk/environ/fcd/research/default.htm
Further information	• GWP (Global Water Partnership Technical Advisory Committee) 2000 Integrated Water Resources Management, TAC Background Paper 4, Stockholm: Global Water Partnership • Green C H 2003 Handbook of Water Economics, Chichester: John Wiley

3.3.10 References

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Technical Support Unit 2004 Integrated Flood Management: Concept Paper, Geneva: World Meteorological Organisation

UNDP (United Nations Development Programme) 1997 Governance for Sustainable Development (http://magnet.undp.org/policy/default.htm)

3.4 Topic Note 4: Helping those disadvantaged by flood and coastal erosion risk management policies and strategies

3.4.1 Introduction

The arguments against adopting a general principle of compensation for flood and coastal erosion losses are strong (in the context of keeping government powers to provide flood and coastal erosion permissive and not obligatory). Many of the arguments were articulated in the *Making Space for Water* consultation documentation and include:

The arguments against adopting a general principle of compensation are strong

- Providing a strong incentive to rational behaviour and avoiding rewarding those who have made unwise decisions about where they live.
- Avoiding fostering undesirable property construction or encouraging speculation in property and property prices.
- The broader danger of fostering expectations of publicly funded compensation for other types of hazard
- Avoidance of distortion of the insurance markets for flood risk
- Compensation may well run counter to the desire to maximise risk reduction through prioritisation based on economic criteria (specifically benefit to cost ratio)

Furthermore, there is a responsibility on operating authorities to educate the public about these arguments and the general presumption against compensating individuals at the expense of others. However, a successful education programme on these matters would not address the underlying issues of social equity and the need to encourage sustainable communities.

This Topic Note describes the options and possible avenues of funding for assisting those that are currently disadvantaged under the present arrangements for flood and coastal erosion risk management. These include:

- Those individuals who are owners of land or properties that are lost to coastal erosion when there is no economic justification for providing coastal defence, maintaining existing defences, or for purchasing the land or properties to improve flood or coastal defence or as required under the Habitats regulations.
- Even the threat of withdrawing protection can be significant. When SMPs propose a change in coastal management policy from “hold the line” to “managed realignment” and/or “do nothing”, there is evidence (from the reaction to SMP2 3B) that the immediate effect of the Plan is to blight the affected coastal areas. Within the zones identified as being under some threat during the lifetime of the plan, there are fears that property values are being depressed leading to financial loss by owners. Consultees quote specific instances when property sales have fallen through and that some postal areas are having difficulties in arranging insurance and mortgages for their properties.

- Those whose property is subject to a high probability of flooding in an area where there is no economic justification for provision of permanent or demountable defences.

Compensation is a local issue, but it has significant implications for the effectiveness of the implementation regional plans and policies and for national expenditure on flood and coastal risk management. For this reason, it may well be best to develop plans and strategies for helping the disadvantaged at the regional level as part of Shoreline Management Planning.

3.4.2 Making space for water

National policy in flood and coastal risk management is moving towards one that accepts flooding and coastal erosion in lower risk areas, particularly where this allows the river system or coastline to revert to a more natural alignment. How then is it possible to deal equitably with those that are the "losers" from this process? The problem is particularly acute in locations where the withdrawal of investment on defence will lead to a rapid rate of erosion and hence the need to absorb significant losses within one generation.

Under the broad banner of sustainability this approach must be followed if cost-effectiveness and environmental sensitivity is to be achieved. The challenge is to bring the social dimension of this approach in line with the other two, given that powers for operating authorities to carry out protection or defence works are (and should remain) permissive not mandatory.

Existing guidance from Defra on the subject offers little hope to those directly affected. Some recent guidance includes "Managed realignment: land purchase, compensation and payment for alternative land use." Defra Flood Management Division, November 2003. See http://www.defra.gov.uk/environ/fcd/policy/mrcomp/mrcomp.htm.

This document sets down a clear policy for Defra, but only considers approaches for the following situations:

i. Retreat to high ground (for example occasioned by the need to "walk away" from existing defences as part of a long-term exit strategy)
ii. Realignment of defence to reduce length to be maintained
iii. Realignment (of coastal, estuary or river defences) to improve performance
iv. Set back in mitigation for encroachment by flood or coastal defence work elsewhere

Further guidance on exit strategies for existing defences is given in "Maintenance of uneconomic flood defences: a way forward." Defra Flood Management Division, November 2003. See http://www.defra.gov.uk/environ/fcd/policy/unecseadef.htm

Defra recognise that the current position is unpopular but that significant challenges need to be overcome if progress is to be made. For further details refer to the Defra document issued as part of the "Making Space for Water" consultation, entitled "Payment of compensation, relocation and other issues in

relation to flood and coastal erosion risk management." Defra Flood Management Division, July 2004. See http://www.defra.gov.uk/environ/fcd/policy/strategy.htm)

It is important to recognise that, in addition to **Defra**, which has the responsibility for policy for flood and coastal erosion risk management, the following are key organisational players in dealing with the disadvantaged:

- The **Office of the Deputy Prime Minister (ODPM)**, which has responsibility for planning policy guidance
- The **Environment Agency and Maritime Local Authorities**, which have responsibility for the delivery of flood and coastal erosion risk management schemes and solutions, with (for example) permissive powers under the Water/Environment Acts and the 1949 Coast Protection Act respectively
- **Local Planning Authorities**, which have responsibility for implementing planning policy guidance
- **Natural England**, which (from 2006) will have responsibility for conservation, recreation, landscape and access

3.4.3 Sustainability principles

A number of the previously articulated sustainability principles and objectives are particularly important and challenging when considering the issue of assisting the disadvantaged whilst managing flood and coastal risks in a way that is consistent with natural processes. The principles of adaptation, integration, appraisal and environment (see boxes below) are those that have a bearing on this issue, but within these there are particular objectives that are especially important.

On the one hand, within the environment principle, the objectives of:
- **Preventing inappropriate development in the floodplain**, and
- **Promoting managed realignment in coastal and fluvial systems**

can be highlighted as being important to maintain.

On the other hand there are equally important objectives associated with reducing the degree to which individuals or communities are disadvantaged:
- **Ensuring a fair balance between reducing risks for present and future generations** poses a particular challenge when individuals and communities within the present generation are seen to be disadvantaged to serve longer term aims such as achieving a more sustainable coastline
- **Taking account of all-important societal objectives including social/community well-being and equity** is both difficult to articulate and achieve. As Professor Sugden (2005) has noted, community well-being is difficult to assess within the present benefit cost framework. Equity can be assessed by looking at the breakdown of costs and benefits for particular groups, but this approach on its own is only informative and unlikely to affect overall economic decisions. Perhaps the best that can be done is to use appropriate disaggregation of the impacts of flooding to help to identify 'winners' and 'losers' more clearly.
- **Carrying out appraisal by a process that is fair and promotes stakeholder engagement**. Stakeholders will only find engaging in the

appraisal process worthwhile, if a degree of fairness exists and particular groups of people are not severely disadvantaged.

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

Objectives:

- Promotion of resilient and adaptive flood defence systems
- 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).

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
- To promote the inclusion of water and coastal management into land use planning
- To take account of wider social policies, including biodiversity and economic regeneration, in planning for flood and coastal defence
- To build strong partnerships with other stakeholders in catchment and coastal zone management
- To seek to adopt multi-functional options where possible

Appraisal. Adopt appraisal methods that are rigorous, coherent and open and consider long term social, environmental and economic costs and benefits.

Objectives:

- **To take account of all-important societal objectives including social/community well-being and 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?

Environment. Protect and enhance the natural environment

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**

3.4.4 Approaches to assist the disadvantaged required or allowable under present legislation and policy

This section deals with

- The implications of the Human Rights Act
- Assistance available in situations subject to flooding.
- Assistance available in situations subject to coastal erosion, including compulsory purchase. In what circumstances can authorities exercise their powers to compulsorily purchase properties on the coast to assist those that would otherwise be disadvantaged.

a. Implications of the Human Rights Act

The Human Rights Act has a significant potential impact on environmental law which to date has been largely untested, and for which little case law has been established. The Act incorporates broad descriptions of rights from the European Convention on Human Rights, including:

- the right to peaceful enjoyment of possessions and protection of property (Article 1); and
- the rights to respect for private and family life, home and correspondence (Article 8).

Consequences of this legislation are that the following may be challenged:
1. the deliberate flooding of land, and
2. refusal to give consent to private landowners to maintain their own defences against flooding or erosion (even where this refusal may be consistent with a reasonable local policy.)

It may also be that decisions not to maintain existing defences to a sufficient standard leading to flooding and damage to property could also be challenged. However, the government currently believes that challenges could not be sustained so long as such decisions are based on a reasonable balance between public interests and private rights and have been given with reasonable notice.

Where it is desired to have the power to deliberately flood land or to prohibit defences, contractual agreements with individual property owners have proved to be one way forward, although back-up of compulsory powers will be required where consent cannot be obtained. Contractual agreements might therefore include:

- rights-to-flood in certain circumstances
- compensation to some landowners for not carrying out, or maintaining, private defences of coastal properties

Action is required to develop national policy guidance on the principles associated with right to flood agreements and prohibition of defence agreements. This will then need to be supported by guidance at local or regional level, linking in with the relevant Regional Spatial Strategy (RSS) or Local Development Framework (LDF.) For example, in the case of private (coastal) landowners, there should be a presumption against landowners initiating new defences on eroding coasts where the policy set by the Shoreline Management Plan is to do nothing and allow natural retreat.

b. Assistance that can be given at present to those disadvantaged by approaches to flood defence

Legal and financial mechanisms are available to deal with flooding issues in a way that seems to be broadly acceptable. In particular:

- Insurance is still generally available for flooding losses in low risk areas, whereas it is generally not available at all for properties at risk of significant flooding or for the more permanent losses associated with coastal erosion. Threats to withdraw insurance for flooding by the Association of British Insurers now only apply to areas where such flooding is more frequent than 1 in 75 years and property owners can make reasonable decisions in these cases based on Environment Agency information. Individual properties can benefit from demountable defences of individual protection.

- Where it is desired to improve the storage or flow capacity of river corridors, especially in rural areas,
  - Precedents exist for funding land owners via right-to-flood agreements and
  - For farmers engaged in Environmental Stewardship schemes (previously called agri-environment schemes) with Defra's Rural Development Service (RDS), Higher Level Stewardship schemes are available with secondary objectives of flood protection

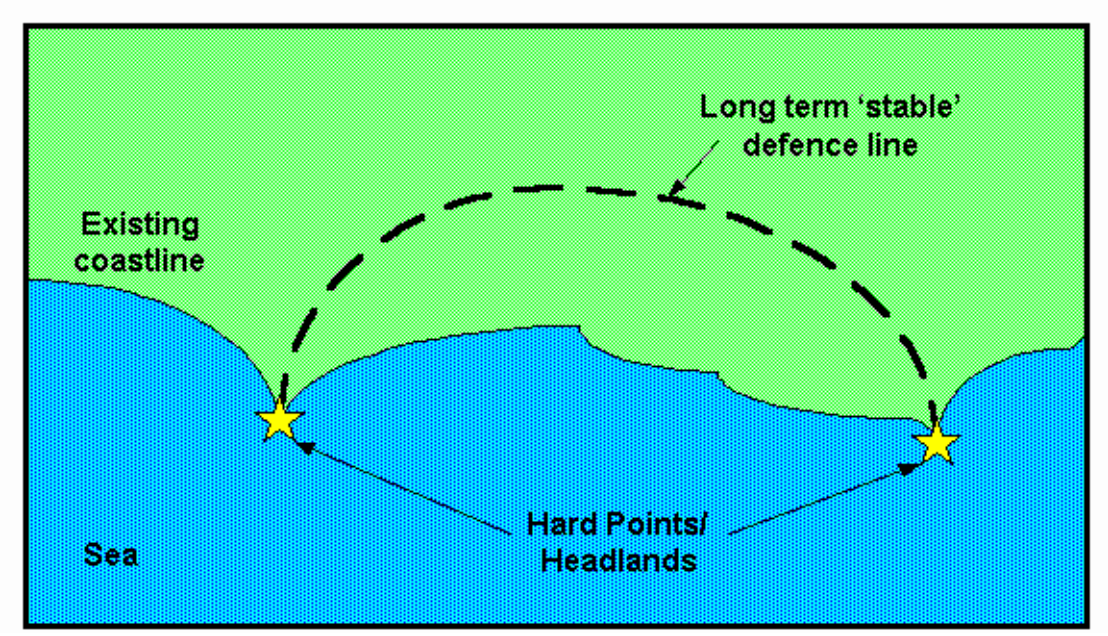
c. Assistance that can be given to those disadvantaged by managed realignment

The particular issues that need to be taken into account in a sympathetic way for coastal communities include:

- The socio-economic importance of coastal communities and their blight when houses start to be gradually lost to the sea
- Distributional inequity when a few individuals lose their homes and all their security whilst others elsewhere are protected.
- Where an actual or desired change in policy (e.g. introduction of a managed realignment policy in a SMP) brings about a material change in circumstances for individuals. Previously, with defences provided, the whole of community would have been protected, but once the community is unprotected, there is total loss of groups of individual properties as the erosion proceeds.

Under a policy of coastal realignment for sustainability (see Figure below) developed as part of the Shoreline Management Plan, particular areas could be allowed to erode to provide material to beneficially nourish adjoining parts of the coast.

Figure 3-3 Coastal realignment for sustainability
*(*from Defra document on land purchase and compensation for managed realignment]



Under Section 14 of the 1949 Coast Protection Act, the Coast Protection Authority has the power to compulsorily purchase land required for the carrying out of coast protection work or to be protected by coast protection work.

In the context of a shoreline management plan, it might be argued that purchase of land currently in private ownership might fulfil the requirement to offer the improvement of flood or coastal defences by providing a sediment source to feed down-drift coasts requiring sediment feed.

The section 14 CPO power is related back to the section 4(3) power to acquire land by agreement which is:

(a) Required by them for the purpose of carrying out thereon any CP work which they have power to carry out under Part I of the Act. (Under section 4(1) they have power to "carry out such coast protection work … as may appear … to be necessary or expedient for the protection of any land in their area")

(b) For the protection of which they propose to carry out such CP work. This power under (b) is qualified by a proviso under section 14(1) that it must appear that the value of the land will be greater after completion of the work.

By section 49(1) "coast protection work" means "any work of construction, alteration, improvement, repair, maintenance, demolition or removal for the purpose of protection of any land …"

There is no reason in principle why the power to acquire land under section 4(3)(a) could not include acquiring land, removing the defences and allowing that land to erode in order to protect land further down the coast. The coast protection

authority would be carrying out a work of coast protection in altering, demolishing or removing those defences to allow natural processes to protect land further down the coast. The test is whether this appears “necessary or expedient” to the authority. This would be reasonable provided that the authority, on the basis of proper scientific evidence, can conclude that there is a reasonable prospect that this will be the result. The greater the degree of doubt, the less likely the Secretary of State may be to confirm the CPO, since he must act proportionately in taking land, and it would be unreasonable to confirm the order if there were simply a speculative possibility that this beneficial result might occur. However, in the planning sphere it is clear that there are cases which show that there is no requirement of absolute certainty that the desired end result (e.g. economic regeneration) will actually occur: see Chesterfield Properties plc v. Secretary of State for the Environment (1997) and Gala Leisure Ltd v. Secretary of State for Environment, Transport and the Regions [2000] EGCS 135.

In such a situation, it might well be in the public interest to acquire land that will erode in the future and it might well be possible to negotiate with the landowner without resorting to Compulsory Purchase. However, it is necessary for the Compulsory Purchase mechanism to be available for landowners who are seeking to stand in the way of the public interest.

Should the Compulsory Purchase powers under the Coast Protection Act 1949, prove to be inadequate and/or insufficiently well defined, then it is possible that ODPM could be persuaded to allow Compulsory Purchase powers to be invoked as an integral part of any Compulsory Purchase Order (CPO) undertaken for development purposes and in accordance with the CPO procedure contained in the Town and Country Planning Act 1990. This reinforces the need for a holistic approach to Coastal Zone Management.

As an example, providing access for recreation to the sea would definitely not fall within coastal protection powers. If that were the real purpose then another basis for a CPO would have to be found – possibly the general planning power under section 226 of the Town and Country Planning Act 1990, or maybe powers relating to countryside access under the Countryside Act 1968.

In considering whether a CPO should be made, the recent ODPM draft circular for consultation on Compulsory Purchase Orders provides a helpful restatement of policy (and underlying law) on CPO. It states:

“17. A compulsory purchase order should only be made where there is a compelling case in the public interest. An acquiring authority should be sure that the purposes for which it is making a compulsory purchase order sufficiently justify interfering with the human rights of those with an interest in the land affected. Regard should be had, in particular to the provisions of Article 1 of The First Protocol to the European Convention on Human Rights and, in the case of a dwelling, Article 8 of the Convention.

18. The confirming Minister has to be able to take a balanced view between the intentions of the acquiring authority and the concerns of those whose interest in land it is proposed to acquire compulsorily. The more comprehensive

the justification which the acquiring authority can present, the stronger its case is likely to be. But each case has to be considered on its own merits and the advice in this Circular is not intended to imply that the Minister will require any particular degree of justification for any specific order. **Nor will a confirming Minister make any general presumption that, in order to show that there is a compelling case in the public interest, an acquiring authority must be able to demonstrate that the land is required immediately in order to secure the purpose for which it is to be acquired.**[28]

19. If an acquiring authority does not have a clear idea of how it intends to use the land which it is proposing to acquire, and cannot show that all the necessary resources are likely to be available to achieve that end within a reasonable time-scale, it will be difficult to show conclusively that the compulsory acquisition of the land acquired is justified in the public interest, at any rate at the time of its making. Parliament has always taken the view that land should only be taken compulsorily where there is clear evidence that the public benefit will outweigh the private loss. The Human Rights Act reinforces that basic requirement."

This policy/law is now reinforced by the need to act proportionately when interfering with the rights of owners under the Human Rights Act 1998. In other words, it is necessary for an authority to look not only at the end it wishes to achieve by the CPO, but also whether the means to the end are appropriate – an authority cannot simply acquire land against the will of the owner on the basis that it might be needed or "come in useful" one day. There must be a definite scheme proposed against which the CPO can be judged. In this case a coast protection scheme would be a definite proposal, and would presumably be the primary "use" of the land.

Evaluation of any option to compulsorily purchase or compensate in some other way to achieve coastal management objectives should remain on a benefit-cost basis, but with explicit reference to social or environmental impacts in broader coastal management.

Future activities required to provide support to those disadvantaged by the adoption of managed realignment as part of sustainable coastal management policies

The following strategies have been identified as being important for government and communities to develop to ensure the disadvantaged are helped whilst not imperilling environmentally sound flood and coastal management

- Improving links to ICZM and integrated regional and local planning
- Land banking arrangements
- Public support of appropriate private development schemes in situations of coastal roll-back
- Development of coastal erosion indemnity fund

[28] Authors' emboldening – this clarification is very useful in the context of purchasing land in advance for anticipated coastal erosion.

- Consideration of a new Coastal Management Act to replace the 1949 Coast Protection Act

It is also worth noting that work has been carried out to examine the idea of 'consistent standards' of defence for all those affected by flooding and coastal erosion (Defra/EA technical report for project FD2009), but this work concluded that consistent standards could only be achieved at the expense of sacrificing some other important principle of equality.

a. Improving links to integrated Coastal Zone Management and integrated regional and local planning

The government is moving towards ICZM with the EU ICZM Recommendation and Defra's broad-ranging interests including both land and water areas associated with the coastal zone. Progress is patchy and slow, due to the complexities of the issues and the large number of organisations involved, but there are promising areas that can be investigated in particular situations.

- A Local Strategic Partnership (LSP) has the potential to bring all interested parties together to enable constructive dialogue and development of a consensus strategy. The East Riding [of Yorkshire] LSP is a good example of what can be achieved in difficult situations with broad ranging aims and focussed objectives and targets covering areas such as health, prosperity, crime, education and the environment. East Riding LSP is developing an interesting approach to the rollback of caravan and holiday home parks from the eroding Holderness coastline.

- Market and Coastal Towns initiatives (MCTi) which have similar ethos to LSPs but are focussed on urban areas.

- The role of Regional Development Agencies in supporting cross-cutting initiatives, such as those developed by LSPs and MCTis, with appropriate funding.

The overall message is that the aspirations of both local communities and of good environmental management on eroding coastlines can only be reconciled and delivered by a partnership approach.

b. Development of coherent land banking policies and arrangements

In order to allow communities to "roll back" over a period of time, a coherent approach to planning must be adopted.

In this situation, what is needed is some form of compensatory "land banking" to allocate equivalent areas for development inland of the erosion areas. This is analogous to the land banking which already takes place in the UK under the Habitats Directive for environmental compensation areas.

In the relatively simple case of a caravan park for example, caravan "pitch banking" gives the local planning authority a rational approach to permitting inland extensions or relocations of caravan parks. Multipliers on the existing areas may

be required when allocating planning permission to allow for changes in requirements and planning guidance since the original site was established.

c. Public support of appropriate private development schemes in situations of coastal roll-back

Support funding for inland property or other developments designed to compensate for coastal erosion could be considered on the following basis, modelled on that put forward for East Riding LSP[29]

a) Grant aid should not be made available specifically to improve the economic viability of a coastal rollback proposal which is driven by the relocation of private assets.
b) Grant aid should be made available to assist in the realisation of specific aspects of rollback proposals which facilitate tangible public benefits. Such benefits would need to be linked to a long-term coastal strategy, but might consist of:
    i) The removal of sea defences in order to help restore natural coastal processes and landscape enhancements.
    ii) Restoration of the vacated site to a condition suitable for habitat creation and biodiversity enhancements
    iii) Management arrangements to ensure that such habitat creation and biodiversity enhancements gains are established and maintained, and interpretation facilities provided to enhance public understanding of local environmental issues.
    iv) The establishment of safe public access to the cliff top, and enhanced linkages to existing or proposed coastal rights of way.
    v) Enhanced screening landscaping to rolled back sites, either within the site boundary, or as off-site planting.
    vi) Improvements to the public road network which facilitate the rollback of a cliff top site, but where specific highway improvements are required by the Highway Authority. (A contribution from the Highway Authority would be expected in such a situation.)
c) Grant aid could be offered as a proportion of the total cost of such works to ensure that the developer maintains a contribution appropriate to his or her environmental responsibilities.
d) Grant aid for coastal defence removal should normally be offered at a higher proportion than the rest of the scheme to ensure essential works are fully and appropriately carried out. Although RDA or other funding may have been allocated to such works, it seems that this aspect could not be funded from specific current government allocations for flood and coastal management (see Defra's paper "Maintenance of Uneconomic Sea Flood Defences," which only considers the implications of abandoning the maintenance of existing sea walls.) However, a broader coastal management objective in any new primary legislation (see Section … below) would be all that would be necessary to justify expenditure on removal of unsustainable defences.
e) In the case of coastal defences requiring removal because they pose a safety hazard, then the occupier (i.e. the person in control of them) may be liable for injuries caused to the public under the Occupiers Liability Act 1957. The

[29] David Tyldesley and Associates (2003) "The rollback of caravan and holiday home parks from the eroding East Yorkshire coastline."

occupier for this purpose would most likely be the owner or occupier of the land where the defences are. However, it could not be ruled out that the authority might also potentially be liable. If anything was to be done the owner/occupier and the authority would need to reach agreement on what was to be done and the proportions in which they were to bear the cost.

d. Coastal erosion indemnity fund

Although private approaches may work in some situations, in most cases, including many isolated and long-standing communities, privately financed arrangements will not be viable.

In this case, it is possible to conceive of some kind of national indemnity fund (somewhat analogous to a pension fund) into which residents from such communities would be obliged to pay (for example, as a precept on the council tax.)

Such a fund could be regionally operated to give improved visibility and accessibility. In the event of a substantial property loss, a resident could make a claim on such an indemnity fund. Some initial "pump priming" of such a fund from government or lottery funding might be necessary to make it viable on an objective actuarial assessment. Assessment of the required levels of funding could be undertaken at a regional scale as part of preparation of the relevant Shoreline Management Plans (and based on realistic models of coastal erosion such as CLIFFPLAN or FUTURECOAST) but thereafter contributions could be adjusted to make it self-sustaining.

Such an approach would enshrine a principle of property owners paying for their coastal erosion risk management in a situation where the reasonable costs for the government defending such a community were not justified by the available national economic benefit.

A final consideration for such communities would be what to do in regard to new property development. Such development, it can be opined, is essential particularly in the case of small communities, if they are not to die. For such new developments a coastal development charge could be made by the planning authority to reflect the cost of the new property buying into the indemnity fund. This new charge could either be raised under the provisions in s.106 of the Town and Country Planning Act for contributions to local infrastructure and amenities or through specific new primary legislation granting LAs powers to raise levies. (The latter is similar to those powers granted under the Transport Act 2000 to introduce congestion charging on roads). The payment by area and class of development would reflect the vulnerability of the land area in question to coastal erosion and also some "ability to pay" criterion. The landowner or developer could be charged at the time of seeking planning permission.

e. Consideration of a new Coastal Management Act to replace the 1949 Coast Protection Act

Given the possible weakness of the current powers to acquire land and carry out other aspects of coastal management, there would appear to be a case for a new Coastal Management Act to replace the 1949 Coast Protection Act. This would

need to consider all the matters raised in this Topic Note (although whether these matters were dealt with by the Act itself or elsewhere would be a matter for detailed practical and legal consideration.)

Candidate objectives for the new act might include:

1. To limit development near the coast by appropriately enhanced or modified planning controls.
2. To put in place appropriate transitional measures for land for which outline planning permission may have been given in the past but which it is now deemed inappropriate to develop.
3. To extend the existing Compulsory Purchase powers to allow Authorities to take ownership of land which will be subject to subsequent erosion.
4. To provide powers for Authorities to take ownership of private land on which defences are built and the associated foreshore (land to the seaward of the defences as far as the appropriate boundary) in return for constructing defence works or managing erosion. This will encourage more holistic and open use of the coasts analogous to the right to roam on land, and potentially will encourage, in rural areas, the "one field's width of unimproved grassland around the open coast" objective of English Nature.
5. To provide powers for Authorities to provide grant aid to [community] coastal management schemes.
6. To facilitate, subject to the administrative arrangements prevailing at the time, better integration of flood defence and coastal erosion objectives within the broader concept of holistic coastal management. In this regard revisions may be required to the 1995 Environment Act and its predecessor acts which relate to the Environment Agency, the IDBs etc.

Directions

Government guidance	• FCDPAG Series • ODPM planning policy and other guidance, e.g. PPG25 • Defra guidance, including that for preparation of second generation Shoreline Management Plans
Tools	• Cliffscape
Indicators	• None
Case study	• Rollback of caravan and holiday home parks from the eroding east Yorkshire coastline [Note: Case study suggested by David Collins regarding flood defence scheme in Morecombe relates to environmental not social compensation.]
Ongoing research & initiatives	• Tyndall centre work on stakeholder engagement
Further information	• "Managed realignment: land purchase, compensation and payment for alternative land use." Defra Flood Management Division, November 2003. See http://www.defra.gov.uk/environ/fcd/policy/mrcomp/mrcomp.htm. • "Maintenance of uneconomic flood defences: a way

forward." Defra Flood Management Division, November 2003. See http://www.defra.gov.uk/environ/fcd/policy/unecseadef.htm

- "Payment of compensation, relocation and other issues in relation to flood and coastal erosion risk management." Defra Flood Management Division, July 2004. See http://www.defra.gov.uk/environ/fcd/policy/strategy.htm)

3.5 Topic Note 5: Integrating Planning and Flood Risk

3.5.1 Introduction

Within the water environment, the Government has identified sustainable development as a key aspect of its vision for flood management and coastal protection (Defra, 2002; 2004b). It has also placed sustainable development at the heart of the planning system through the *Planning and Compulsory Purchase Act 2004* (United Kingdom, 2004) and *Planning Policy Statement 1* (Office of the Deputy Prime Minister (ODPM), 2005). It is important to ensure that there is continued integration of flood management issues into planning and regeneration decisions, so that the optimum outcome is secured for sustainable development.

This note describes a range of activities and measures for improving this integration, including better strategic decision-making by strengthening links between flood risk management planning undertaken by Flood Defence Authorities (FDAs) and Regional Spatial Strategies[30] and Local Development Frameworks[31] undertaken by Regional Assemblies and Planning Authorities; and promoting examples of good practice more widely in the planning community.

This note also describes related activities regarding integrating the management of water as part of the planning process, which is also an important component of sustainable development.

3.5.2 Key Activities

There are five key activities for integrating flood risk within urban planning, regeneration, water management and sustainable development. These are the following:

1. Consider flood risk (and the integrated management of water) early and at all scales of development planning.
2. Undertake planning based on a “sequential approach”.
3. Understand the components of 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.

3.5.3 Links with Sustainability Principles

These 5 key activities relate to all nine of the sustainable flood risk principles described in Section 2, with the closest links to:-

[30] For Wales this is the *Wales Spatial Plan* and for London this is the *London Plan*.
[31] In England consisting of *Local Development Schemes* plus *Local Development Documents* or *Local Development Plans* in Wales.

Risk Management. Manage flood and coastal erosion risks to people and property, the economy and the environment.
Integration. Develop solutions that integrate flood and erosion risk management as part of integrated catchment management and coastal zone management.
Engagement. Work with all those affected by flooding and erosion, empowering those affected to take appropriate actions to reduce risks.
Appraisal. Adopt appraisal methods that are rigorous, coherent and open and consider long term social, environmental and economic costs and benefits.

3.5.4 Consider flood risk early and at all scales of development planning

a. Flood risk should be considered at the initial stages of strategic planning and be integrated throughout all levels of spatial planning (i.e. from national to site-specific), so that it forms part of the strategic thinking behind planning, rather than only being considered as part of the response to strategic decisions. Otherwise, there is a lack of consistency of approach and an undermining of the application of sustainable principles at different levels.[32] Figure 3-4 provides a simplified representation of how each level of the development planning system should contribute to achieving sustainable development.

Figure 3-4 The development planning system and how this influences sustainable development

b. The management of water should be considered in an integrated manner and as part of the strategic planning process. This should include integration between the different strands of water policy and between water policy and other policy areas. The management of water is important in achieving sustainability objectives, as acknowledged in Achieving a Better Quality of Life (Defra, 2004c), and should include consideration of factors such as river quality, reducing urban and rural pollution, sustainable abstraction regimes

[32] The Defra/EA R&D project FD2320 provides guidance for assessing flood risk at all levels of development planning (HR Wallingford, 2005b).

and the reduction of leakages. As highlighted in Directing the Flow (Defra, 2002), good quality water in rivers and canals has been, and can continue to be, a catalyst for urban regeneration.

c. Sustainability Appraisals should be used as the primary mechanism to ensure that there is due consideration of flood risk and management of water in all policies and plans. Sustainability Appraisals are required for Regional Spatial Strategies, Sub-Regional Spatial Plans and Local Development Frameworks.[33]

d. Assessments of flood risk should be undertaken to inform the development planning process and feed into Sustainability Appraisals. These need not be restricted to local scale planning only (such as the use of Strategic Flood Risk Assessments), but can also be undertaken at the regional level. The extent of these higher-level assessments will depend on data availability, the relative significance of flood risk for the region and the availability of existing studies, such as SFRAs, CFMPs, SMPs, etc.

e. Integration of flood risk management planning (as undertaken by the EA and other flood defence authorities) and development planning should be sought at all scales of planning. This is best achieved through the assessments of flood risk, which should include identification of existing policies, plans, strategies and provide a two-way process of informing both development planning and flood risk management planning.

f. A difficulty experienced with integrating flood and coastal risk management planning with the development planning system is the difference in scales and spatial distribution of these two different types of planning exercises. Flood and coastal risk management tends to work to the natural boundaries of fluvial, coastal or tidal processes, such as river catchments or coastal cells. On the other hand, development planning is undertaken within administrative boundaries. Regional assessments of flood risk are best developed on a catchment and/or coastal cell basis. This means that they will tend to be a sub-regional issue, but could include parts of more than one Region. More often than not, this will be similar to many other related sub-regional issues (such as water resources, water quality, conservation, emergency services, transportation) and should, therefore, promote further integration of sustainability objectives.

g. The integration of flood and coastal risk management planning and development planning in the urban environment is likely to be best achieved through “integrated urban drainage management”, which is an evolving concept being researched by Defra as result of the consultation exercise Making space for water. Although intended to be a means to enable the different authorities responsible for different parts of the drainage system to work together and manage flood risk, this needs to take a long-term, strategic approach, which cannot be undertaken in isolation from the planning authorities.

[33] Further information on Sustainability Appraisals can be found in Guidance Note 1.

h. The management of flood risk and water resource issues should work with natural processes wherever possible. This includes providing sufficient space for, and making best use of both flood storage and channel conveyance in fluvial systems, managed realignment in coastal systems and the use of sustainable drainage systems (SUDS).34

i. The management of flood risk and water resource issues should be considered at the regional and local levels to maximise the achievement of multiple objectives and to enable a higher degree of sustainable environmental management. For example, by examining the sustainable management of surface water from a neighbourhood, rather than only in the site-specific context, opportunities may arise to integrate different functions, such as green space, amenity, drainage and flood storage whilst still achieving density requirements (OST, 2004).

j. Planners should make themselves as well informed as possible about flood risk and water resource management or employ appropriate specialists to provide advice as early as possible in the planning process.

k. The Environment Agency and other Flood Defence Authorities should work closely and positively with Planners to seek "common sense" approaches towards flood risk. Part of this process is attempting to fit into each others timescales for delivering plans and developing more consistent time horizons for related plans. For example, issues such as climate change can become sidelined when a plan has only a short time horizon, say 6 years, but it is only through early action that impacts of climate change can be adapted to or mitigated without excessive costs in the future.

3.5.5 Undertake planning based on a "sequential approach"

a. A sequential approach[35] should be applied at all scales of planning. This is a simple risk-based approach whereby planners should select areas with the lowest likelihood of flooding first, where possible, and then in ascending order of flood hazard. This should be based on an understanding of current and future flooding over the life-time of the development, taking into consideration issues such as climate change and changes in sea level. Information about this approach can be found in PPS25 Annex G. [36]

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[34] The Interim Code of Practice for Sustainable Drainage Systems (National SUDS Working Group, 2004) provides a large number of cross-references to detailed technical guidance including Martin *et al.*. (2000 and 2001) and Wilson *et al.*. (2004).

[35] This is distinct from the Sequential Test as specified in PPG25 and its successor PPS25, but is based on the same philosophy.

[36] http://www.odpm.gov.uk/ - links to PPS25 pdf file

3.5.6 Understand the components of flood risk

a. All types of flooding should be considered when determining flood risk. This includes flooding from sewers, rivers, sea and tides, groundwater and runoff from impermeable surfaces and saturated, frozen or compacted soil surfaces. However, the extent to which these are considered as part of higher-level assessments (particularly at the regional level) will depend on data availability and the scale of any particular type of flooding relative to the area being considered.

b. It is important to identify both the probability and consequences of flooding[37]. PPS 25 Annex C describes the forms of flooding that should be considered.

c. The sustainability of any flood risk management methods should be determined based on the whole life-cycle of the solution, including extraction of raw materials, design, processing or manufacturing, distribution, construction, use, reuse, recycling and waste disposal.[38] Therefore, there will be occasions where management of the consequences may prove more sustainable, especially when considered in parallel to other sustainability principles, such as protecting our natural resources and enhancing the environment.

3.5.7 Recognise the differences between reducing and managing flood risk

a. Development planning should seek to reduce, but at the very least not add to the level of flood risk (for both the development itself and the surrounding area). However, the definition of the "level of flood risk" can take a number of different forms, including components such as theoretical risk (i.e. in the absence of defences), residual risk (i.e. with defences), predicted annual economic damages, risks to people (either individual or societal). PPS25 is specific about which risk measures are appropriate for different levels of decision making.

b. Once a baseline flood risk has been agreed, it is then possible to understand whether the proposed development will alter the flood risk. In all cases, uncertainties and assumptions should be identified and accounted for in the appraisal process.

c. There are clearly potential benefits of reducing flood risk, but the planning system is only required to prevent the worsening of flood risk compared to the existing situation (over the life-time of the development). In other words, it is not a legal requirement to provide betterment, but Planners should try to improve areas in the most sustainable ways possible. This may require some form of trade-off between the different aspects of sustainability: social, economic, environmental factors. Flood risk can impact on each of these factors.

[37] Based on the concept of probability * consequence = risk
[38] Further guidance on the Wise Use of Materials is provided in Guidance Note 10.

3.5.8 Ensure transparency and community engagement

a. Sustainability Appraisals act as the mechanism for stakeholder engagement, including the community, flood defence authorities and water service providers.[39]

b. Stakeholder engagement is an essential component of sustainability.[40] In particular in relation to flood risk and development planning, stakeholder engagement is essential to ensure consensus regarding the decision-making approach, the assessment approach, baseline conditions, acceptability of flood risk, appropriate weightings for different sustainability objectives, etc.

c. All assessments of flood risk need to be clearly reported and useable within the context of the decision-making process, bearing in mind that these will need to be used by those without technical expertise in the subject.

3.5.9 Where to get more information

The following are key websites for up to date information on flood risk, urban planning, regeneration, water management and sustainable development.

Association of British Insurers
Flooding:- http://www.abi.org.uk/flooding

CIRIA
Repair & Restoration of Buildings following Floods:-
http://www.ciria.org.uk/flooding/
Sustainable Drainage Systems:- http://www.ciria.org.uk/SUDS/
Sustainability:- http://www.ciria.org.uk/theme.htm?ThemeIDNo=17

Department of the Environment, Food and Rural Affairs (Defra)
Flood and Coastal Erosion Risk Management:-
http://www.defra.gov.uk/environ/fcd/default.htm
Sustainable Development:-
http://www.defra.gov.uk/environment/sustainable/index.htm
Water:- http://www.defra.gov.uk/environment/water/index.htm

Environment Agency
Flooding:-
http://www.environment-agency.gov.uk/subjects/flood/?lang=_e
Water quality:-
http://www.environment-agency.gov.uk/subjects/waterquality/?lang=_e
Water resources:-
http://www.environment-agency.gov.uk/subjects/waterres/?lang=_e

[39] Further guidance on Sustainability Appraisals is provided in Guidance Note 1.
[40] Further guidance on Community Engagement is provided in Guidance Note 2.

Standing Advice for Development and Flood Risk:-
http://www.pipernetworking.com/floodrisk/
Repair and restoration after floods:-
http://www.environment-agency.gov.uk/regions/southwest/315944/321704/876872/?lang=_e
BSI Kitemark scheme for local flood protection products:-
http://www.environment-agency.gov.uk/subjects/flood/826674/830330/877142/484693/?lang=_e

Fore*sight* Future Flooding:-
http://www.foresight.gov.uk/Previous_Projects/Flood_and_Coastal_Defence/index.html

The Office of the Deputy Prime Minister (ODPM)
Sustainable Communities:-
http://www.odpm.gov.uk/stellent/groups/odpm_communities/documents/sectionhomepage/odpm_communities_page.hcsp
Planning:-
http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/sectionhomepage/odpm_planning_page.hcsp
Building Regulations:-
http://www.odpm.gov.uk/stellent/groups/odpm_buildreg/documents/sectionhomepage/odpm_buildreg_page.hcsp

The Planning Portal:- http://www.planningportal.gov.uk/

3.5.10 References

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3.6 Topic Note 6. Rural Development

3.6.1 Introduction

'*Making Space for Water'* states that flood and coastal erosion risk management will be clearly embedded across a range of Government policies, including rural development. The strategy takes a wide ranging view, acknowledging that flood risk can encompass a variety of different areas, from the highly developed former tidal marshes in parts of central London, through to rural communities, including highly productive agricultural land and sites with a few riverside fields of low grade agricultural land.

Flood risk management has the potential to make major contributions to other Government strategic priorities, including Sustainable Communities, and one of Defra's five key areas of strategic priority, namely Sustainable Rural Communities. This Topic Note highlights how better land and water management can contribute to sustainable development.

3.6.2 Sustainability principles & key activities

There are many opportunities create a better linkage between flood risk management and rural development and the key activities include:-

1. Innovative use of the Environmental Stewardship scheme to enhance the environment and provide flood risk management. The scheme includes flood management as a secondary objective, so enhancement within the floodplain or catchments as a whole can contribute to flood risk management.
2. Providing better advice and engagement with land managers in order to improve on-farm soil and water management that can have benefits for farmers, water managers and the environment.
3. Improving understanding the links between land and water management and the catchment scale.
4. Improved land use planning that makes good use of land within rural floodplains, including landscape, amenity and recreational uses (with reference to the activities described in Topic Note 5 on planning and flood risk).

These activities are related to all nine of the sustainable flood risk principles and particularly linked to:-

- **Integration.** Develop solutions that integrate flood and erosion risk management as part of integrated catchment management and coastal zone management.
- **Engagement.** Work with all those affected by flooding and erosion, empowering those affected to take appropriate actions to reduce risks.
- **Appraisal.** Adopt appraisal methods that are rigorous, coherent and open and consider long term social, environmental and economic costs and benefits.

- **Environment.** Protect natural resources and enhance the environment where it is most degraded.

These principles are reflected, at least in part in the Government's Sustainable Communities Plan (Office of the Deputy Prime Minister, 2003a; 2003b) that recognises that:-

"amongst other things, current and future potential flood risk must be addressed in order that the new communities in both urban and rural areas follow sustainable principles. In particular, it is important that the siting and design of all new developments adhere to the sequential test within Planning Policy Guidance 25: Development and Flood Risk (Department for Transport, Local Government and the Regions, 2001) to ensure that if risk cannot be avoided then it should be managed, for example by flood resilience measures

The Government also acknowledges that it is important to encourage and promote joint working between those responsible for flood management and the rural development agencies. Where undeveloped space is available in rural areas there may well be significant benefits to the environment, the landscape, and consequently to human amenity and recreational activities, if rivers and floodplains are allowed to re-establish a more natural function with less management intervention (Defra, 2002)"

3.6.3 Who is this topic note for?

Rural development, such as within Regional Planning Bodies or Regional Spatial Strategies, is concerned with the national, regional and local levels. The national and regional tiers are focused on delivering the policy framework, whilst the local level implements the strategies and interact with stakeholders.

Defra are responsible for both flood risk management and rural affairs. There are also a number of other agencies who are relevant to this field. For example, Regional Development Agencies can play a role in facilitating sustainable rural development, whilst the Office of the Deputy Prime Minster, Regional Planning Bodies and Local Planning Authorities can formulate policies to promote and attract tourism and recreation.

3.6.4 Activities to support sustainable flood risk management

Over the short term there are a number of opportunities within rural development to support sustainable flood and coastal erosion risk management.

3.6.4.1 Utilise agri-environmental schemes to pursue sustainable flood and coastal management

The trend to redistribute agricultural subsidies from more intensive farming to environmentally sensitive agriculture will provide a vital mechanism to achieve rural development objectives whilst being sensitive to both environmental needs and catchment management. The new Environmental Stewardship Scheme provides funding to farmers and other land managers in England who deliver effective environmental management on their land. The scheme is intended to

build on the recognised success of the Environmental Sensitive Areas scheme and the countryside Stewardship Scheme. Its primary objectives are to:

- Conserve wildlife (biodiversity)
- Maintain and enhance landscape quality and character
- Protect the historic environment and natural resources
- Promote public access and understanding of the countryside
- Natural resource protection

Within the primary objectives it also has the secondary objectives of:

- Genetic conservation
- Flood management

Enhancing rural floodplains, from the creation of wetlands to opening countryside areas for public access, can meet the primary objectives of this scheme at the same time as providing more physical space for flood conveyance and flood storage. There are a number of ways the scheme may contribute to managing flood risks, for example:-

- Enhancing floodplains and wetland creation
    - Creation or re-instatement of wetland on land that was previously protected from flooding. This will provide additional storage (between the ground or seasonal water level and the prior defence height) that can contribute to reducing flood risk downstream.
    - Creation of wetlands or enhancement of washlands in undefended areas. Established washlands are part of the functional floodplain that provide storage for a range of flood events. In some cases the washlands could be enhanced to provide additional storage in extreme floods. In the Netherlands, some washlands are deepened to provide greater storage – careful engineering and ecological design is required to meet environmental and flood benefits.
    - Set-back of defences can create more room for water conveyance and some additional storage.
- Improving the landscape character and controlling runoff.
    - Land use changes from arable rotation to an environmental use can reduce runoff and erosion at the local scale.
    - Similarly, changes that include removing drainage systems and reducing livestock densities are likely to contribute to better water management and erosion control (See next section).

3.6.4.2 Promote integrated catchment management and better farming practices to reduce runoff and erosion

Better soil and water management at the catchment scale can also create win-win situations for farmers and flood risk managers. The Foresight Future Flooding project identified a number of catchment management measures to reduce flood risk:-

Response Group	Response Measure, Policy or Intervention
1. Water retention and management of infiltration into the catchment	Changing tillage practice
	Worms
	Extensification
	Field drainage (to increase storage)
	Afforestation
	Buffer strips and buffering zones
2. Water retention through catchment-storage Schemes	Detention ponds and bunds
	Rainwater harvesting
	Wetlands and washlands
	Riparian zone management
3. Managing conveyance	Management of hillslope connectivity
	Channel maintenance
	Channel realignment

There is clear evidence that these measures in Group 1 affect surface runoff generation at the local scale and can therefore clearly help to reduce local flooding and erosion problems. Response group 2 and 3 can help to reduce flood levels through storage and improved conveyance.

The Environment Agency in its report on “Best Farming Practices” (EA, 1999) identified how best practice can help farmers and land managers as well as improving catchment management.

Benefits include:-

- Increased net profits by reduction of variable costs
- Improved soils, crop yields, animal production and health
- Improved potential for diversification and alternative enterprises such as farm
- tourism
- Increased capital value
- Improved protection of drinking, agricultural and coastal water
- Reduced runoff, flooding and damage to highways and property
- Less water pollution by sediment affecting fisheries, nutrients causing algal blooms and pesticides affecting aquatic life
- Enhanced habitats and diversity of wildlife

Poor land management has the opposite effect and can cause a deterioration in runoff and erosion control as shown by the examples in Figure 3-5.

Figure 3-5 Examples of how land management can affect runoff and erosion

4. Capping and compaction of soils causing excessive runoff

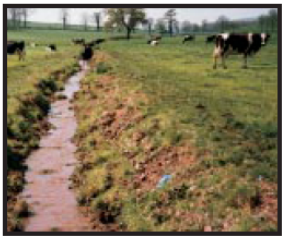
5. Soil erosion causing crop damage

6. Low crop cover increasing runoff and erosion

7. Erosion of unprotected natural drainageways

8. Wet soils poached by stock

9. Runoff from farm tracks



10. Stock access damaging ditches and drainage systems

11. Stock grazing and trampling adding to bank erosion

There is less evidence that the measures in group 1 reduce flood risk at a catchment scale (O. Connell, et al.., 2004) but despite this uncertainty, taking a whole catchment or coastal cell view, can have clear benefits. CFMPs, SMPs and broader RBMPs are appropriate plans for making sure that flood risk managers and planners take this holistic view that considers spatial planning, flood risk, ecological status and seeks development options that have multiple benefits.

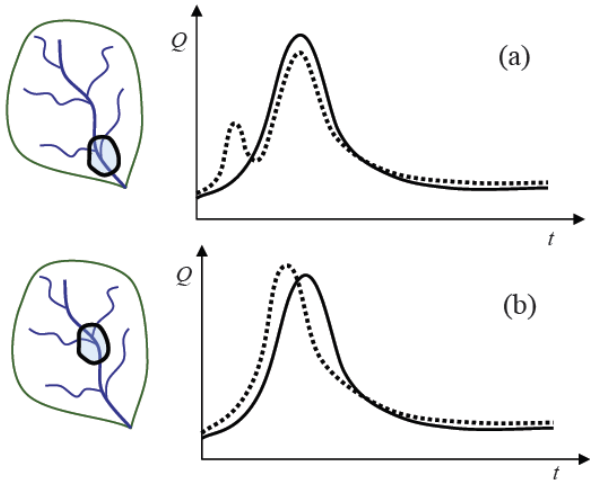
3.6.4.3 Improving our understanding of the links between spatial planning and flood risk

Further research is required on the links between land management and flood risk so that spatial planning decisions can be based on a good understanding of the impacts of development on flood risk.

The spatial planning of land use within a catchment may affect water quality, ecological status or potential and flood risk downstream. For example, a good catchment understanding may demonstrate that allowing rapid runoff in a development at the bottom of a catchment reduces peak flows because this

runoff drains before the main flood flow arrives at the catchment outlet. Conversely, development in headwaters or central catchment areas can increase peak flows and in these cases the development of SUDS will be appropriate to reduce runoff rates. (Figure 3-6).

Figure 3-6 Hypothetical example of the impact of spatial location on peak flow (from O,Connell, et al.., 2004)



This kind of understanding needs to be developed within strategic plans, such as CFMPs, SMPs and RBMPs, and considered in the land use planning process.

3.6.4.4 Promote sustainable flood and coastal management within Regional Development Agencies and Regional Planning Bodies

Sustainable flood and coastal management has linkages with a number of different aims. A process of education should be conducted within Regional Development Agencies and Regional Planning Bodies to demonstrate how flood risk policies can be explored from a rural context. For example, there may be opportunities to combine factors such as tourism or environmental improvement within the flood mitigation strategies.

3.6.4.5 Recognise the changing needs of rural communities

Water has been identified as being a key element in all productive sectors (Defra, 2002) and sustainable flood and coastal management can exploit the resource to facilitate modern rural development. There are significant synergies between environmental and economic aims with regard to water, such as through tourism, recreation and regeneration. In this context, providing flood defences where appropriate can continue to provide wider economic benefits to rural environments, such as protecting valuable farm land or enabling development to occur in areas previously at risk from flooding.

3.6.4.6 Increasingly acknowledge the links between flood risk management, recreation and rural development.

Recreation and tourism in rural areas often take place in, on or near to water, helping to boost local economies (Defra, 2002). Although there can be conflicts, such as between recreational and conservation objectives, or flood defence and environmental issues, a greater degree of consideration should be given to both recognising and exploiting opportunities to achieve win-win scenarios.

3.6.4.7 Provide a higher degree of 'good practice' examples.

The above activities emphasise the benefits that rural development can gain from a sustainable flood and coastal defence strategy. Yet, many of these areas are relatively undeveloped with regard to areas such as research, policy inclusion and best practice. A higher degree of good practice would assist all areas from the strategic level, for example, within the policies and practices of Regional Development Agencies, and the local level such as by practical examples of how flood risk management schemes can help to boost local rural communities. Examples of agri-environmental schemes that combine sustainable flood risk management with farming practices would also be beneficial.

Further information

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3.7 Topic Note 7. Adaptation and resilience of defences

3.7.1 Introduction

Adaptation and resilience are concepts which relate to the entire flood and coastal erosion risk management system as explained in sections 2.4.2 and 2.4.3. However, this topic note is focussed on giving guidance on the adaptation and resilience of defences.

Defences are used as an integral part of catchment flood management or shoreline management. A wide range of types exists, including both fully engineered structures and also managed natural defences such as coastal dunes, beaches and salt marshes. The presence, location and alignment of engineered defences are normally decided at a strategic level as part of the plan, strategy or scheme development. Generally defences are used to solve problems of coastal and fluvial flooding and are not normally relevant to solving pluvial, muddy, groundwater or intra-urban flooding, where other measures related to capacity/conveyance of flood water channels and pumping systems will need to be considered.

Where defences are adopted, sustainable flood and coastal management must avoid as far as possible tying future generations into inflexible and expensive options. It is for this reason that a proper understanding of their performance, resilience and adaptation is important

3.7.2 Definitions

A general definition of performance is:

the degree to which a process succeeds when evaluated against some stated initial aim or objective.

The principal objective for the process of constructing and maintaining defences is to keep out flood water or to prevent erosion in order to reduce flood and coastal erosion risk. However, there may be many other subsidiary objectives. A good example of such and objective, given that defences can only reduce and not eliminate flood risk, is avoidance of irreversible structural failure during extreme events.

Resilience of defences is a concept related to this last objective. It can be defined as:

the ability to respond to a wide range of probable or possible loadings during its entire working life, without suffering long-term loss of functionality / performance during extreme events.

Defences that change suddenly or collapse when loading increases above some threshold cannot be considered resilient. Thus resilient flood and coastal defences are:

defences with the ability to survive extreme loadings despite being overtopped / overwhelmed.

These definitions of resilience are similar to the meanings given to resilience in coastal zone management (Klein *et al.*, 1998). Resilience strategies in flood risk

management are based on the concept of minimising the consequences of flooding or learning to live with the floods instead of reducing the flood hazard (Vis *et al.*, 2003).

Adaptation of defences is:

> *the ability to modify a defence 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. Availability of physical and financial resources is also important.

3.7.3 Making space for water

The concepts of resistance and resilience are found clearly articulated in both Making Space for Water and in the subsequent "First government response" to the consultation. However, the emphasis in these documents is not on the resistance and resilience of defences blocking the pathway for floodwater but on the resistance and resilience of buildings potentially affected by flooding in receptor zones. The papers distinguish between flood resistance of buildings (those measures that aim to keep floodwater outside the outer walls of buildings) and resilience measures. Resilience measures for buildings which are those that consider the form of construction and the materials used with a view to minimising damage when something is flooded. Thus the definitions of resilience for defences and buildings are different but consistent.

3.7.4 Sustainability principles

A number of the previously articulated sustainability principles and objectives are particularly important and challenging when considering the issue of performance, resilience and adaptation of defences. The principles of risk management, adaptation, resilience, appraisal, environment, consumption & production and knowledge (see boxes below) are those that have a bearing on this issue, but within these there are particular objectives that are especially important:

The adaptation and resilience principles are at the heart of this topic. In particular, **promotion of adaptive flood defences** is the key objective under the **adaptation principle** and all the objectives under the **resilience principle** are relevant including:

- Promotion of resilient flood defence systems
- Reparability of damaged defence assets
- Adoption of performance-based asset management, with appropriate monitoring and maintenance

In addition the following key sustainability objectives can be identified:

- Taking account of performance adaptation and resilience is part of the objective of **considering a wide range of options to reduce the probability of flood or coastal erosion** within the **risk management principle**

- **Appraisal** principle objectives that are met when the nature of and options for adaptive and resilient performance are understood includes **increasing understanding of the nature of the choices that must be made and encourage the invention of new and better flood and coastal defence options** and the ability to better estimate and **take account of full life cycle costs in making decisions**
- **Environment** principle objectives that can be met by focussing on resilient and adaptive performance include the ability to **develop innovative solutions that enhance modified systems or create new habitats,** to **prevent inappropriate development in the floodplain** and in some cases to **promote managed realignment in coastal and fluvial systems**
- Promotion of **sustainable consumption and production** is achievable by proper understanding and taking account of resilient and adaptive defences, because it will **promote use of renewable resources** and the **use of re-used and recycled material** and will **minimise the amount of waste**, thereby helping to make **more efficient use of capital assets.**
- Within the knowledge principle part of **understanding that catchments and the coastal zones are dynamic systems,** involves understanding the need for adaptive defences and the associated need for ongoing investment.

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

Objectives:

- **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 take account of the full range of risks over the whole life cycle of the option or portfolio of measures adopted
- To reduce the health and safety risks during and after construction of flood risk schemes
- 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

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

Objectives:

- **Promotion of adaptive flood defence systems**
- 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).

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**
- **Reparability 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

Appraisal. Adopt appraisal methods that are rigorous, coherent and open 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?

Environment. Protecting our natural resources and enhancing the environment

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**

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**

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
- **Understand that catchments and the coastal zones are dynamic systems**

3.7.5 Performance-based asset management thinking

The concepts of resilience and adaptation can only be properly understood and implemented, within a framework of performance-based management of defence assets within the flood risk management system. Such thinking considers:

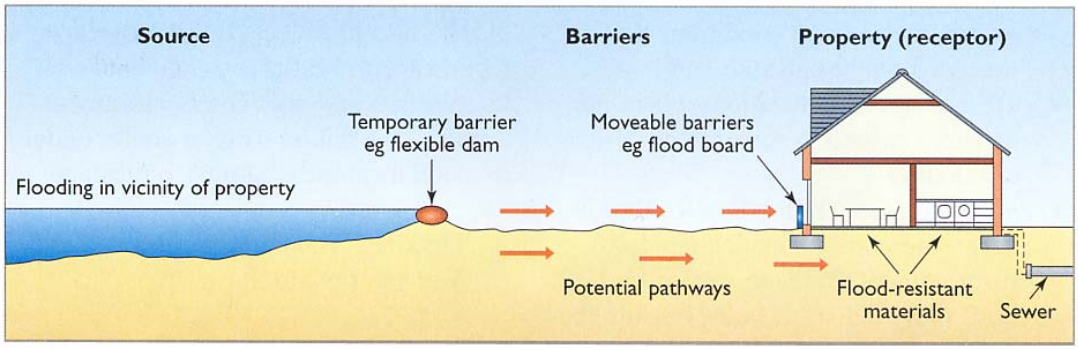
- the whole life cycle of systems (to secure the greatest return on investment and concurrent delivery of other sustainability objectives)
- maintenance, renewal, and replacement options with the goal of optimising the performance and effectiveness of the assets.

Within performance management of defences there must be a philosophy that is based on answering a series of key questions with reference to the source-pathway-receptor model (see also Figure 3.7) of flood risk management.

- What is the **source** (loading) and how has this changed?
- How have the **pathways** changed?
- How have the **receptors** changed?
- How frequently should future **monitoring** and inspection of the asset take place?

- What kinds of **interventions** are required to reduce risk appropriately? These may include combinations of regular maintenance, upgrading of defences or new works

Figure 3-7 Source / Pathway / Receptor / Consequence model for flood risk



In terms of pure flood and coastal defence assets, both for such defences type and for flood water conveyance assets it is normally possible in each case to distinguish the following asset levels (HR Wallingford, 2003):

- Geographical asset level – position/alignment of the asset
- Geometrical asset level – physical shape of the asset
- Structural asset level – physical condition of the asset.

Within this Topic Note, the focus is on the geometrical and the structural asset levels of flood and coastal defences; for geographical level asset issues, reference is made to the paper on Shoreline Management Plans and Catchment Flood Management Plans.

Case Study 4a - River Severn Temporary and Demountable Systems

Temporary and demountable systems can be used to manage flood risks where permanent flood defences would have a negative impact on environment, heritage or amenity.

The use of temporary flood protection relies on completion of necessary operational activities for deployment before the flood level is reached. Key requirements, such as a reliable flood forecasting system, enough lead time, availability of resources flood operational plan and the size of the systems are discussed.

Specific lessons learnt with regard to temporary and demountable systems along the River Severn are presented in the case study and summarized below:

- Safe deployment during night time hours
- Assessment of operational requirements and costs
- Operational plans should allow for complex storm events
- Development of a clear flood plan
- Once erected, need for continuous monitoring
- Consideration of bedding area when line of defence agreed
- Adequate temporary pumping arrangements to be in place
- Keep the barriers in an easily accessible area
- Opt for barriers that are easy to erect or raise within partially flooded areas
- Education of the public as part of scheme development.
- Health and safety during the periods of deployment is important.
- surveys to identify all drainage and routes for flood water to bypass the barrier,
- Contingency plans to prevent ingress of flood water when the barrier is in place.
- Measures to isolate sewers from the influence of high river levels

Pallet Barrier, used in Ironbridge and Worcester

3.7.6 Performance evaluation

It is only possible to know whether sustainable defences are being achieved if their performance is evaluated on a regular basis. Performance evaluation can be defined as:

> *a formal and periodic process aimed at demonstrating value for money, providing lessons for future management of the process under consideration and disseminating experience throughout the flood and coastal defence industry.*

Performance evaluation is applicable to all areas of significant investment in flood and coastal management, from high level policy and strategic processes to more detailed implementation and operation processes. It is particularly relevant here, because it takes the long-term view which is all pervading requirement of a sustainable approach.

Performance evaluation of defences is part of the project appraisal process and helps in achieving overall aims in flood and coastal management. As given in the definition of performance evaluation, three aims to carry out performance evaluation can be distinguished:

1. Assessment of the performance against original aims and objectives
2. Provision of insights for effective future monitoring and management of the system being evaluated
3. Identification of lessons learned for future practice in similar situations.

The key steps in Performance Evaluation are:

1. Establish clear Performance Objectives for the process being evaluated.
2. Identify characteristics (Performance Indicators) of that process that can be used to measure how it is performing relative to objectives.
3. On the basis of measurable evidence, establish how the process is performing compared with objectives.
4. Communicate the results of the evaluation as appropriate.
5. Decide what further action needs to be taken as a result.

Long term **monitoring** of the performance of selected, but typical, strategies/schemes or assets, is essential to track the sustainability of proposed/actual measures. This includes the transfer and storage of appropriate data in national databases such as NFCDD. Monitoring data should be compared with the anticipated hydraulic and structural responses of structure under a range of loading events. A comprehensive set of *baseline observations* are an essential prerequisite.

Defence asset monitoring must be carried out at both the geometric and structural condition levels.

Geometric monitoring must include the line and level of cross sectional profiles and most crucially of defence crest level, since global settlements of defences can otherwise go undetected.

Performance of existing defences, related to the objective to provide protection against flooding and erosion, is monitored by carrying out condition characterisation. The present standard methodology, used in England and Wales by the Environment Agency, ranks a defence between 1 (very good) and 5 (very poor). The allocated score is based on visual inspection of the defence by comparison to standard photos, using linguistic descriptions of condition set out in the Condition Assessment Manual.

Structural monitoring can be a complex operation, but the simplest form is visual condition grading. Improved procedures are being developed for condition characterisation, which are more closely related to structural performance under load. The Environment Agency's proposed Performance-based Asset Management System (PAMS) should provide a means of identifying the optimum management interventions to achieve particular outcomes and will reflect the significance of individual defences on risk reduction within the context of complete systems of defences.

There is also a long-term need to have a system to learn from specific (extreme) events, accidents and incidents and the reaction to these. A key part of this will be development of no-blame contractual/legal arrangements for Defra funded projects that will permit learning from mistakes and avoid cover up of important lessons for fear of litigation. An overview of some of the issues that might need to be addressed in setting up appropriate conditions of engagement for designers is given in the box below. The nature and variability of river and coastal engineering is such that the lessons learned are often too important to be covered up; instead proper forensic analysis is needed followed by appropriate dissemination and training.

Professional liability issues in the design of innovative and/or flexible defences

Contractual Obligations

The designer will owe a duty to carry out his/her services under the contract with reasonable skill and care. This arises as an implied term although the contract will usually contain an express term to the same effect. In exercising such reasonable skill and care, the designer will have to comply with any relevant Codes of Practice, British Standards and industry guidance.

The "standard of care" is the standard of the ordinary skilled person exercising and professing to have the same skill.

The designer can, by contract, warrant the fitness for purpose of the design. It should be noted that in practice insurers are extremely reluctant to allow designers to give such warranties.

The designer will normally seek to *exclude* or *limit* its liability for breach of the duty to exercise reasonable skill and care (although liability for death or personal injury cannot be excluded). It is not uncommon to see limitation of liability clauses that limit the liability of a designer to the value of the designer's insurance cover. When designing some innovative and/or flexible defences, a further financial limitation of liability may be appropriate and should be carefully considered by employers.

The Contracts (Rights of Third Parties) Act 1999, which gives rights to third parties to a contract under certain circumstances, should be excluded from the contract.

Liabilities in Tort

To establish a claim in tort, a claimant must show:

a) the existence in law of a duty of care;
b) behaviour which falls below the requisite standard on the part of the consultant (being the standard of the ordinary skilled person exercising and professing to have the same skill);
c) a causal relationship between consultant's conduct and the damage; and
d) foreseeability that conduct of the type in question was likely to cause damage of the type claimed.

The consultant will owe a similar duty to exercise reasonable skill and care as that owed in contract, although different considerations will apply in relation to damages and the limitation period. It would be possible to seek to exclude or limit such liability under the contract.

The designer of a structure will owe a common law duty of care to persons who might reasonably be expected to be affected by the design of the structure to take such care as is reasonable in all the circumstances to see that they are reasonably safe from personal injury caused by the design or from physical damage to property other than the product of the design itself.

Generally, designers do not owe a common law duty of care in tort to third parties in respect of economic/financial loss. A negligent misstatement or misrepresentation, however, may give rise to an action in damages for economic/financial loss since the law will imply a duty of care when a party seeking information from a party possessing special skills trusts him to exercise due care and that party knew or ought to have known that reliance was being placed on his skill and judgement.

3.7.6.1 Resilience

Geometrically resilient defences are those which have relatively large freeboards that have the ability to withstand significantly higher water levels than those for which they were originally designed. Such defences are extremely rare, as they are not generally cost-effective. They only tend to occur where the defences are protecting very valuable or vulnerable assets (e.g. nuclear power stations)

For assets involved in conveying floodwater, it may be that the rate at which the asset is able to adjust or recover following an extreme loading will be important. De Bruin *et al.* (2003) note that both geomorphological systems and ecosystems need time to recover and that this is a problem if the next flood occurs before the natural system has had time to recover from the impact of a previous perturbation. Pumping systems can be overwhelmed if there is insufficient capacity at high flows. Resilient pumping systems will either be those where there is sufficient excess capacity to cope with all conceivable loadings or where there is an alternative location where the excess volume of water can be stored as the peak of the hydrograph passes through.

Structurally resilient defences are therefore those which exhibit relatively slow rates of failure under extreme loading, and are repairable when and where failure does occur. (Rock structures provide a good example of repairable structures as the armourstone can be reconfigured after damage into a renewed structural form.) This view of resilience is consistent with that recommended in section 4.3 of FCDPAG 1 (MAFF, 2001) and is supported by 'Learning to live with rivers' (ICE, 2002). ICE (2002) recommended that, during the examination of design options, not only the ability to withstand the design flood but also the performance when overwhelmed by a more extreme flood should be considered.

Whilst the structures may appear to be resilient, problems can still arise because of other challenges they face. Of particular importance to address are:

- the geomorphology surrounding the structures, which may be less well understood and hence otherwise robust structures can, for example, be undermined by toe erosion or attacked by erosion from the rear if they are overtopped. It is not always possible to quantify all these processes even if the possibility of them occurring has been identified.
- the durability of the component materials, which may be limited. This is especially true in the highly abrasive environments experienced in coastal waters and for this reason, many coastal structures only have an effective life of 20 to 30 years. Although some work has been undertaken on materials guidance manuals, more work is still needed to identify, codify and update resilient approaches to design.

For the management of resilient flood defence assets, policy makers and practitioners need to:-

- Adopt performance-based management systems and understand how structures will perform under a wide range of loads, including extreme conditions above the nominal 'design event'.
- Monitor, inspect and maintain flood defences particularly following extreme events (see 'monitoring and evaluation' below)
- Understand the consequences of more extreme climate change by using sensitivity tests and, for large strategic projects, by considering a wide range of future climate change and other uncertainties.

3.7.6.2 Adaptation

Defences may need to be adapted geometrically by raising them further in response to climate change and others may need to be removed or set-back to reduce flood risks downstream and provide environmental benefits.

Geometrically adaptable defences are those with enough surrounding space to permit adaptations. These are of two main forms:

(a) Raising of the flood defence crest level often requiring a widening of the defence. In rural areas, lack of space may not be an issue although there have been examples in recent years where a desire to avoid disturbing other features (e.g. habitats) has led to constraints on embankment widening. In urban areas the space for defence widening may be limited by the close proximity of infrastructure and buildings to the defences. There is also the contentious issue of loss of view of the river or coast when defences are raised in such areas.

(b) a moving back of the defence line, arising from managed realignment or by natural system movements (e.g. river channel migration or the "roll back" of a coastal dune or bank).

Natural systems such as river channels, dune and shingle bank systems and cliffs may be adaptive (as opposed to adaptable) adjusting their profile or cross-sectional area to suit increased loading or demand for additional capacity. However, year to year adjustments are also frequently imposed on beaches and channels by profiling, dredging or weed cutting.

In order to "future-proof" decisions about geometrical adaptability of defence assets, managers need to:-

- Avoid encroachment of development onto existing defences (or areas allocated alongside them for future raising) making it difficult to upgrade or remove them in future.
- Ensure that new defences and other risk management schemes are adaptable, and/or sufficient space around them for set-back and reconfiguration following land use change.

Structurally adaptable defences are those which are of a form which will permit changes without making prior works redundant. Achieving lack of redundancy is easier where the defence is maintained on the same geographic line (e.g. defence raising.) In this case the raised defence should make as much use as possible of the existing structure. This can either be as the foundation for the new structure or by re-using the materials from the old structure within the new one. Defences can only be adaptable in terms of relocation if the materials themselves can be re-used. In this regard 'flexible defences' (typically those formed of granular materials or rock) have a significant advantage over piled or gravity structures.

In order to "future-proof" decisions about structural adaptability of assets, managers need to consider:-

- Use of flexible structures where possible

- When adopting piled and gravity structures, use of foundations that are strong enough to support higher defences
- Use of demountable defences that are easier to upgrade and remove if flood risks or socio-economic priorities change.

3.7.6.3 Differences between resilient and adaptable defences

In the context of sustainability, resilience and adaptation to possible or probable and changing loads are important characteristics of flood and coastal defences. For, by considering resilience and adaptation of defences, the long term perspective appropriate to sustainable development is taken into account. However it must be understood that adoption of flood and coastal defences with high levels of resilience or high levels of adaptability may not be possible to achieve in the same location. Consideration of the following table illustrates the differences that might arise.

Table 3-5 Some characteristics of resilient and adaptable defences

	Defences with a high level of resilience, but little adaptability	**Defences with a high level of adaptation, but limited resilience**
Structural asset level characterisation	Conventionally designed (complex) scheme	Simple scheme, possibly innovative
Geometric asset level characterisation	Relatively large freeboard	Enough surrounding space
Response to changing loads	Possible change in inspection and maintenance	Possible adaptation/replacement of defence

Flood and coastal defences can be categorised by their level of resilience and adaptability, both contributing to sustainability of the defence scheme as illustrated in Figure 3.8.

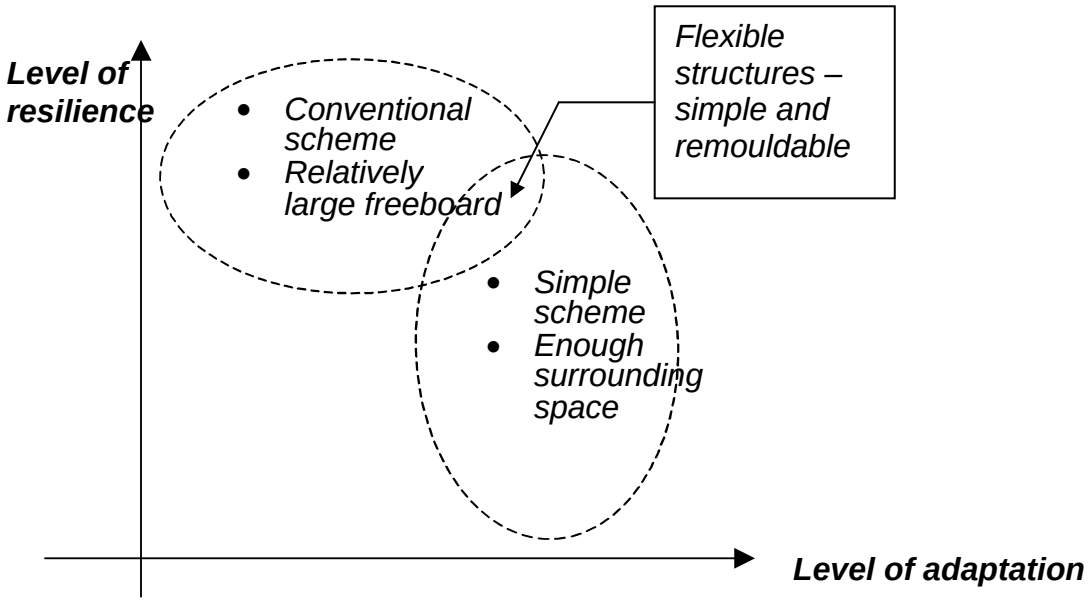


Figure 3-8 Resilience and adaptation of defence assets

Flexible vs. inflexible defences – issues for the future

Given that flexible structures offer great potential for resilient and adaptable solutions, it is important to understand the issues which must be addressed if there are to be used more widely in the future:

1. Future financial resources. A clear commitment is needed to invest the money in monitoring and maintenance that will be required if flexible defences are to be promoted. This will require implementation of pilot projects on which the capital and maintenance costs of such solutions can be evaluated within a framework of whole life costs and life cycle assessment.
2. Liability for design. Flexible adaptable defences tend to be less complicated (fewer material types/gradings) than conventionally designed defences and may have simpler and/or less deep foundations. By reducing the complexity of the scheme, they become more flexible for adaptation to changing circumstances. Some examples of flexible defences are described in the Defra/EA research on 'Low cost rock structures for beach control and coast protection' (Crossman *et al.*, 2003). However, achieving this flexibility may involve deviating from conventional design rules and thereby the performance of these structures becomes less predictable. Most of the adaptable structures existing to date have been designed by client organisations rather than consulting engineers. This is because clients are more prepared to experiment and be prepared to invest the higher level of maintenance activity which is required for adaptable or adaptive structures. Conversely, there is reluctance amongst consulting engineers to propose and design adaptable defences because they believe that they may be subject to claims from their clients should these defences fail rather quickly even if this possibility is made clear from the beginning. For this reason the contractual/legal arrangements adopted for designers employed on such projects need to be carefully considered (see Box … above)
3. Access and resources for maintenance. Flexible defences are ideal where the location of the defence is easily accessible for maintenance works and when practical and financial resources are available to carry out any maintenance or repair. Flexible defences are likely to require a higher level of resources / organisation for post construction management, especially during and after extreme events. Non-flexible defences are therefore more appropriate where access is poor and here alternative means of ensuring resilience and flexibility must be considered.
4. Beaches providing protection against storms are particularly good examples of flexible 'structures.' 'Failure' of beaches during storm events is unlikely to be catastrophic, so long as there is sufficient volume of material available in the beach. Beaches do however pose longer-term challenges because the material resources available for ongoing replenishment of beach volume are limited, especially for gravel/shingle beaches.) It is important that decisions are not made that tie future generations into unsustainable patterns of resourcing.

Further investigation of how resource limitations can be overcome may be required, for example by identification of new resources, increased use of secondary and recycled materials and/or reduced dependence on defences for flood and coastal risk mitigation in lower risk areas.

3.7.7 References

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3.8 Topic Note 8. Precautionary climate change allowances

3.8.1 Introduction

This Topic Note describes how the risks and uncertainties related to climate change should be considered in flood and coastal erosion risk management. It makes reference to existing guidance on the use of precautionary allowances and sensitivity tests for sea level rise and river flows respectively that are also included in Project Appraisal Guidance, SMP and CFMP guidance and PPG25.

The UK Government's Making Space for Water consultation document (Defra, 2004) highlighted the potential impacts of climate change as:-

- a four to ten-fold increase in coastal flood and erosion risk over the next 100 years with the greatest impacts in the South East.
- a two to four-fold increase in fluvial flood risk over the next 100 years with the greatest impacts in the North and West.

Research on the impacts of climate change on flood risks, such as the Office and Science and Technology's Foresight Future Flooding project, indicates a very wide range of uncertainty regarding the magnitude of changes in peak river flow and extreme sea levels (OST, 2004; CEH, 2005). Therefore, a wider range of possible scenarios for specific time periods (or epochs) up to 2100 should be considered in national assessments, strategic plans and large flood risk management projects where climate change has a significant impact on the cost and\or benefits. Understanding these uncertainties will ensure that solutions are developed that meet sustainability principles of:-

Scenarios should be used in strategic plans to test the sensitivity of flood risk management solutions

- **Risk Management.** Manage flood and coastal erosion risks to people and property, the economy and the environment.
- **Adaptation.** Take account of climate change and other long-term uncertainties in decision making.
- **Appraisal.** Adopt appraisal methods that are rigorous, coherent and open and consider long term social, environmental and economic costs and benefits.

This note describes how different scenarios can be used to test the sensitivity of flood risk management solutions to different rates of climate change. It does not recommend immediate changes to the current allowances in use for future applications for grant aided flood and coastal defence projects. These are sufficient for some projects and should be completed as a first step on all projects. In addition:-

- Ongoing Environment Agency and Defra research requires completion before further detailed guidance can be provided

Existing guidance is based on using a set of precautionary allowances that provide transparent and equal treatment of climate change in funding decisions

- For some projects there are practical barriers to considering a larger range of climate change scenarios, particularly for river flows[41]

3.8.2 Who is this topic note for?

Climate change impacts on flood risk should be considered in all water management policies and plans

This guidance is aimed at policy makers, engineers, planners and water managers involved in managing flood and coastal erosion risks. In particular:-

- Defra has the responsibility for many of the policy areas, including flood and coastal erosion risk management, which have been identified as priority areas for adaptation by the UK Climate Impacts Programme. The Department is also responsible reducing the UK's greenhouse gas emissions and for sustainable development.

The Foresight study showed that flood risks increase under all future climate change scenarios

- The Environment Agency is committed to *"limiting and adapting to climate change"* and aims to ensure that appropriate allowance for climate change is included in CFMPs and SMPs. The Environment Agency and their framework contractors are responsible for the delivery of flood risk management schemes and solutions.
- Regional planning bodies should consider the potential impacts of climate change on flood risk in regional spatial strategies. In particular Regional Spatial Strategies need to take a long term view that provides physical space for adaptation in terms of increasing river conveyance and floodplain storage.
- Local Authorities, many of whom have signed up to the Nottingham Declaration on Climate Change[42] to combat and adapt to climate change, must consider guidance included in forthcoming Planning Policy Statements on Development and Flood Risk (Topic Note 5) and should ensure climate change and flood risk is considered in Local Development Frameworks.
- Maritime authorities must ensure that appropriate allowances are made for climate change in coastal erosion schemes.

3.8.3 Limiting and adapting to climate change

Limiting and adapting to climate change is a key theme in Government's Sustainable Development Strategy. In a warmer climate, rising sea levels and

[41] There are already a wide range of event return periods and scenarios that need to be considered in strategic plans. Flood risk managers are mindful of the additional costs incurred by considering larger flows and at the same time lack confidence in some of the earlier science to produce the current river flow allowance.
New research on climate change impacts indicates a wide range of uncertainty rather than narrowing this range or providing more precise allowances.

[42] http://www.barking-dagenham.gov.uk/6-living/envir-protect/pdf/envir-nott-declaration.pdf

changing patterns in seasonal rainfall will increase pressure on flood risk management systems. The Foresight study showed that flooding risks increase under all future climate change scenarios and to unacceptable levels for some scenarios. It demonstrated the need to develop long term policies to adapt to an evolving and uncertain future (OST, 2004).

Existing guidance on taking account of climate change in flood and coastal erosion risk management includes:-

- Flood and Coastal Defence Project Appraisal Guidance Volume 1 (FCDPAG1) Chapter 6 and Volume 3 (FCDPAG3) set out the basis for the application of precautionary allowances to account for climate change.
- Further research led a supplementary note on climate change that summarised the precautionary allowances and sensitivity tests for sea level rise, waves, rainfall, fluvial flows (HR Wallingford, 2003).
- Planning Policy Topic Note PPG25 (DLTR, 2000) and PPS25 (forthcoming).
- Guidance on Shoreline Management Plans (Defra, 2005)
- Guidance for Catchment Flood Management Plans (EA, 2004)

Further guidance is provided in this document on the following activities:-

- Development of resilient and adaptive flood defence systems (Topic Note 7).
- Reduction of greenhouse gas emissions from flood and coastal management sector. (Topic Note 9).
- Monitoring of the impact of climate on flood risk (Example sustainability indicators in Appendix 2).

3.8.4 Link with sustainability principles

Climate change is a cross-cutting and key issue in the context of sustainable development. It is most closely related to the principle of adaptation.

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

Objectives:

- Promotion of resilient and adaptive flood defence systems
- 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).

The purpose of the precautionary principle is to ensure that decisions are taken notwithstanding scientific uncertainty about the nature and extent of the risk.

According to Government guidance it should be invoked *when "there is good reason that harmful effects may occur"* and when the *"best available scientific advice cannot assess the risk with sufficient confidence to inform decision making." (ILGRA, 2002).*

Defra and the Environment Agency have taken the lead in adopting the precautionary principle through the use of precautionary allowances for sea level rise in the appraisal of coastal flood defence schemes. However the precautionary principle and existing guidance does not rule out the use of risk-based approaches as long as these are based on credible scenarios.

3.8.5 Climate change allowances or climate change scenarios?

Precautionary allowances have the advantages that they are very simple to apply and provide a transparent and equal treatment of climate change for funding decisions across the UK. However, their precise nature does not reflect the uncertainty related to possible changes in river flow and extreme sea level that may be much lower, higher or highly variable depending on regional climate changes and catchment or coastal cell characteristics. If the adopted allowances are too high or too long term, the costs of schemes will be higher than needed and (assuming a fixed budget) it will take longer for future schemes to be implemented placing people and property at risk[43]. Such an approach will not *"ensure a fair balance between reducing risks for present and future generations"* or a fair balance spatially as some schemes are funded at the expense of others and funds from general taxation are diverted for the benefit of those at flood risk from other worthwhile projects. In order to take a long term view it is more appropriate to consider the adaptability and resilience of "portfolios of measures" (Appendix 4) so that regional spatial plans and flood risk management can be adapted in future as and when the pressures on flood risk and coastal systems become evident.

Understanding uncertainty can help decision makers and stakeholders select "low regret" measures that have clear benefits under a range of future scenarios

Developing credible climate change scenarios is time-consuming and complex and the impacts will be wide ranging (from negative to positive for changes in fluvial flows) providing the decision maker multiple scenarios to consider. However, understanding this uncertainty can help decision makers select

[43] Detailed research as part of the project has examined the impacts of increasing the precautionary allowances for fluvial and coastal flood defences to consider longer-term changes (FD2015 Project Record). This showed that increasing the sea level and fluvial allowances to 2100 would increase costs by 25%, influence the choice of options and delay the protection of properties from flooding. In addition, increasing the time-scale and adopting a more precautionary position (broadly equivalent to the UK Climate Change Impacts Programme High Emissions scenario) would increase costs by 35%.
Increasing the costs of flood risk management schemes could have a range of implications and could potentially lead to an unequal distribution of benefits both spatially and between generations (Project Record). Government approaches with regard to dealing with time preferences in project appraisal and attitudes to risk were set out in a background paper to the Making Space for Water consultation exercise[43]. This argues against a risk averse stance (equivalent to across the board increases precautionary allowances) because this would divert funding from other worthwhile projects. Indeed risk aversion is only an appropriate approach if the consequences would affect the national economy; modern examples of such risks are "Black Wednesday" £3-5 billion loss, "Foot and Mouth disease", about the same loss and various terrorist bombs in London and Birmingham with similar losses. Therefore flood risks that would incur greater than several £ billion losses may justify some aversion and an increase in precautionary allowances and the only potential example of this in the UK would be a flood affecting the City of London.

measures that are “low regrets” i.e. they have clear benefits (high benefit: cost ratios) under a range of possible future scenarios. The case study in Box 1 provides an example of how climate change scenarios influence the benefit: cost of different management measures. Further examples of this decision-making approach include the Foresight project (OST, 2004) and approaches described in Environment Agency and UK Climate Impacts Programme (UKCIP) guidance on risk, uncertainty and decision making (Willows and Connell, 2003). The latter guidance provides a comprehensive overview of methods that can be applied to climate change impacts assessment in large flood risk management projects.

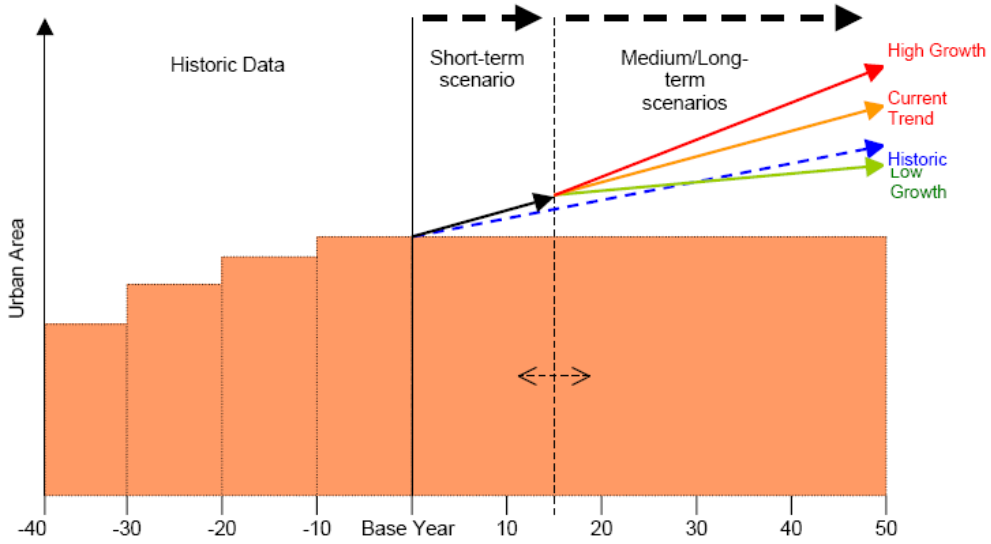
Climate change scenarios can be developed based on the outputs of Global Climate Models (GCMs). The UK Climate Impacts Programme have developed a set of climate change scenarios based on the outputs of the Met Office Hadley Centre’s Regional Climate Model (RCM) that provide changes in sea level rise and precipitation for different greenhouse gas emissions scenarios (Hulme *et al.*., 2002). Research in the water resources sector has shown that the major uncertainties in climate change scenarios relate to the choice of climate model and methods to translate changes to the catchment scale (UKWIR, 2005a). The water industry is developing practical methods for dealing with climate change that include using the outputs of more than one Global Climate Model (UKWIR, 2005b). The next generation of UKCIP climate change scenarios (due 2008) will be based on outputs from a wider range of models presented in a probabilistic form that will provide engineers with improved information regarding changes in rainfall and relative sea levels.

Scenarios can be developed in the form of a sensitivity analysis around the existing guidance on changes in sea level and peak river flow.

Alternatively scenarios can also be developed in the form a sensitivity analysis based on the existing allowances, expert opinion or stakeholder consultation. For example, rather than using a single allowance of 20% increase in fluvial flows, scenarios of “no change”, 10%, 20% and 40% provide an indication of the potential range of changes due to climate change over the next 100 years. This kind of approach is recommended in Environment Agency guidance on CFMPs (EA, 2004, Volume 2, p42) as part of the development of scenarios to 2100 that consider urbanisation and land management as well as climate change. Ongoing Defra and Environment Agency research aims to provide the scientific understanding to support the development of new allowances and scenarios.

Climate change is a driver for the probability of flooding but the consequences also depend upon future socio-economic changes that affect the number of properties and people in the floodplain. Therefore it is necessary to consider future socio-economic change as well as climate change in major flood risk studies. The Foresight study provides information on socio-economic change in the UK that can be paired with climate change scenarios to understand possible changes in flood risk (Table 2). CFMP guidance describes how land use change can be considered in future plans.

Figure 3-9 CFMP guidance – example of the development of scenarios of catchment urbanisation



Flood risk management activities are wide ranging and it is clear that a combination of precautionary allowance and scenario approaches are required for different flood risk management activities. Existing guidance on the use of precautionary allowances provides an appropriate first-pass assessment of the potential impacts of climate change for any study. For national flood risk assessments strategic plans, large-scale flood and coastal projects the selection of management measures should be based on a range of future scenarios and this paper describes how these can be developed in subsequent sections.

3.8.6 Taking a long-term view

At present flood risk management typically considers time-scales of 30 to 50 years, while geomorphological studies, like those described in the Humber Estuary case study (See Handbook Volume 2), take a much longer term view. There is now greater emphasis on appraisal of policies and schemes over a longer time scale of 100 years. SMP and CFMP guidance sets out the requirement for considering changes to 2100 in order to ensure that policies adopted now do not limit future coastal policies (Topic Notes 10 and 11).

For reasons already explained in Section 3.8.2, it is not appropriate to add allowances for 2100 into immediate flood risk management schemes because this “risk averse” approach would reduce the relative number of funded schemes, and therefore the number of properties and people, protected from flooding. However the impact of today’s decisions on future choices must be considered in strategic plans. In general terms adaptive policies will be those that create physical space for increased conveyance and storage and involve using a wide range of flood risk management measures.

3.8.7 Activities

3.8.7.1 Use of precautionary allowances and sensitivity tests

Defra and the Environment Agency have adopted a precautionary approach in assessing the impacts of climate change on flood risk. This includes the use of standard precautionary allowances to account for rises in sea level, changes in wave height and river flows over the next 50 years. The allowances for sea level rise have been in place since 1989 and other allowances have been added as the science of climate modelling and impacts assessment has improved. Table 3-6 summarises the current climate change allowances following a review of the UK Climate Change Impacts Programme climate change scenarios that were produced in 2002.

Table 3-6 Precautionary allowances and sensitivity tests currently adopted and recommended following a review of the UKCIP02 scenarios (from HR Wallingford, 2003)

Parameter	Current practice	Recommendation #
Mean sea level	4 mm/yr for the NW & NE (North of Flamborough Head) 5 mm/yr for SW & Wales 6mm/yr Thames, Anglian, Southern, NE (South of Flamborough Head)	No change
Extreme sea level	Usually assumed to be as for mean sea level	No change, but review if higher values for Thames and Anglian are supported by other models
High and extreme rainfall and river flow	Add 20% over 50 years*	No change to sensitivity allowance, but ongoing research may lead to refinements, possibly by region and/or duration
High and extreme wind speeds and wave conditions	None	Add 10% sensitivity allowance to offshore wind speeds and wave heights by 2080s (and 5% to wave periods)

* The 20% figure is based on limited research and further guidance is expected following the completion of research at CEH.
# Further sensitivity testing based on climate change scenarios was recommended for larger projects.

Currently these allowances are used in the following flood and coastal erosion risk management activities:-

- Sea level rise must be considered in the appraisal of capital schemes, typically considering a time horizon of 50 years (FCDPAG3)
- Guidance on risk (FCDPAG4) recommends sensitivity analysis on fluvial schemes to take account of a 20% increase in peak river flows over the next 50 years.

- The sea level rise and river flows allowances were adopted in the Section 105 Floodplain Mapping Programme and in Policy Guidance (PPG) Note 25 on development and flood risk.
- The allowances have also been included in guidance for Shoreline Management Plans (SMPs) Catchment Flood Management Plans (CFMPs).
- In drainage design 10% is typically added to design rainfall depths or storage volumes (HR Wallingford, 2004).

3.8.7.2 Consideration of climate change in planning

Climate change is discussed in Appendix A of PPG25. The information provided is consistent with the allowances included in Table 1, except no specific sensitivity tests are suggested for waves and wind and a figure of a 10% increase in rainfall is quoted. For the consideration of coastal erosion, tidal flooding and fluvial flooding the guidance provided in Table 1 should be followed.

For drainage design a sensitivity test of +10% rainfall is an appropriate precautionary allowance for climate change up until the 2050s and is consistent with guidance provide to drainage engineers (HR Wallingford, 2004). Sensitivity tests of +20% or the use of catchment scale winter rainfall factors for the 2020s, 2050s and 2080s based on the UK Climate Impacts Programme climate change scenarios may be used to test the robustness of schemes over a longer time frame and for more extreme scenarios.

The first draft of national groundwater flood maps were recently produced by the Environment Agency[44]. Climate change was not considered in these maps and there are no standard guidelines for considering the impacts of climate change on groundwater flooding.

3.8.7.3 Catchment Flood Management Plans

CFMPs require the development of credible future scenarios for 50 and 100 year planning horizon. Recent guidance (CFMP guidance Volume 1, July 2004) suggests that this should draw upon the findings of the Government's Foresight project and suggests an approach using sensitivity tests around the +20% allowance for fluvial flows (CFMP guidance, Volume 2). The increases in flow should be applied to flow at the inputs to hydraulic models in order to consider the attenuation of flood volumes within the floodplain system.

CFMP's should also consider land use change based on different socio-economic scenarios. Table 3-7 summarises the pairing of climate change and socio-economic scenarios used in the Foresight project (OST, 2004). Clearly other pairings or more tailored scenarios are possible and may be explored through the stakeholder consultation process and then tested in the draft CFMP.

[44] http://www.defra.gov.uk/environ/fcd/policy/strategy.htm

Table 3-7 Correspondence between UKCIP02 scenarios and Foresight Futures

UKCIP02	Foresight Futures 2020	Commentary
Low emissions	Global Sustainability	Medium-high growth, but low primary energy consumption. High emphasis on international action for environmental goals (*e.g.* greenhouse gas emissions control). Innovation of new and renewable energy sources.
Medium-low emissions	Local Stewardship	Low growth. Low consumption. However, less effective international action. Low innovation.
Medium-high emissions	National Enterprise	Medium-low growth, but with no action to limit emissions. Increasing and unregulated emissions from newly industrialised countries.
High emissions	World Markets	Highest national and global growth. No action to limit emissions. Price of fossil fuels may drive development of alternatives in the long term.

Example sets of climate change sensitivity figures are summarised in Table 3-8. However, these are simply examples - stakeholders and project engineers with local knowledge may develop appropriate assessments of the impacts of climate change and ongoing research may produce new improved guidance in the near future.

Table 3-8 Examples of climate change sensitivity tests

(a) Example sensitivity tests to take account of climate change impacts on fluvial flows: % increase in peak flow. Based on the UKCIP02 scenarios and the scaling factors used to scale temperature between scenarios. To be replaced by outputs from W5B-01-050[45].

Time slice	Low Emissions	Medium Low Emissions	Medium High Emissions	High Emissions
2020s	8%	9%	9%	10%
2050s	15%	18%	20% (current guidance)	24%
2080s	21%	25%	35%	41%

(b) Example sensitivity tests to take account of climate change impacts on fluvial flows: % increase in peak flow. Based on expert opinion and considering that different GCMs and downscaling methods will produce different results. To be replaced by outputs from W5B-01-050.

Time slice	Low	Medium	High
2020s	No change	No change	10%
2050s	No change	10%	20%(current guidance)
2080s	10%	20%	40%

3.8.7.4 Shoreline Management Plans

It is now a requirement for SMPs to take a long term view, considering changes beyond a 50 year time horizon. This is achieved by considering objectives, policy setting and management requirements for different time scales, 0 to 20 years, 20 to 50 years and 50 to 100 years. Scenarios are developed that describes changes for coastal cells for each time period. This approach aims to ensure that management policies proposed in the short term are not detrimental to the long term development of a sustainable plan.

Guidance on relative rates of sea level rise is well established with rates of 4, 5 and 6 mm per year used for different parts of the England and Wales coastline (HR Wallingford, 2003). Table 3-9 provides rates of sea level rise that can be used for sensitivity testing around the current guidance figures. These rates are based on the relative rises used in the Foresight Future Flooding project.

[45] These are based on climate variable scaling factors presented in the UKCIP02 climate scenarios technical report (Hulme et al., 2002; Table 7) and the assumption that +20% is an appropriate allowance for the 2050s Medium High Emissions scenario. Clearly the relationship between changes in temperature and river flow or extreme sea level will not be linear because it depends on the interaction of a large number of variables (precipitation, potential evapotranspiration) and catchment parameters. The table provides guidance where no better information are available. Catchment specific or regional factors may be produced as an output of ongoing Defra and EA research (W5B-01-050) or can be developed on a project by project basis using rainfall-runoff models and continuous simulation.

Table 3-9 Relative sea level rise under different climate change scenarios (based on Burgess and Townsend, 2004 and HR Wallingford, 2003).

Relative Sea Level Rise mm per year		Sensitivity tests for other scenarios			
Assume the same rate per year for each epoch (multiply rate by number of years assuming a base year of 2000)	Current Guidance	High	Medium High	Medium Low	Low
North East	4	8	4	3	2
South	6	8	6	3	2
West	5	8	5	3	2

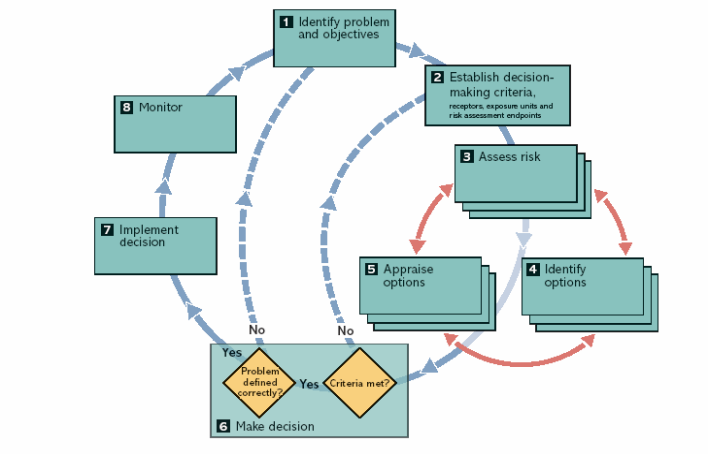
As similar approach can be taken for extreme sea levels and waves (e.g. see Burgess and Townsend, 2004) but the current guidance is adequate given that climate models are very poor at reproducing observed wind and the surge models are too coarse to provide useful data for most coastlines and estuaries.

3.8.7.5 Options appraisal

Methods for options appraisal are described in Volume 3 of the Project Appraisal Guidance series and discussed in Topic Note 3.

Dealing with multiple scenarios adds further complexity to the decision making process but there is guidance available on how this can be achieved published by the UK Climate Change Impacts Programme (Figure 3-6) and in the Treasury Green Book. Considering multiple scenarios within options appraisal and economic assessment can help to identify “low regret” options, like raising flood awareness and emergency planning that are likely to have benefits for all future scenarios. However practical approaches are required, perhaps linking with MCA or SA that can demonstrably improve decision making rather than simply increasing the complexity of the options appraisal process.

Figure 3-10 Risk and uncertainty framework for decision making (Willows and Connell, 2003)



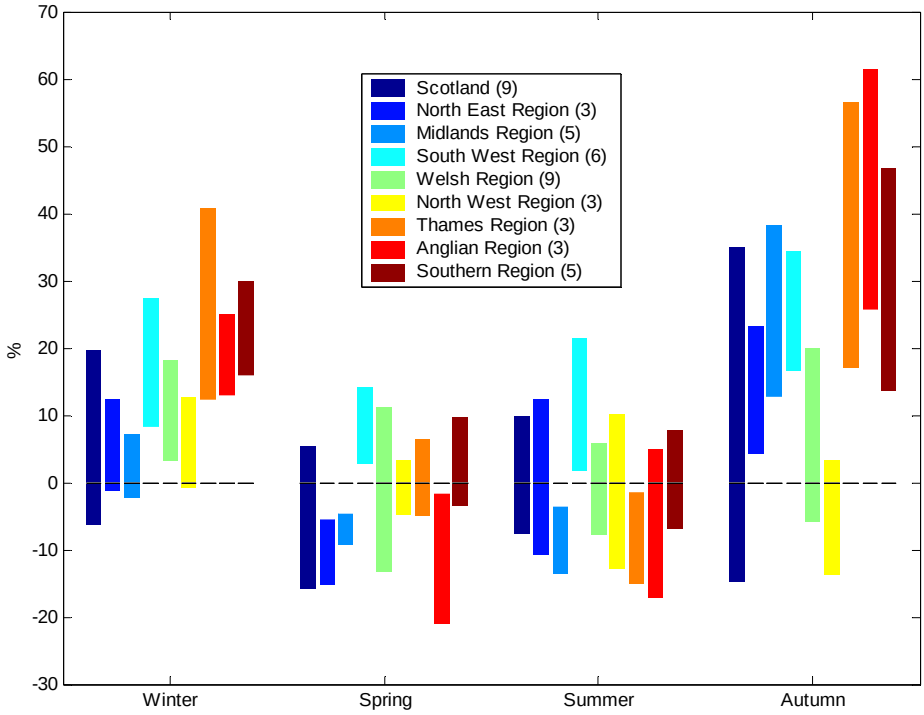
3.8.7.6 Reduction of greenhouse gas emissions from flood and coastal management sector

The flood risk management sector is not a major contributor to UK greenhouse gas emissions. Nevertheless, the production, transport and consumption of materials and the personal travel of individuals involved all contribute to emissions and the sector can make an important contribution to more sustainable production and consumption of materials. Topic Note 9 provides advice on the use of materials and Part 2 of the Handbook includes a case study on the use of the Ecopoints tool, that considers transport of materials as one environmental factor that influences options for scheme design.

3.8.7.7 Monitoring of the impact of climate on flood risk

Given the considerable uncertainty regarding climate change and its impacts on flood risks, it is important to continually monitor trends in sea level rise, wind speeds, rainfall and river flows. There are a range of hydrological and coastal indicators that can be used to monitor change but due to the natural variability it will take decades before significant trends can be detected and attributed to climate change. Figure 3-6 summarises trends in average seasonal runoff for more than 40 rivers in the UK. There appears to have been an increase in autumn and winter runoff but only a very small number of trends are statistically significant (UKWIR, 2005c).

Figure 3-11 Percent change in average seasonal trend component between the periods 1978 to 1990 and 1991 to 2003 for different regions. **The number in parentheses is the number of sites used to determine the percent change interval. Positive values indicate an increase in flow and negative values a decrease in flow. (UKWIR, 2005c)**



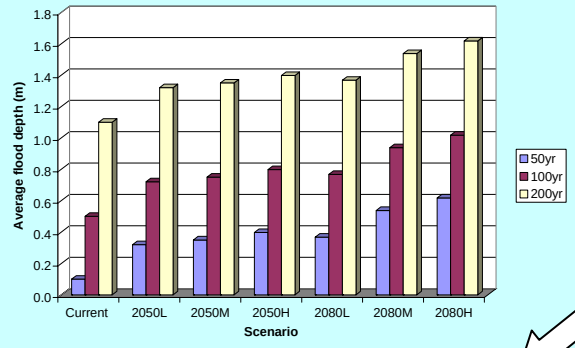
3.8.7.8 Research on the impacts of climate change on flood risk

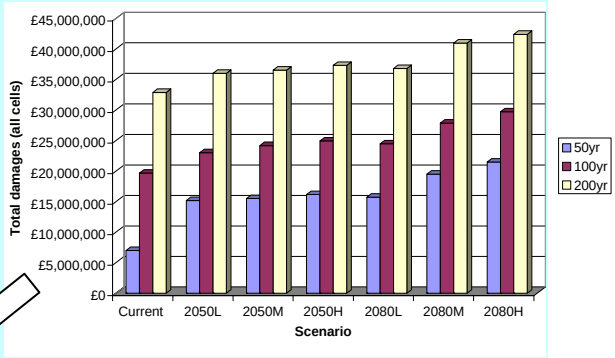
Flood and coastal erosion risk policy and management must be informed by research into the potential impacts of climate change on flood and coastal erosion risk. The recent Government Foresight project on Future Flooding highlighted the wide range of uncertainties in climate change impacts and the effectiveness of alternative adaptation measures. Ongoing research as part of Defra, Environment Agency, research council and European Commission projects will improve our understanding of the impacts of climate change and filter down into policy and practice. Major ongoing research projects include the Flood Risk Management Research Consortium (FRMC) and the FLOOD*site* project (see “Directions” below).

Box 1. Example of considering different climate change scenarios

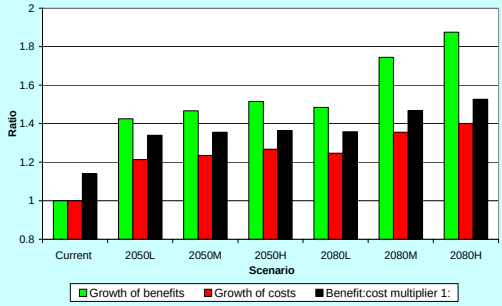
Increased flood depth and extent

Increase in damages and costs to maintain specific level of service





Changing cost: benefit for different options under each scenario



Selection of package of measures that meets economic criteria and performs well under future scenarios

3.8.8 Directions

Government guidance

- FCDPAG series http://www.defra.gov.uk/environ/fcd/pubs/pagn/default.htm
- PPG25 http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_606931.hcsp
- Environment Agency.
- ODPM includes a range of guidance include a guidance document on tackling climate change http://www.odpm.gov.uk/stellent/groups/odpm_planning/documents/page/odpm_plan_032088.pdf
- Consultation of Government flood risk management strategy http://www.defra.gov.uk/environ/fcd/policy/strategy.htm

Tools

- UKCIP02 climate change scenarios www.ukcip.org.uk
- UKCIP02 Risk and Uncertainty Framework www.ukcip.org.uk
- Rainfall-runoff models (Annex 1)

	• Combined probability analysis (Annex 1) • Flood Estimation Handbook (Annex 1) http://www.nwl.ac.uk/ih/feh/ • River Conveyance calculator http://www.river-conveyance.net/ • Risk Assessment for Strategic Planning (RASP) – RASP is a useful tool for assessing risks at a national or regional scale.
Example indicator groups	1. Trends in flood "forcing variables" (annual maxima; peaks over threshold; mean winter flows; relative sea level rise) 2. Trends in flood risk (annual average damage; annual average risks to people) 3. Awareness of climate change
Case study	• No specific case study but refer to Foresight Future Flooding project http://www.foresight.gov.uk/Flood_and_Coastal_Defence/index.html
Ongoing research & initiatives	• FLOOD*site* http://www.floodsite.net • FRMRC http://www.floodrisk.org.uk • Defra and Environment Agency joint programme http://www.defra.gov.uk/environ/fcd/research/default.htm
Further information	• Defra information on climate change http://www.defra.gov.uk/environment/climatechange/07.htm

3.8.9 References

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3.9 Topic Note 9 : Wise Use of Materials

3.9.1 Introduction

The wise use of materials is an important consideration for sustainable flood and coastal risk management.

This Topic Note describes how the use of materials can be considered as part of the move towards more sustainable flood and coastal erosion risk management. Because of the increase in recent years of severe river flooding in the UK and the predicted acceleration in sea level rise, it is expected that the increase in demand for materials will be proportionately greater in this sector of civil engineering than for general construction. This guidance outlines the existing mechanisms and tools that can and should contribute to their sustainable production and consumption of flood defence and erosion control materials throughout the resource life-cycle from extraction through to disposal.

3.9.2 Why is the use of materials an important sustainability issue?

Demand for materials in river and coastal engineering is likely to increase in the future.

Reducing the consumption of non-renewable natural resources and limiting the generation of waste is a key theme in UK Government Strategy. Coastal and river engineering activities in the UK presently use about 1 million tonnes of armour-stone and about 2 million tonnes of largely sea-won aggregates, at a value well in excess of £100M each year. At present, this usage consists almost entirely of primary materials, for example, marine dredged sand and gravel for beach recharge schemes and high-quality rock, predominantly from coastal quarries. At present, the average volume of sediments involved in beach recharge and recycling operations is of the order of 2 million tonnes per annum; this is predominantly sand, although there have been a number of major shingle beach recharge schemes in recent years as well.

There are growing concerns regarding the environmental consequences and sustainability of using primary resources for construction materials.

Increasing the use of alternative materials is potentially a more sustainable solution for future demand.

It is therefore important that coastal and river engineers, in particular, address their resource usage and reduce consumption wherever possible. The Environment Agency has introduced targets to encourage the use of alternatives to primary aggregates to this end. If demand grows as presently expected, then by 2012 an extra 20 million tonnes of aggregates will be needed annually by the construction industry as a whole.[46] There are no reliable estimates available as to the volume of remaining accessible primary resources of this nature however

[46] see http://www.aggregain.org.uk

there are growing concerns regarding the environmental consequences and long-term sustainability of extracting, processing and transporting large amounts of construction material.

The Aggregates Levy introduced by the Government in 2002 is an environmental tax on the commercial exploitation of aggregates in the UK. The main aim of this is to reduce the demand for primary aggregates and encourage the use of alternative materials. Increasing the use of alternatives such as recycled construction materials is potentially a more sustainable option for meeting the future demand for aggregates.

In addition to being a major consumer of natural resources, the construction industry is also one of the largest generators of waste in the UK, producing approximately 150 million tonnes of waste per annum (Smith *et al.*, 2002). Landfill space is limited in the UK and the implementation of the EU Landfill Directive prompted the UK Government to introduce the landfill tax and a new waste strategy in an effort to promote changes in behaviour and to meet new waste targets. However inert construction and demolition materials are still going to landfill. Increased recycling of such materials where appropriate can further reduce the demand for primary aggregates for new construction projects and could also reduce non-renewable resource consumption.

3.9.3 Sustainability Principles

The wise use of materials is linked with several principles and specific objectives (shown in bold) below:-

Environment. Protect and enhance the natural environment

Objectives:

- Understand 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.
- Reduce runoff at source through the use of SUDS
- Prevent inappropriate development in the floodplain
- Promote managed realignment in coastal and fluvial systems

Consumption & Production.

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

3.9.4 Environmental Challenges

The whole life-cycle from extraction to waste disposal needs to be considered in sustainability terms.

From an environmental perspective, Sustainable Development is concerned with improving the efficiency with which energy is used, materials are extracted from nature and waste is minimised. To apply the principles of sustainable development requires improvements in eco-efficiency throughout the life-cycle of a particular product, structure or service. Within construction, the typical life-cycle consists of a series of stages from extraction of raw materials, design, processing or manufacturing, distribution, construction, use, reuse, recycling and ultimately waste disposal. Thus in the design of any flood or coastal defence structure, life-cycle assessment (LCA) is aimed at supporting better and more informed decisions.

Analysis needs to include consideration of energy consumption and emissions, as well as the use of materials.

In addition to reducing the basic resource demands, there are further potential advantages to the natural environment in reducing the impacts such as CO_2 emissions, embodied energy (see Box 1), etc. associated with the extraction, processing and transport of primary materials to construction sites. Embodied energy analysis can be used as an integral part of a full Life-Cycle Assessment or used in isolation depending on the requirements. In construction, materials are normally heavy and transportation can be energy intensive. However, it is often the case that smaller quantities of materials with a higher embodied energy are required to perform the same function as larger quantities of materials with lower embodied energy. For this reason it is preferable to compare the total embodied energy of different structural options rather than individual materials.

Box 1: What is embodied energy?

Embodied energy is the quantity of energy required by all of the activities associated with the production process and associated usage. Using a clay brick as an example, the embodied energy includes the energy to extract the clay, transport it to the brick-works, mould the brick, fire it, transport it to the construction site and put the brick into place. It also includes the energy required to manufacture the equipment and materials needed to manufacture a brick, e.g. trucks, kilns, mining equipment, etc. All have a proportion of their energy invested in the brick.

The environmental challenges, therefore, include:

- Avoiding / minimising physical disturbance and damage to habitats (above and below sea level);
- Avoiding pollution or contamination by spills, leaching of heavy metals and chemicals, washing-out of fine sediments, etc;
- Limiting pollution and emissions through energy use;
- Limiting disturbance to local residents caused by traffic, noise and vibration, especially at night; and
- Preserving and enhancing the environment for amenity, recreation, and tourism (landscape aesthetics, beach quality, etc).

The environmental suitability of alternative, secondary and recycled materials, where previously untested, needs careful consideration.

With increasing consideration of alternative, secondary and recycled materials for construction in flood and coastal engineering where they are previously untested, comes the concern over potential environmental impacts. The close proximity of sensitive receptors such as potable water and aquatic habitats and species to flood protection schemes and structures requires confidence in the environmental suitability of the materials to be used for construction. The *Coastal and Marine Environmental Site Guide* (CIRIA, 2003. C584) provides general guidance on the precautionary practices that should be applied during construction.

3.9.5 Economic Challenges

Flood defences, in addition to reducing the risk of flooding to human life, also reduce risks to property, the loss of which can be both distressing and costly.

In a survey conducted for the Environment Agency's 2001 Flood Defence Investment Strategy for England (Halcrow Maritime, 2001), regional Environment Agency (EA) offices gave their spend in the 1999/2000 financial period for maintenance and replacement of river and sea defences. For river and related defences, maintenance costs amounted to over £35m, and replacement costs of just under £122m.

For sea and tidal defences, maintenance costs equated to over £17m and replacement costs of just under £97m. That totals a yearly spend for maintenance and replacement of coastal and river defences of over £271m. This excludes the expenditure incurred by local authorities, for example on coast protection schemes, and on schemes carried out in other parts of the UK.

Economic challenges, therefore, include:

Recycling and reuse of construction and demolition waste may prove cost-effective.

Alternatively, the incorporation of existing structures within new schemes may also have both financial and environmental benefits.

- The requirement to keep costs to acceptably low levels, as the majority of schemes in flood and coastal engineering are publicly funded;
- The costs of further research into the use of recycled and alternative materials in coastal and river engineering required to establish adequacy, demonstrate design and application, and to promote uptake and use;
- Uncertainty in 'best value' option decision-making.

At present, the total cost of sediments involved in beach recharge and recycling operations (predominantly sand and some recent major shingle schemes) on average is typically in excess of £10 million per annum. With many defences in poor condition and the threat of greater dilapidation and inadequacy due to increased storminess and sea level, this cost is likely to rise.

Expenditure on flood embankments greatly outweighs that on any other type of coastal protection and flood defence works in the UK considering all embankments alongside rivers, estuaries, tidal inlets and the coast. Collectively the estimated annual maintenance and replacement costs in the UK are about £25 million and £95 million respectively.

The annual replacement cost of floodwalls is estimated to be £10 million and expenditure on riverbank protection schemes amounts to some £20 million per annum although there are numerous privately funded schemes with a similar purpose.

An important consideration is the opportunity for the recycling and reuse of construction and demolition waste (e.g. concrete) from coastal and river structures themselves. In some cases this may prove to be the most cost-effective and environmentally sensible solution. Often however this opportunity does not arise as original structures tend to be incorporated as they exist within new schemes. This reduces the scale of the new works and saves energy that would otherwise have been used in the disposal or recycling of the original structure. The wider consideration though of other generic option choices for coastal defence such as realignment could increase the amount of material produced from the decommissioning of defences.

As flood risk rises and public awareness grows there is likely to be a congruent rise in privately funded schemes looking for part funding from the exchequer.

Public pressure calling for funds from the government may become very difficult to manage.

Coast protection and beach management schemes are the most common types of coastal engineering works in the UK and the most likely to be influenced by any national incentives and targets for reduction in the use of primary aggregates.

Analysis of whole life costs is important, as the deterioration in performance of materials over the longer term can be significant.

If the costs of providing flood protection can be reduced by utilising lower value materials then there may well be better cost/benefit justification for the defence of lower value assets. Materials for consideration may for example include old railway sleepers for temporary/de-mountable flood defences in rural areas. Emergency interventions can often lead to improvisation utilising whatever materials are to hand, primary or secondary.

Whole life cost estimates for structures may be significantly inaccurate if performance of materials over the longer term is not better understood. Poor performance due to deterioration of structural fabric and materials increases maintenance costs and can shorten the life span of a structure, increasing whole life costs.

3.9.6 Making Space for Water

The UK Government's Making Space for Water consultation document did not highlight the use of materials in flood and coastal construction as a major issue other than in terms of increasing flood 'resilience' in buildings to improve the quality and sustainability of new and refurbished buildings. However, sustainable production and consumption is an emergent theme of the Government's new strategy on Sustainable Development and this will become a more important issue in flood and coastal erosion risk management.

3.9.7 Level or location in framework

Materials and the sustainable use of resources is a cross-cutting issue that is relevant to all levels of flood and coastal management and to all the sustainability priority areas identified in *Taking it on* (2004).

3.9.8 Legal and Regulatory Conditions

Any potential for reducing the costs of coastal and river engineering schemes should be a high priority for those responsible for their construction, maintenance and replacement. Especially in large-scale projects, choosing cheaper but acceptable resources in the form of alternative materials could result in a significant reduction in project costs and the use of primary materials.

At present, planning conditions can sometimes inhibit the use of secondary and recycled materials.

The best approach for increasing the use of recycled and secondary materials under the existing legal and regulatory conditions would probably be through collaborative pilot studies, trials and dissemination involving the relevant licensing bodies (such as the EA, SEPA, Countryside Council for Wales, FEPA, Local Planning Authorities, Crown Estate, etc.), suppliers, processors, engineers, designers and contractors.

Greater incentives and means to demonstrate the potential gains of using alternative materials (both economic and environmental) need to be developed.

Conditions placed on planning permissions for works, such as specified finishes for schemes, can inhibit the use of secondary and recycled materials in coastal and river schemes. Often those responsible for writing conditions on licenses do not have the technical expertise to take into account the implications of the restrictions they place on materials, which can adversely affect the use of alternative materials. Over stringent specifications under Food and Environmental Protection Act 1985 (FEPA) licenses relating to the use of materials, particularly in environmentally sensitive areas limit the choice of materials that can be used in schemes. As experience of using secondary and recycled aggregates increases and dissemination of the successes and benefits of such schemes take place, regulatory authorities will probably view applications for the use these materials in schemes more favourably.

3.9.9 Activities

There is currently little positive incentive to use alternative aggregates in coastal and river engineering schemes. If there were economic gains through lower costs of such materials or better recognition for such schemes and those engineering them then the uptake of alternative materials might improve.

Central, regional and local government offer limited support for the use of these materials in such schemes. For example, the Defra appraisal process for coastal and river schemes usually dismisses any uncertain solutions at an early stage. Schemes involving alternatives to primary aggregates about which concerns exist, for instance, over environmental impacts or the supply of construction materials are likely to be discounted in preference to ‘safer’ designs employing tried and tested methods and materials. Defra’s requirement for publicly funded schemes to be assessed on a cost benefit basis, also acts as a barrier, as these assessments rarely prove favourable for recycled or secondary materials.

3.9.10 The Timber Manual

The ‘Timber Manual’ by Crossman and Simm (2004) demonstrates how principles for materials can be identified researched and developed into tools for the practice of sustainable procurement and use. The manual provides a framework for the responsible procurement of timber. Similar guidance can and should be developed for other materials.

3.9.11 The Ecopoints Estimator Tool

The ‘Ecopoints Estimator’ (developed by the Building Research Establishment and HR Wallingford in collaboration with representatives of the construction materials sector) enables the identification of scheme and material options that have less impact on the environment and are more sustainable. Ecopoints are calculated from the effects on the environment of the extraction, processing and transport components of the life-cycle of each material up to the time they leave the factory gate.

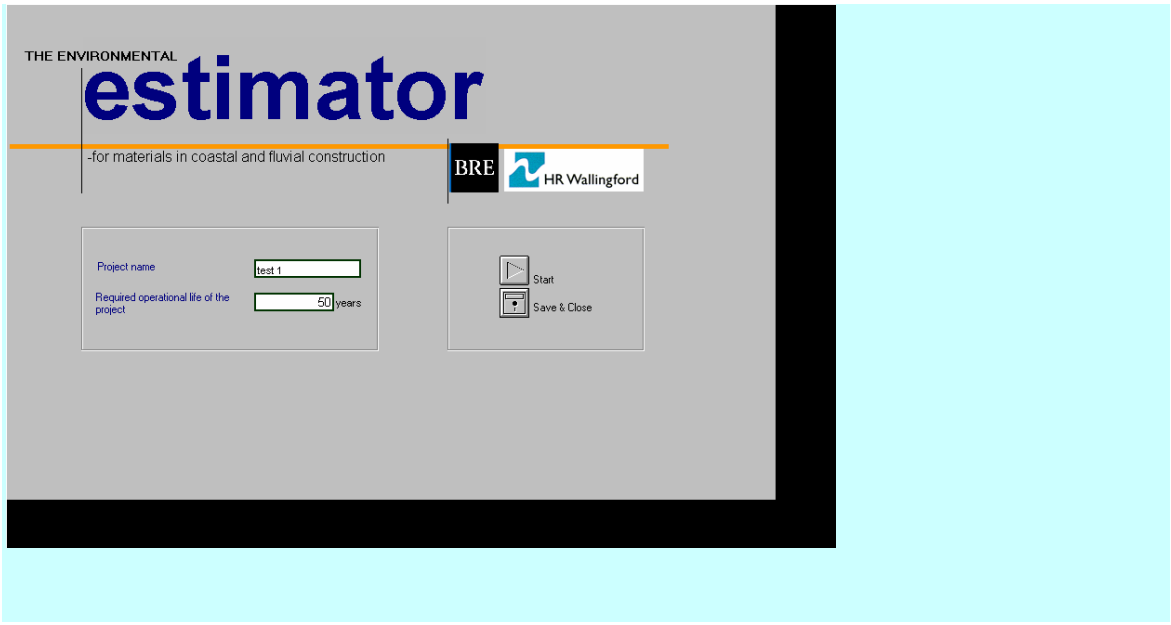
The Estimator can be used to compliment other methods and processes, such as Environmental Impact Assessments, for evaluating the environmental impacts of different project options. It can help to identify specific areas of different project options that can be targeted and modified in order to decrease their impact on the environment.

This tool is designed to be used by authorities in the project appraisal and tender evaluation process. It may also be appropriate for tenderers to use the Ecopoints spreadsheet to assess the environmental impacts of using alternative sources of materials.

Box 2: The Ecopoints estimator tool and case study

Case study 6 describes the sustainable use of materials for the Brighton Marina to Ovingdean Coast Protection Scheme (Handbook, Part 2). The scheme design and the construction process of this seawall incorporated significant reuse of materials from the existing defences in the new works. In this case study the Eco-point estimator was tested to analyse its user friendliness and to make a comparison for what was actually done on site and the score for the same scheme without recycling.

The Ecopoints estimator was originally developed as a method for comparing the environmental impacts of scheme design options. In this case study its usage was tested on a scheme under construction. Results show that the Eco-point estimator is a very user-friendly tool to easily assess the environmental impact of decisions made with regard to the use of materials in design and also construction. For the Brighton to Ovingdean coastal protection scheme, the reduction of environmental impact through the reuse of materials was estimated to be around 3%.



Physical and biological effects can vary with the use of different materials.

The Ecopoints Estimator, however, does not adequately consider the potential for ecological and aesthetic impacts of the use of different materials.

3.9.12 Water Framework Directive

The Water Framework Directive (2000/60/EC) aims to raise coastal and inland water quality and aquatic ecosystem health across Europe to a 'high' status by 2015. This requires member states to take action to protect the morphology and ecological status of watercourses. It is not yet clear what impact the directive will have on the construction of river and coastal defences, or on such activities as maintenance dredging.

Physical and biological effects can vary with the use of different materials. Structural dimensions can change depending on the construction material to be used, which, for instance, might enlarge the footprint of a structure. Dispersion and wash-out of fine grained particles from a structure affects water clarity and may cause changes in the sedimentary or morphological characteristics of a river or seabed. Another example is a change to the permeability, and hence the gradient of a beach. This could cause an increase in the rate of sediment transport along a coastline, leading to changes in beach levels in front of seawalls or existing patterns of shoreline change.

Rivers, coastal waters and the adjacent land margins are often of great importance as habitats, supporting a wide variety of plants and animals. Chemical and physical effects of the use of different materials may also create different or extra biological impacts.

The effects on water quality need to be assessed on a site by site basis.

Although some general guidance is possible on the acceptability of materials for schemes, each project proposal has to be judged on its particular circumstances. For example, concerns about the effect on water quality will be greater in areas where the water is particularly clear and for rivers used by salmon or trout for breeding.

Stringent specifications under Food and Environmental Protection Act 1985 (FEPA) licences relating to the use of materials, particularly in environmentally sensitive areas (e.g. SSSI, SPA, SAC), limit the range of materials that can be used in engineering schemes. FEPA licence applications are considered on a case by case basis, reflecting the possible differences in each location. This can result in uncertainties at the design stage regarding which materials might be acceptable. Thus there is a tendency for engineers to opt for more analogous materials.

Aesthetic impact may be more perceived than actual.

New obligations under the Water Framework Directive, particularly stringent specifications for pollutants from diffuse sources, may act against the use of some materials in water environments.

The aesthetics of coastal and river environments can be very important to an area, particularly if tourism, recreation and related activities depend upon it. There is already some resistance to the use of novel types of structures in river and coastal engineering schemes, for example rock groynes, because of the perceived aesthetic effects, and in areas designated because of their scenic qualities there are often guidelines on appropriate forms of construction. Aesthetic impact may be more perceived than actual. In Cornwall for instance, many beaches formed largely of China Clay mining waste are regarded not only as acceptable but also an asset to the landscape and to tourism.

3.9.13 Environmental Management Systems, ISO14001, and Life-Cycle Analysis

Environmental Management Systems, ISO 14001 and Life-Cycle Analysis can be used to identify, account for and remediate environmental impacts.

Environmental Management Systems and ISO 14001 can be used by companies involved in flood and coastal works to identify, account for and remediate the environmental impacts of some their practices and works. Those commissioning works can use ISO performance and compliance by the contractor as a policy prerequisite for tender consideration. The *Coastal and Marine Environmental Site Guide* (CIRIA, 2003. C584) provides specific guidance on the precautionary practices that should be applied during construction and when working on coastal and marine sites.

The adoption of Environmental Management Systems such as ISO14001 and EMAS encourages the consideration of environmental costs and benefits through life-cycle assessment by the constructor and should promote fuel efficient

practices. Adoption of the principles by the designer and contractor also enables better choices to be made in sustainable procurement, environmentally sensitive design, reduced energy costs in transportation and during construction works, and consumption during the operational lifetime of the structure.

There are many Life-cycle Assessment methodologies and tools available and there is no standard way of conducting a Life-Cycle Analysis, but they are an integral part of ISO 14001. Other guidance is also available from the Society of Environmental Toxicology and Chemistry (SETAC), 1991, the Nordic guidelines on LCA (Lindfors, 1995), and from the European Environment Agency (Jensen *et al..,* 1998*).*

3.9.14 Directions

Government guidance	• Waste Management Licensing Regulations • EC Framework Dir. on Waste (75/442/EEC as amended) • Environment Agency • ODPM
Tools	• Ecopoints estimator / BREEAM • ISO14001 / EMAS • Whole Life Costing / Life-Cycle Analysis / Embodied Energy Analysis • Material procurement frameworks (e.g. timber)
Indicators	• Proportion of recycled/alternative materials used compared to primary materials. • Audits of Environmental Management Systems • Use of Ecopoints Estimator (used with an appropriate operational life expectancy of scheme) • Evidence of environmental cost/benefit analysis of materials during design/planning period of scheme (used with an appropriate operational life expectancy of scheme). • Percentage of waste materials recycled in scheme.
Case study	• Ovingdean, Brighton Seawall refurbishment / upgrade
Ongoing research & initiatives	• Defra/EA engineering R&D theme including materials
Further information	Existing guidance on taking account of sustainable procurement, the use of alternative

materials, and costs in flood and coastal engineering in particular includes:

- Sustainable use of new and recycled materials in coastal and fluvial construction: A guidance manual, by N. Masters, 2001 (Thomas Telford).
- BRE methodology for environmental profiles of construction materials, components and buildings by Howard, N., Edwards, S and Anderson, J.,1999 (CRC Ltd., ISBN 1 86081 294).
- Whole life costs and project procurement in port, coastal and shoreline engineering, by Simm and Masters, 2003 (CIRIA R154).
- Potential use of alternatives to primary aggregates in coastal and river engineering, by Brampton, Wallis and Holliday, 2004 (CIRIA C590).
- Manual on the use of timber in coastal and river engineering, by Crossman and Simm, 2004 (Thomas Telford).
- Sustainable re-use of tyres in port, coastal and river engineering, by Simm, Wallis and Collins, 2004 (HR Wallingford).
- Coastal and Marine Environmental Site Guide (CIRIA, C584)
- A technical framework for Life-cycle Assessment. Society of Environmental Toxicology and Chemistry (SETAC), 1991.
- Nordic guidelines on Life-cycle Assessment. Linfors, P. (1995). Copenhagen.
- Life-cycle Assessment (LCA): A guide to approaches, experiences and information sources. Jensen, A.A., et al.. (1997). Dk TECHNIK Energy and Environment, Denmark

A further useful collection of references to a wide range materials related publications is the Defra/EA Flood and Coastal Defence R&D Programme Technical Report W5A-069/TR/1 - *Engineering materials in flood and coastal defence – a review of current knowledge.*

The Waste Resources Action Programme (WRAP) is also a good source of information on materials recycling and reuse generally. Supported by funding from Defra and the DTI

amongst others it works to promote sustainable waste management by creating stable and efficient markets for recycled materials and products (see http://www.wrap.org.uk).

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3.10 Topic Note 10: Using CFMPs to deliver sustainable flood risk management

3.10.1 Introduction

A Catchment Flood Management Plan (CFMP) is a *"high level strategic planning tool through which the Environment Agency will seek to work with other key decision makers within a river catchment to identify and agree policies for* ***sustainable flood risk management****.*" (Environment Agency, 2004). This Topic Note describes how Catchment Flood Management Plans (CFMPs) can contribute to the principles of sustainable flood risk management. It cross-references the following two volumes of Government guidance:-

- Environment Agency, 2004. Catchment Flood Management Plans. Volume I – Policy Guidance (July 2004).
- Environment Agency, 2005. Catchment Flood Management Plans. Volume II – Processes and Procedures Guidance (April 2005).

> CFMPs will identify broad policies for sustainable flood risk management that make sense in the context of the whole catchment and for the long term (50 to 100 years). They will not determine specific flood risk reduction measures or management approach for flooding issues in a catchment. Whilst it is not possible to understand in detail what will occur in 50 to 100 years time, general trends can be projected to test the sustainability of plans. CFMPs will be reviewed as appropriate to reflect changes in the catchment, although this is unlikely to be within 5 years of the CFMP being produced.

(Environment Agency, 2004).

A national CFMP programme is underway and will involve the production of plans for all catchments in England and Wales.

3.10.2 Sustainability Principles

The definition of sustainable development adopted in the CFMP guidance is aligned with the UK Government's 1999 Strategy, A Better Quality of Life and the Agency's Environmental Vision (Environment Agency, 2001). Multiple aims and several overarching objectives are described in Volume 1 of the guidance. The key objective is to:-

"deliver complimentary policies for long-term management of flood risk" that *"take account of the likely impacts of changes in climate, the effects of land use and land management, deliver multiple benefits and contribute to sustainable development."* (Environment Agency, 2004).

As such the CFMP process is closely aligned to the Government strategy on flood risk management and a number of six of the principles of sustainable flood and coastal erosion risk management (Section 1):-

- **Risk Management.** Manage flood and coastal erosion risks to people and property, the economy and the environment.
- **Adaptation.** Take account of climate change and other long-term uncertainties in decision making.
- **Integration.** Develop solutions that integrate flood and erosion risk management as part of integrated catchment management and coastal zone management.
- **Engagement.** Work with all those affected by flooding and erosion
- **Appraisal.** Adopt appraisal methods that are rigorous, coherent and open and consider long term social, environmental and economic costs and benefits.
- **Environment**. Protect natural resources and enhance the environment where it is most degraded.

CFMPs are high level documents that sit at the regional and strategic level of flood risk management. The plans must be considered in Regional Spatial Strategies and should inform rural land management planning and other regional and catchment scale water plans, in particular, River Basin Management Plans that are required under the Water Framework Directive.

3.10.3 Who is this guidance for?

The Topic Notes provides an overview of the CFMP process for policy makers and practitioners involved in flood risk management, water resources management and land use planning. The CFMP guidance that has been issued to Environment Agency staff and their consultants provides an overall framework but it is not prescriptive in terms of several sustainability principles, such as **Adaptation** and **Appraisal.** Therefore this note provides supplementary guidance by highlighting activities that would promote sustainability within the CFMP.

3.10.4 Activities to support sustainable flood risk management

3.10.4.1 Implementation of CFMP guidance

The CFMP guidance documents state that:

> *The **aims [of the CFMP]** set the overall direction of flood risk management at the catchment scale. They represent long term aspirational targets that are not necessarily deliverable within the life of a single CFMP.*
>
> *The **objectives** define the goals: clear targets of delivery for the CFMP.*

The aims of Catchment Flood Management Planning are defined in the guidance documents as:

- *To reduce the risk of flooding and harm to people, the natural, historic and built environment caused by floods*
- *To maximise opportunities to work with natural processes and to deliver multiple benefits from flood risk management, and make an effective contribution to **sustainable development***

- *To support the implementation of EU directives, the delivery of Government and other stakeholder policies and targets, and the Agency's Environmental Vision*[5]
- *To promote* ***sustainable flood risk management****; and*
- *To inform and support planning policies, statutory land use plans and implementation of the Water Framework Directive.*

In conjunction with the aims given above a key objective and a list of overarching objectives has been identified, common to all CFMPs.

The key objective is to *"develop complementary policies for long-term management of flood risk within the catchment that take into account the likely impacts of changes in climate, the effects of land use and land management, deliver multiple benefits and contribute to sustainable development."*

The overarching objectives are as follows:-

- *To undertake a high-level strategic assessment of current and future flood risk from all sources (i.e. rivers, sewers, groundwater etc) within the catchment, by understanding the components that constitute the risk (i.e. both probability and impact) and the effect of current risk reduction measures. The scale of risk should be broadly quantified in economic, social and environmental terms;*
- *To identify opportunities and constraints within the catchment for reducing flood risk through strategic changes or responses, such as changes in land use, land management practices and/or the flood defence infrastructure;*
- *To identify opportunities during flood risk management to maintain, restore or enhance the total stock of natural and historic assets (including biodiversity);*
- *To identify the relative priorities for strategic studies, actions or projects to be undertaken to manage flood risk within the catchment, and assign responsibility to the Agency, other operating authorities, local authorities, water companies or other key stakeholders.*

Figure 3-12 presents the outline approach for catchment flood management planning. In this figure, the different stages within the development of a CFMP are given together with activities. In most of these stages sustainability issues will come forward, activities where sustainability is most important are indicated in the figure with red arrows. Addition supplementary guidance for some these activities are provided in the subsequent sections.

Figure 3-12 Outline of the process of catchment flood management planning with activities to support sustainable flood risk management highlighted in green (consultation) and yellow (catchment understanding, scenario planning and appraisal).

CFMP stage and activities	Indicative timescale	Relevant chapters from CFMP guidance Vol. II.	Supplementary guidance within this report
1. Project Start –up	**½ month**	**1, 2**	**~**
2. Inception Stage	**1½ months**	**3, 4, 5, & 6**	**~**
(a) Establish CFMP Steering Group			~
(b) Initial data collection			~
(c) Initial understanding of catchment			Section 1
(d) Produce Communications Plan			
(e) Produce Inception Report			~
3. Scoping Stage	**4 months**	**4, 5, 6, 7,8, 9 &10**	**~**
(a) Review existing policies, plans, etc.			Section 1
(b) Collate additional data			~
(c) Understanding of current flood risks and their management			Section 1
(d) Scope possible future scenarios			Topic Note – Climate Change
(e) Identify draft objectives for the catchment, including opportunities and constraints			Section 2
(f) Produce Scoping Report			~
(g) Issue Scoping Report for consultation			Topic Note 2
Consultation	3 months	9	Topic Note 2
4. Draft CFMP Stage	**4 months**	**6, 7, 8, 11, 12 & 13**	
(a) Review consultation responses			
(b) Finalise future scenarios			Topic Note 2
(c) Assessment of future flood risk under scenarios			Topic Note 2
(d) Develop opportunities and constraints			~
(e) Identify policy options and policy units			~
(f) Appraise policies			Topic Note 3
(g) Select preferred policy			Topic Note 1 & 3
(h) Develop Monitoring and Action Plan			
(i) Produce Draft CFMP			
(j) Issue Draft CFMP for consultation			
Consultation	3 months	9	
5. Finalise Plan	**2 months**	**11, 12 & 13**	
(a) Review consultation responses			
(b) Produce the final CFMP			
(c) Produce Post Adoption Statement			
Monitor and Review	Periodic	13	Appendix 2

3.10.4.2 Understanding of catchment issues

Developing an understanding of catchment issues should be achieved in consultation with the Project Steering Group and wider partnership of

stakeholders. In the scoping phase of the project large scale urban development and key environmental issues should be identified.

There are a range of methods and risk assessment models that can help to define catchment issues. These include:-

- Risk assessment methods, e.g. as described in the Environment Agency guidelines on environmental risk assessment and management (Environment Agency, 2000). The CFMP guidance promotes the use of a Source-Pathway-Receptor model of flood risk as discussed in Section 1 of this handbook. Figure 3-14 provides an example "catchment network diagram" illustrating contributions to flood risk.
- The specific risk assessment approaches taken in the Foresight Future Flooding project, particularly relating to the drivers and pressures on flood risk management (OST, 2004).
- The Management Decision Support Framework (MDSF) tool that was developed specifically to support CFMPs. This is a GIS tool that includes a number of flood risk data sets including demographic data. It can be used to estimate flood extent and depth, economic damages and social vulnerability and present data for different flood risk policies.
- Risks to people mapping, i.e. understanding the vulnerability of different parts of the catchment and variation in flood hazard (Risks to People project, FD2321).
- Review of Impacts of Rural Land Use and Management on Flood Generation (Project FD2114)

The MDSF can manipulate and present data on the basis of "cases" for combinations of climate change, land use and policy scenario (Figure 3-13).

Figure 3-13 MDSF Case Construction (Environment Agency, 2005).

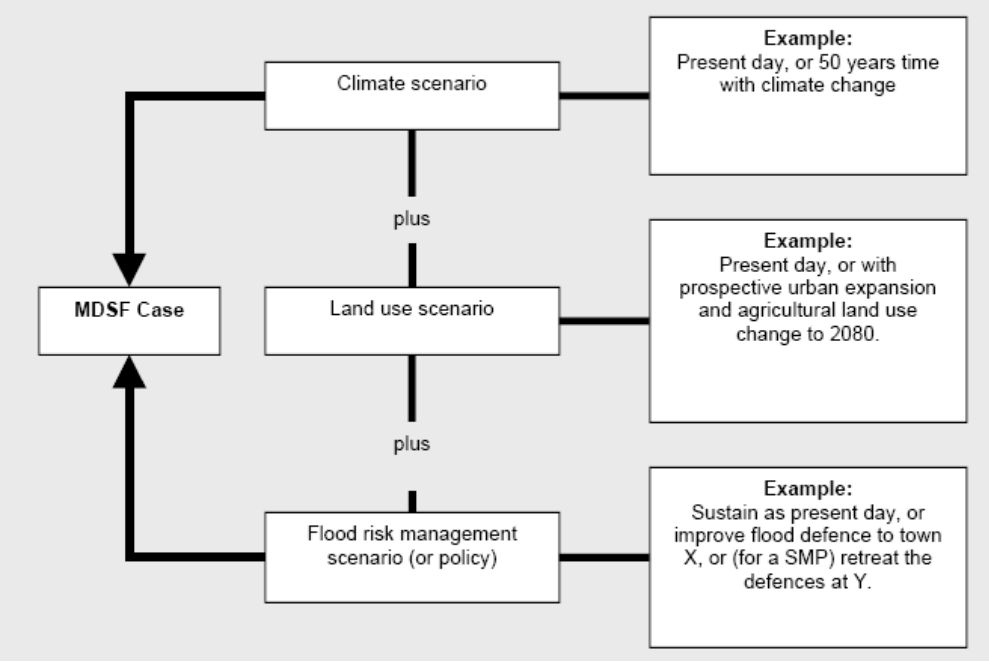
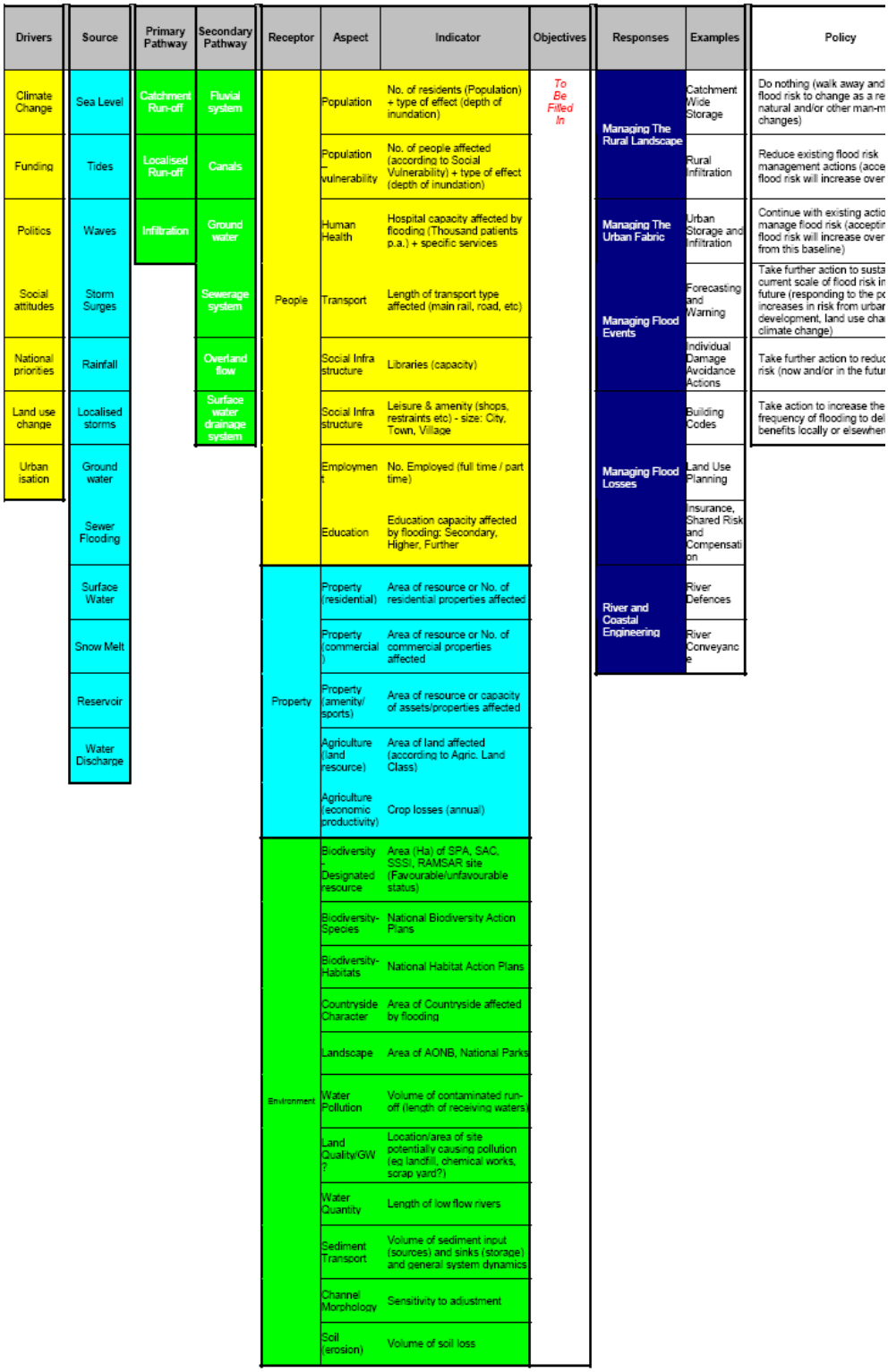


Figure 3-14 An example catchment network diagram following the source-pathway-receptor model (Environment Agency, 2005).



Drivers	Source	Primary Pathway	Secondary Pathway	Receptor	Aspect	Indicator	Objectives	Responses	Examples	Policy
Climate Change	Sea Level	Catchment Run-off	Fluvial system	People	Population	No. of residents (Population) + type of effect (depth of inundation)	*To Be Filled In*	Managing The Rural Landscape	Catchment Wide Storage	Do nothing (walk away and flood risk to change as a re natural and/or other man-m changes)
Funding	Tides	Localised Run-off	Canals		Population - vulnerability	No. of people affected (according to Social Vulnerability) + type of effect (depth of inundation)			Rural Infiltration	Reduce existing flood risk management actions (acce flood risk will increase over
Politics	Waves	Infiltration	Ground water		Human Health	Hospital capacity affected by flooding (Thousand patients p.a.) + specific services		Managing The Urban Fabric	Urban Storage and Infiltration	Continue with existing actio manage flood risk (acceptir flood risk will increase over from this baseline)
Social attitudes	Storm Surges		Sewerage system		Transport	Length of transport type affected (main rail, road, etc)		Managing Flood Events	Forecasting and Warning	Take further action to susta current scale of flood risk in future (responding to the pc increases in risk from urbar development, land use cha climate change)
National priorities	Rainfall		Overland flow		Social Infra structure	Libraries (capacity)			Individual Damage Avoidance Actions	Take further action to reduc risk (now and/or in the futu
Land use change	Localised storms		Surface water drainage system		Social Infra structure	Leisure & amenity (shops, restraints etc) - size: City, Town, Village		Managing Flood Losses	Building Codes	Take action to increase the frequency of flooding to del benefits locally or elsewher
Urban isation	Ground water				Employmen t	No. Employed (full time / part time)			Land Use Planning	
	Sewer Flooding				Education	Education capacity affected by flooding: Secondary, Higher, Further			Insurance, Shared Risk and Compensati on	
	Surface Water			Property	Property (residential)	Area of resource or No. of residential properties affected		River and Coastal Engineering	River Defences	
	Snow Melt				Property (commercial)	Area of resource or No. of commercial properties affected			River Conveyanc e	
	Reservoir				Property (amenity/ sports)	Area of resource or capacity of assets/properties affected				
	Water Discharge				Agriculture (land resource)	Area of land affected (according to Agric. Land Class)				
					Agriculture (economic productivity)	Crop losses (annual)				
				Environment	Biodiversity - Designated resource	Area (Ha) of SPA, SAC, SSSI, RAMSAR site (Favourable/unfavourable status)				
					Biodiversity- Species	National Biodiversity Action Plans				
					Biodiversity- Habitats	National Habitat Action Plans				
					Countryside Character	Area of Countryside affected by flooding				
					Landscape	Area of AONB, National Parks				
					Water Pollution	Volume of contaminated run-off (length of receiving waters)				
					Land Quality/GW ?	Location/area of site potentially causing pollution (eg landfill, chemical works, scrap yard?)				
					Water Quantity	Length of low flow rivers				
					Sediment Transport	Volume of sediment input (sources) and sinks (storage) and general system dynamics				
					Channel Morphology	Sensitivity to adjustment				
					Soil (erosion)	Volume of soil loss				

3.10.4.3 Developing scenarios

CFMPs require the development of future scenarios that consider urban development, land use change and climate change.

Inappropriate development within the floodplain will increase flood risk and urban development outside the floodplain can significantly increase downstream flood flows, particularly in small catchments. Available evidence and stakeholder views should be used to derive low, medium and high development scenarios for the 50 to 100 year period.

The potential impacts of other land use changes on flood risk are not clearly established at the catchment scale. However, large scale afforestation or changes in agricultural systems may influence flood flows and the CFMP guidance suggests completing sensitivity tests on future hydrological parameters (Table 3-10).

Figure 3-15 Changes in the agricultural landscape (O'Connell et al.., 2004, Environment Agency/Defra research project FD2114)

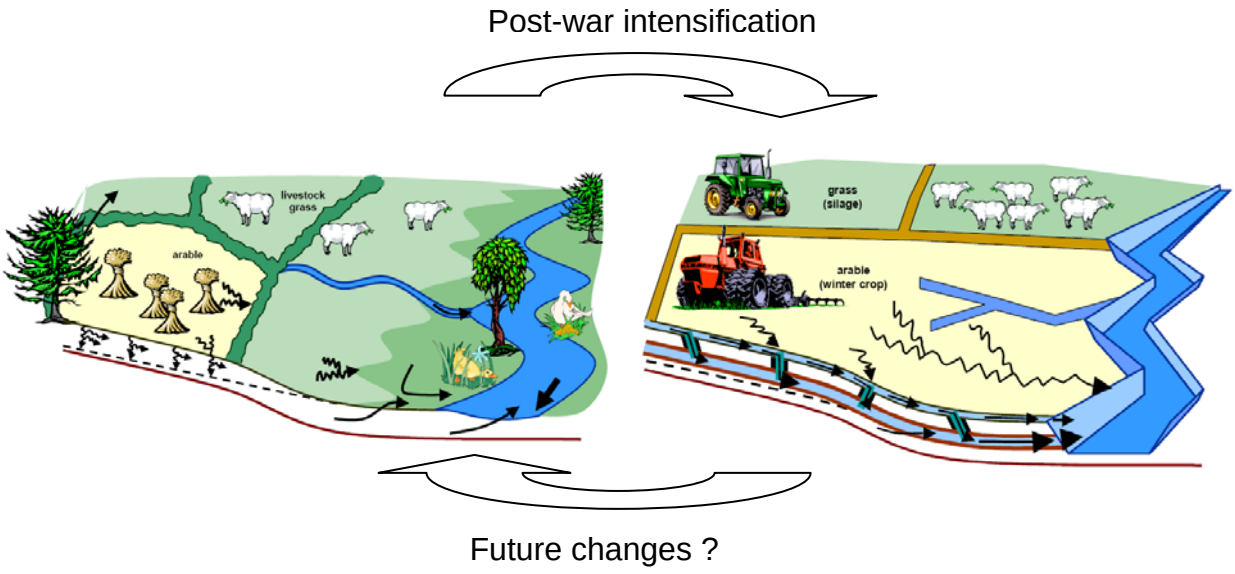


Table 3-10 Suggested modifications to hydrological parameters for the investigation of land use change.
(Tp is the Flood Estimation Handbook Time to Peak parameter and PR is the Percent Runoff)

Land use change	Suggested changes to Tp and SPR
Afforestation	Subtract 10% of the original value from SPR Reduce Tp by 3 hours for immature cover – no change for mature growth.
Improved agricultural drainage	Reduce Tp by 2 hours for low PR soils. Increase Tp by 2 hours for high PR soils.
Agricultural intensification	Increase SPR by a factor of 1.15.

The consideration of climate change is discussed in Topic Note 8 on precautionary allowances.

Stakeholder involvement in the development of scenarios will strengthen the planning process and stakeholder engagement is discussed in Topic Note 2.

3.10.4.4 Strategic Environmental Assessment and Sustainability Appraisal

There is no legal requirement for CFMPs to include an Strategic Environmental Assessment (SEA) but Defra and Environment Agency guidance recommends that SEA's are produced in order to promote a strategic approach. Therefore CFMPs should include an Environmental Report that documents the SEA process and demonstrates that the requirements of the Directive have been met. Guidance on the production of the Environment Report is provided in Chapter 11, Volume 2 of the CFMP guidance (Environment Agency, 2005).

The Environment Report should consider the development of a suitable set of sustainability indicators that could be used to monitor progress in implementation of the CFMP (See Topic Note 1 on Sustainability Appraisal). These indicators should be:-

- Encompass the sustainable flood risk principles (Section 1).
- Developed as part of each project with stakeholder consultation.
- Linked to national performance and the sustainability indicator sets (Appendix 2).
- Integrated or linked to the criteria used in the integrated policy appraisal (Topic Note 2).

3.10.4.5 Policy development and appraisal

Policy appraisal is discussed in Chapter 12 of the CFMP Guidance, Volume II. A policy within a CFMP is *"a sustainable aspiration or proposed overall direction to manage current and future flood risk"* and *"to help deliver specific catchment objectives (taking into account associated opportunities and constraints) for specific areas of the catchment affected by flood risk (called policy units)."*

There are six generic responses that should be applied at the scale of policy units that are set out in Volume I of CFMP guidance:-

- **No active intervention** (including flood warning and maintenance) – continue to monitor and advise
- **Reduce existing flood risk management actions** (accepting that flood risk will increase with time)
- **Continue with existing or alternative actions** to manage flood risk at the current time (accepting that flood risk will increase over time from this baseline).
- **Take further action to sustain** the current scale of flood risk into the future (responding to increases in flood risk from urban development, land use and climate change)
- **Take further action to reduce** flood risk (now and/or in the future)
- **Take action to increase the frequency of flooding** to deliver benefits locally or elsewhere (e.g. habitat creation).

The responses are evaluated using Integrated Policy Appraisal (IPA) that considers a policy's impact on a set of economic, social and environmental objectives.

Multi-Criteria Assessment (MCA) provides a framework for evaluating options against sets of criteria that were developed as part of Defra and Environment Agency research. The recommended set of criteria were developed in consulation with a wide range of stakeholders and should therefore provide a good general set of criteria for CFMPs and other strategic plans. However for a specific CFMP, criteria could be refined according to specific sustainability principles and objectives that are relevant to the catchment (See the Topic Note on MCA and the Moray Case Study, FD2015 Volume 2).

3.10.4.6 Involving stakeholders

The CFMP process involves stakeholders at different levels of the project and different stages of the process. The success of the CFMP will depend upon and effective consultation and communications strategy. Typical CFMP steering groups include:-

- Environment Agency (Project Manager, Area Flood Risk Manager)
- Defra/Welsh Assembly Representative
- Regional Flood Defence Committee
- Local Authority (Planning)
- Drainage Board (if appropriate)

- Water and drainage service providers
- English Nature/Countryside Council for Wales

The CFMP guidance (Volume II) provides full lists of the organisations that should be consulted and the content of each stage of the consultation process.

Guidance on stakeholder consultation is provided in Topic Note 2.

3.10.5 Directions

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Environment Agency, 2005. Catchment Flood Management Plans. Volume II – Processes and Procedures Guidance (April 2005).

Website for the Environment Agency's Strategic Flood Risk Management programme http://www.sfrm.co.uk/ (requires a password).

3.10.6 References

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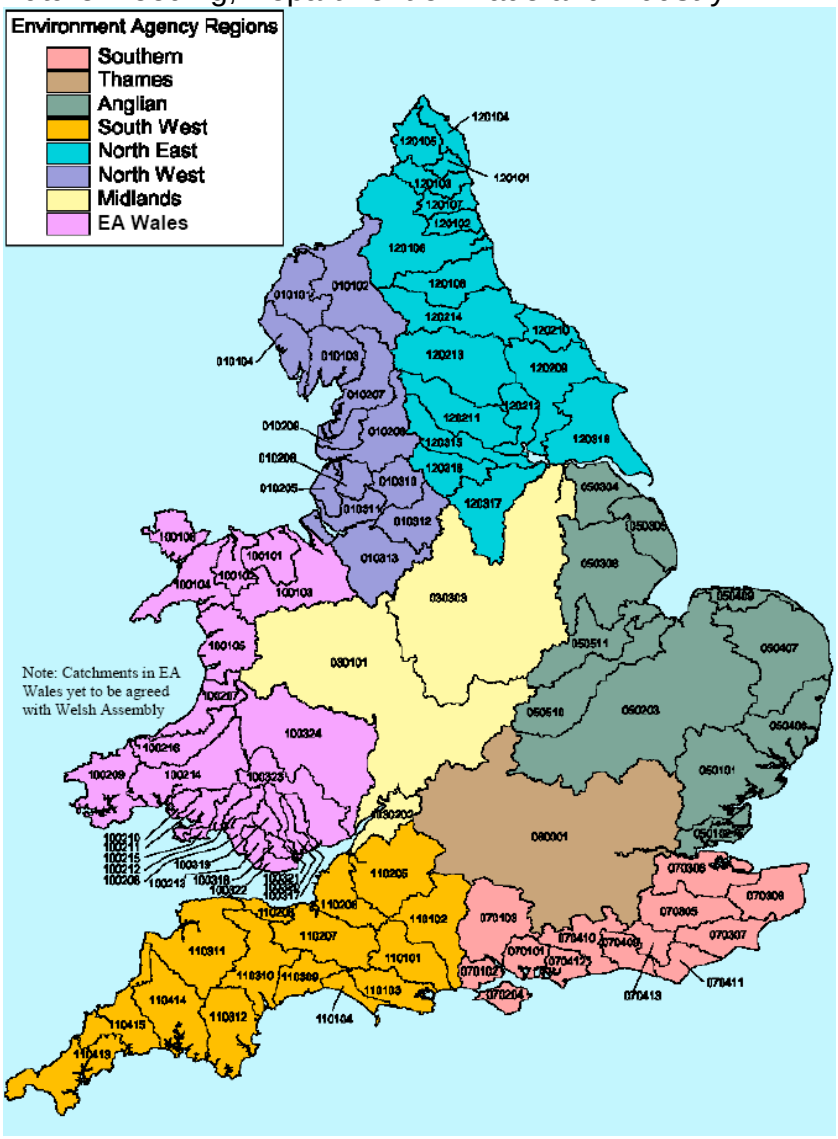

3.11 Topic Note 11: Using Shoreline Management Plans to deliver sustainable flood and coastal erosion risk management

3.11.1 Introduction

A Shoreline Management Plan (SMP) is *"a document that provides a large scale assessment of the risk associated with coastal processes and presents a policy framework to reduce these risks to people and the developed, historic and natural environment in a sustainable manner"* (Defra, 2001). An SMP is a non-statutory policy document that takes account of other plans and legislation. It should inform wider strategic guidance and in future it may become a legal requirement for other regional spatial strategies to consider the SMP (?).

The second round of Shoreline Management Plans (SMP2) is a review and update of the policies set out in the first generation of SMPs. The new SMP2s are longer term plans, looking beyond the 50 year horizon used in previous studies. They aim to improve the clarity of decision making processes and justify some of the original policies as part of developing a sustainable plan which may require some significant changes from present management practices, immediately or in the future (Defra, 2005).

This Topic Note describes how SMPs can contribute to the principles of sustainable flood and erosion risk management. It cross-references the most recent Government guidance:-

- Defra 2005. Guidance for the Production of Shoreline Management Plans. Draft Final Guidance[47].

The Topic Note provides supplementary information and does not supersede any of the following documents, which should be referenced for further information:-

- Defra (2001) Shoreline Management Plans: A guide for coastal defence authorities, Defra PB5519.
- Defra (2003) Procedural Guidance on the Production of Shoreline Management Plans, Interim Guidance, Defra.
- Department of the Environment and the Welsh Office (1992) Planning Policy Guidance 20: Coastal Planning, HMSO, London. Usually referred to as PPG20.
- Department of the Environment and the Welsh Office (1990) Planning Policy Guidance 14: Development on Unstable Land, HMSO, London. Usually referred to as PPG14.

Three pilot SMPs: Kelling to Lowestoft Ness, South Foreland to Beachy Head and Beachy Head to Selsey Bill were completed in 2005 and a national SMP2

[47] This guidance is still in draft from and is the outcome of a detailed consultation phase, background material for which can be found at: http://www.defra.gov.uk/corporate/consult/smpguidance/index.htm

programme is now underway that will involve the production of plans for all coastal cells by 2010.

[The issues related to SMPs are similar to those in CFMPs discussed in the previous note, so only the pertinent differences will be highlighted in this note].

3.11.2 Sustainability Principles

SMPs aim to provide long term *"sustainable shoreline management policies*" that *"consider people, nature, historic and economic realities."* (Defra, 2005). The new plans recognise that it is not possible to promote wholesale changes to existing defence management so SMPs should provide a "route map" for decision makers to move from the present situation towards a more sustainable future. Therefore policies are considered on three timescales:-

- the immediate term (0 to 20 years)
- medium term (20-50 years) and
- long term (50-100 years).

Given the long timescales required for the replacement and possibly relocation of infrastructure away from the coast, the consideration of these "epochs" will facilitate a practical rate of adaptation to rising sea levels and changing political and economic situation, legislation and social attitudes towards coastal protection. Plans developed now should be flexible enough to adapt to these changes over time.

The "*primary function of the SMP should be to demonstrate that defence management policies proposed today, i.e. in the immediate term, are not detrimental to achievement of [the long term sustainable] plan*." (Defra, 2005).

As such the SMP process is closely aligned to the Government strategy on flood and coastal erosion risk management. In particular, six of the sustainability principles outlined in Section 1:-

- **Risk Management.** Manage flood and coastal erosion risks to people and property, the economy and the environment.
- **Adaptation.** Take account of climate change and other long-term uncertainties in decision making.
- **Integration.** Develop solutions that integrate flood and erosion risk management as part of integrated catchment management and coastal zone management.
- **Engagement.** Work with all those affected by flooding and erosion
- **Appraisal.** Adopt appraisal methods that are rigorous, coherent and open and consider long term social, environmental and economic costs and benefits.
- **Environment**. Protect natural resources and enhance the environment where it is most degraded.

SMPs are high level documents that sit at the regional and strategic level of flood and coastal erosion risk management. The plans should be considered in

Regional Spatial Strategies and Local Development Frameworks and should inform rural land management planning and other regional and catchment scale water plans, in particular, River Basin Management Plans that are required under the Water Framework Directive.

3.11.3 Who is this guidance for?

The Topic Note provides an overview of the SMP process for policy makers and practitioners involved in flood and coastal erosion risk management, water resources management and land use planning. Detailed procedural guidance for coastal engineers was published in 2005 (Defra, 2005). Therefore this note provides supplementary guidance, primarily for other stakeholders who may not need to read the full SMP guidance, and highlights activities that would promote sustainability within the SMP. In particular, it is important for regional planners and others involved in making land use decisions to understand and respond to SMPs.

3.11.4 Activities to support sustainable flood risk management

3.11.4.1 Implementation of SMP guidance

The SMP guidance provides details of how the SMP would be implemented (Defra, 2005). Volume II of the guidance sets out the following:-

- An evaluation process that considers the relevant importance of issues and links this to the policy development.
- Methods for the analysis of policy scenarios for the entire SMP area.
- Methods for the analysis of shoreline interactions and responses over the long term.

In very general terms the SMP process follows similar stages to a CFMP, the important difference being that SMPs are a review of previous plans so considerable data and policies are already in place:-

SMP stages (* stakeholder engagement)

- Scoping (*)
- Assessments
- Policy Development
- Public Examination(*)
- Final Plan
- Dissemination (*)
- Monitor and review

A typical SMP will take 18 months to develop plans from the scoping to dissemination phases.

Related plans:-

- Strategy Plans developed since the last SMP can provide valuable information, but there are issues regarding strategies running concurrently or where they have not been approved.
- Estuary Management Plans (EMPs) arose from an initiative by English Nature and are intended to bring together all stakeholders with an interest in an estuary to reach a consensus on the sustainable use of the estuary. These cover all of the major estuaries in England.
- Harbour Management Plans have a similar purpose with the intention of reaching a consensus on the appropriate management of the harbour to promote sustainable use for conservation, recreation and economic activity.
- Coastal Habitat Management Plans (CHaMPs) are intended to assist in the development of sustainable coastal defence strategies in those areas where coastal defence measures have implications for internationally important wildlife sites.
- Heritage Coast Management Plans are prepared by Local Authorities together with The Countryside Agency and the involvement of other relevant stakeholders. Their aim is to guide management to achieve the heritage coast objectives of conservation, recreation, rural economic development and environmental health.
- Integrated Coastal Zone Management Plans are prepared by a variety of organisations. They are aimed at encouraging the sustainable management of all aspects of the human use of the coast.

How can the outputs be used for development planning?

SMPs should inform and be informed by the development planning process. SMPs should primarily feed into regional or local planning. However, the subsequent policies should also be taken into consideration in determining planning applications.

Where the preferred option is either non-intervention or retreat, development planning policies should strongly discourage further development in low-lying areas behind present shorelines. Additional development in such areas could unnecessarily commit flood defence authorities to expensive and unsustainable policies, which may in turn adversely affect biodiversity or other areas of the coast.[48]

3.11.4.2 Understanding of coastal cells

"An analytical approach is required that can accommodate changes in forcing (waves, tides etc.), sediment storage and supply, rates of movement, and provide the information to assess the consequential morphological response of features throughout the coastal zone. The recommended means of achieving this is to adopt a "Behavioural Systems" approach, as adopted, albeit at a larger scale, in Futurecoast (Halcrow, 2002). There is no single analytical method that will fully address the complexity of coastal systems, but a variety of techniques are available, which can be used in combination to undertake these assessments.

[48] DTLR (2001) *Planning Policy Guidance Note 25: Development and Flood Risk*, HMSO, London.

Further details on the recommended methodology and techniques available are discussed in Appendix D."

3.11.4.3 Developing scenarios

Figure 3-16 Example of a Baseline Scenario Statement

SCENARIO REF: BASELINE SCENARIO 1 – NO ACTIVE INTERVENTION			
Location	Predicted Change for		
	Years 0 – 20 (2025)	Years 20 – 50 (2055)	Years 50 – 100 (2105)
West Runton to Cromer	Along majority of frontage there are no defences, but the short stretches of masonry wall will start to fail during this period.	No defences.	No defences.
	There will be continued erosion of the cliffs, apart from along the short stretches of wall at West Runton and East Runton. Net cliffline retreat will be between 5 and 20m by 2025. Small embayments will form on either side of the walls and by the end of the period it is likely that these walls will start to be outflanked. Cliff erosion will feed beaches locally and downdrift. There will also be some increased feed (although drift rates low) from the west therefore a similar beach to today should be maintained.	As short stretches of walls are outflanked there will be rapid erosion of the cliffline behind and the small promontories will become eroded with the development of a more linear cliffline in plan. For a short time the structures may interrupt longshore drift along the frontage, but this will reduce as the cliffs behind eroded, leaving them as isolated structures. A cliffline retreat of 15 to 30m is expected by 2055. The beaches are likely to remain in a similar form to present as they will receive some sediment from cliff erosion and from updrift, but as the defences fail at Cromer there will be greater longshore transport to downdrift areas.	There would be increased cliff erosion, due to rising sea levels, with linear retreat of the shoreline, resulting in 30 to 50m of retreat by 2105. Minimum change in beach width/volume would occur due to the supply of sediment from cliff erosion both locally and along updrift areas.
Cromer	Along most of the frontage the seawall will remain in place for this period. The groynes will fail towards the end of the period.	Complete failure of the seawall at the start of this period.	No defences.
	The seawall will continue to hold the cliffline position along most of the frontage. Narrower, steeper beaches will develop due to the lack of local input and the low drift rates. Failure of the groynes toward the end of the period will also result in more throughput of sediment. There will also be loss of some beach material to the south,	There will be continued failure of the seawall, which will result in very rapid erosion of the cliffs behind. There could be a loss of up to 50m in places, within the first five years of the defences failing. Cliff retreat will be greatest along the central section of the frontage, where the shoreline	There would be continued cliff recession at a relatively uniform rate characterised by periodic landslides, with lower periods of erosion in between. A net retreat of between 100 and 160 m is expected by 2025. There could also be occasionally large-scale failures associated with storm surges.

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Appendix 1 Defra Strategy

Details of Defra's strategy including consultation documents, the Government's first response and background material can be found here:-
http://www.defra.gov.uk/environ/fcd/policy/strategy.htm

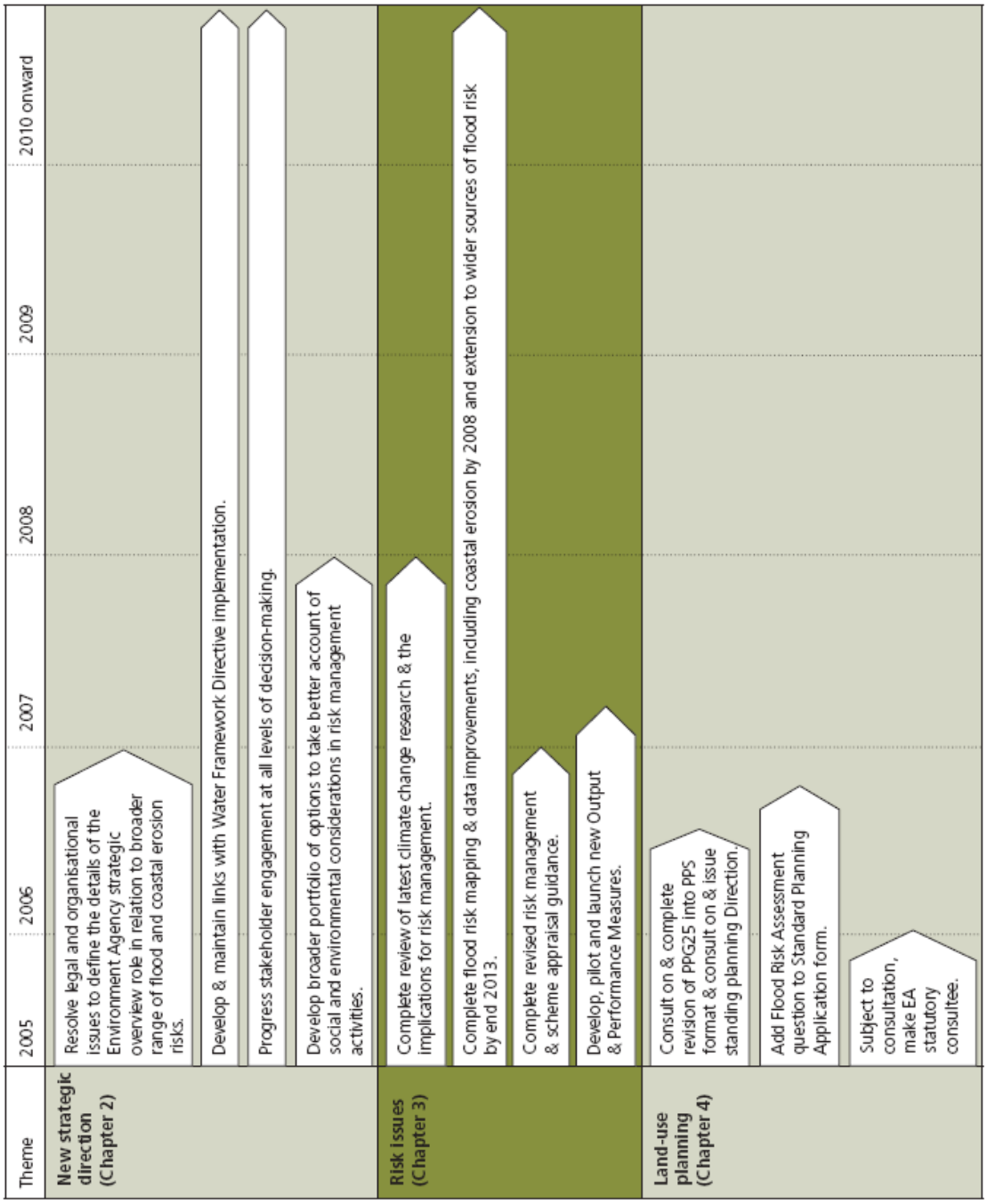
Vision: the future as a result of this strategy

- 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

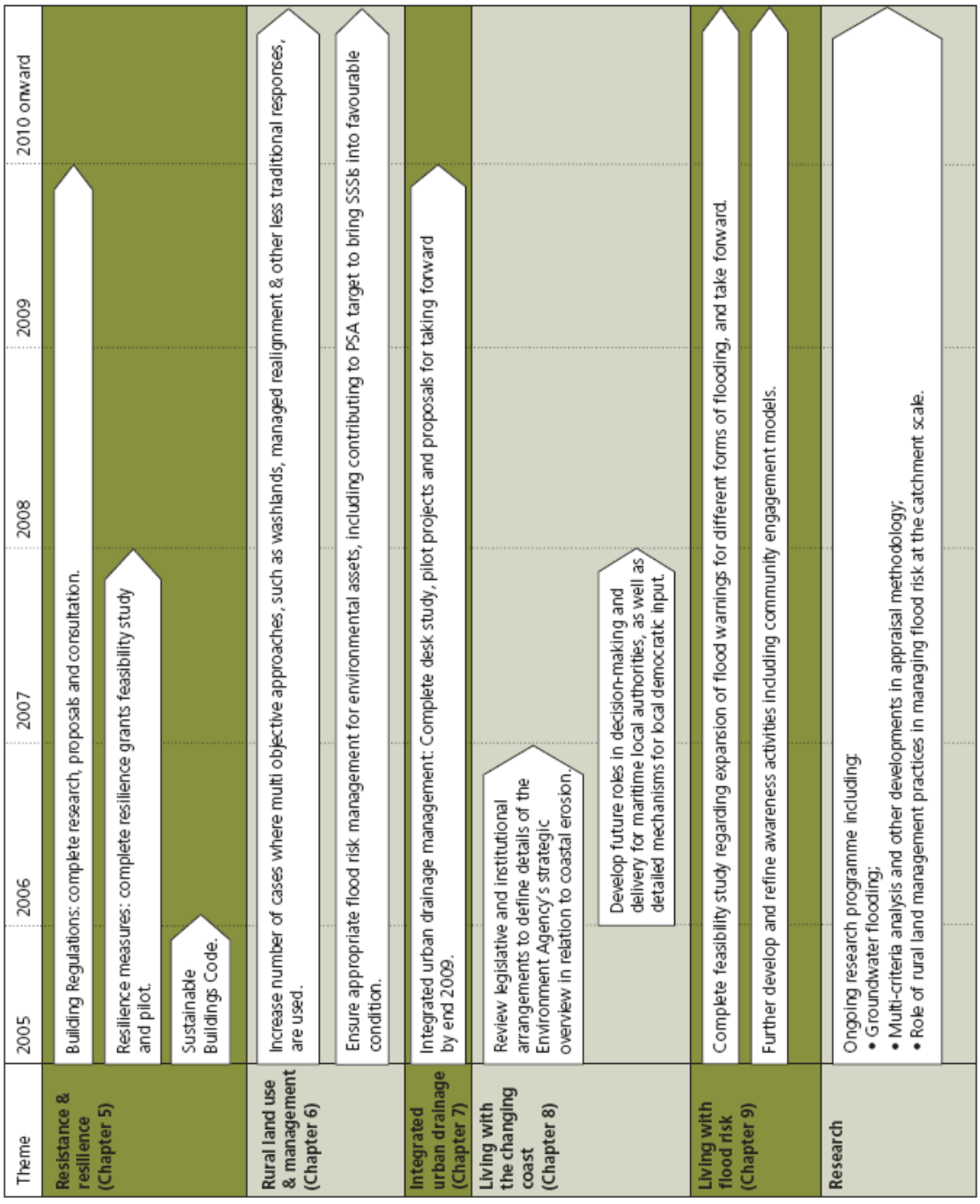
Plans and Shoreline Management Plans, within a broader planning matrix which will include River Basin Management Plans prepared under the Water Framework Directive and Integrated Coastal Zone Management.

- 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.

Timeline of actions proposed in the First Response to Making Space for Water (Defra, 2005b).



Timeline of actions proposed in the First Response to Making Space for Water (Defra, 2005b) (cont.)



Appendix 2 Example sustainability indicators

An indicator of sustainable flood risk management can take a number of forms, which in general terms would be one of the following:

- a measurable attribute of the existing flood risk management
- the change in that attribute as a result of a proposed flood risk management option
- the estimated sustainability of a proposed flood risk management option
- a measure of the appropriateness of the process behind determining sustainable flood risk management

Indicators can be used to help understand and measure the extent to which past or existing flood risk management schemes have met sustainability criteria as well as how sustainable proposed schemes will be.

Indicators can relate to any of the nine principles of sustainable flood risk management. These being:

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.
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

Indicators should to be used to support the decision making and evaluation processes in conjunction with further information, analysis and judgement to determine the outcome of the process.

Indicators should be selected on a case by case basis, with appropriate consideration of the following criteria:

Specific – unambiguous regarding what is being determined

Measurable – the information required to undertake the calculation can be obtained
Achievable – relate to realistic sustainability objectives
Relevant – appropriate for the decision-making process required
Time-bound – can be calculated within the timescale of the decision-making process

In aiming to understand the sustainability of a flood risk management activity it would be optimum to take into account at least one indicator relating to each of the principles listed above.

The table of example indicators presented in this appendix provides guidance on the scale at which the indicator is suitable (i.e. national , regional or local) and the type of information it gives (i.e. whether it relates to economic, social or environmental consequences of flood risk). The level of detail required to calculate the indicator will depend on whether it is being applied at a national, regional or local scale. Some indicators are flexible and can be applied at more than one scale.

				Relates to the following aspects of flood risk			General Suitability				
Ref	**Category**	**Indicator**	**Units**	**Economic**	**Social**	**Environmental**	**National**	**Regional**	**Local**	**Comments**	**Reference**
1	**Risk Management**	Number of properties in the floodplain	Number	y	y	y	y	y	y	This can be subdivided into number of properties in Zones 2 or 3 (England) or Zones B, C1 or C2 (Wales)	South East England Regional Assembly (2005) *Data and Trends. Part of the Integrated Regional Framework 2004: A Better Quality of Life in the South East.* South East England Regional Assembly *et.al.*
2		Number of people living and/or working in the floodplain	Number	y	y		y	y	y	This can be subdivided into number of properties in Zones 2 or 3 (England) or Zones B, C1 or C2 (Wales)	South East England Regional Assembly (2005) *Data and Trends. Part of the Integrated Regional Framework 2004: A Better Quality of Life in the South East.* South East England Regional Assembly *et.al.*
3		Number of people experiencing intangible impacts from flooding	Number		y			y	y	Intangible impacts include psycological (stress, anxiety, distress) and physical (lack of sleep, health problems due to flood conditions.	DEFRA/EA (2005) *The Appraisal of Human-Related Intangible Impacts of Flooding.* R&D Technical Report FD2005/TR
4		Number of lives lost due to flooding	Number/year		y		y	y	y		HR Wallingford (2005) Flood Risks to People Phase 2. TR2
5		Number of people being seriously injured by flooding	Number/year		y		y	y	y		
6		Properties covered by effective flood warning as a percentage of those at risk from flooding	%		y		y	y	y		
7		Proportion of those receiving flood warning that respond	%		y			y	y		

				Relates to the following aspects of flood risk			General Suitability				
Ref	**Category**	**Indicator**	**Units**	**Economic**	**Social**	**Environmental**	**National**	**Regional**	**Local**	**Comments**	**Reference**
		effectively									
8		Number of incidences where roads are closed due to flooding	Number/year		y			y	y		
9		Annual Average Damage (AAD) from flooding	£/capita	y			y	y	y	As used for Risk Assessment for Strategic Planning (RASP)	
10		Annual average economic loss in production and sales due to flooding	£	y			y	y	y		
11		Number of properties compulsory purchased to be removed from floodplain	Number/year		y		y	y			
12		Investment in flood risk management relative to GDP	%	y			y			Requires an evaluation of what is included in "flood risk management"	DEFRA (2003) *Achieving a better quality of life: Review of progress towards sustainable development.* Government annual report 2003.
13	**Resilience**	Proportion of properties at risk from flooding with flood protection products	%	y	y			y	y		
14		Proportion of properties at risk from flooding with flood resilient design	%	y	y			y	y		
15		Proportion of properties at risk from flooding that can safely continue to function during floods	%	y	y			y	y		

				Relates to the following aspects of flood risk			General Suitability				
Ref	**Category**	**Indicator**	**Units**	**Economic**	**Social**	**Environmental**	**National**	**Regional**	**Local**	**Comments**	**Reference**
16		Proportion of properties at risk from flooding that can be reinstated after a flood event within a specified time period	%	y	y			y	y		
17	**Adaptation**	Proportion of existing and/or proposed flood and coastal defence schemes with space for adaptation	%	y				y	y		
18		Costs of adaptation of existing and/or proposed flood and coastal defence schemes	£	y				y	y		
19		Proportion of proposed schemes accounting for future socio-economic changes	%	y	y		y	y	y		
20		Condition of flood defence and erosion management assets and their resilience to higher rates of climate change	Score	y	y	y	y	y	y	NFCDD contains information on defence condition, which currently is likely to be adequate at National/Regional Levels, but more accurate local knowledge should be used at Regional/Local Levels.	
21		Average time horizon that existing defences meet their standard of protection	Years		y	y	y	y	y	Should take into account climate change.	

				Relates to the following aspects of flood risk			General Suitability				
Ref	**Category**	**Indicator**	**Units**	**Economic**	**Social**	**Environmental**	**National**	**Regional**	**Local**	**Comments**	**Reference**
22		Proportion of schemes with built-in precautionary allowances	%		y	y	y	y	y		
23	**Integration**	Number of schemes implemented with multiple objectives and funding streams	Number	y	y	y	y	y			
24		Number of schemes implemented with co-ordinated funding streams	Number	y	y	y	y	y			
25		Proportion of related plans that have been integrated into the flood risk management plan	%	y	y	y	y	y	y		
26		Proportion of related plans that have been informed and co-ordinated with the flood risk management plan	%	y	y	y	y	y	y		
27		Contribution of flood risk management to national biodiversity targets	Ha. or no. of sites or £			y	y	y		Can be evaluated on an area, number of sites or investment basis.	
28		Proportion of locations implementing SUDS to reduce runoff at source where it can be shown to reduce risks	%			y		y	y	Demonstrates integration of land use planning, flood risk management and environment	South East England Regional Assembly (2005) *Data and Trends. Part of the Integrated Regional Framework 2004: A Better Quality of Life in the South East.* South East England Regional Assembly *et.al.*

				Relates to the following aspects of flood risk			General Suitability				
Ref	Category	Indicator	Units	Economic	Social	Environmental	National	Regional	Local	Comments	Reference
29	Engagement	Measures of stakeholder satisfaction at the end of flood risk management process and during processes	Score		y			y	y	Specific measurement criteria would be determined on a case by case basis	
30		Success in keeping stakeholders involved throughout the projects and plans	% retention		y			y	y		
31		Allocated staff time and/or funding of organisations to stakeholder engagement processes	% or £		y			y	y		
32		Existence of policy or project statements on stakeholder engagement	yes/no		y		y	y	y		
33		Staff sent on participation in stakeholder engagement training	Number		y		y	y	y		
34		Existence of outreach activities	Number		y		y	y	y		
35		Public awareness of flood risk	Score		y		y	y	y		
36	Appraisal	Application of risk-based decision-making approach	yes / no	y	y	y	y	y	y		
37		Identification of uncertainties and assumptions	yes / no	y	y	y	y	y	y		

				Relates to the following aspects of flood risk			General Suitability				
Ref	**Category**	**Indicator**	**Units**	**Economic**	**Social**	**Environmental**	**National**	**Regional**	**Local**	**Comments**	**Reference**
38		Identification of agreed baseline conditions	yes / no	y	y	y	y	y	y		
39		Application of multi-criteria assessment (MCA) methods	yes / no	y	y	y	y	y	y		
40		Existence and demonstration of an auditable evaluation process	yes / no	y	y	y	y	y	y		
41	**Environment**	Area of habitat created to support BAPs	Ha.			y		y	y		
42		Extent of river or coastal realignment	Number or schemes or Ha or Km length			y	y	y		The smaller extent shows less modification from the natural state	
43		Proportion of greenfield development footprint in the indicative floodplain	%		y	y	y	y			
44		Proportion of monitored river lengths with good or fair chemical and/or biological water quality	%			y		y		Indicates success of rehabilitation schemes and environmental sustainability of flood risk management schemes	DEFRA (2003) *Achieving a better quality of life: Review of progress towards sustainable development.* Government annual report 2003.
45	**Consumption and Production**	Proportion of materials used in flood defence schemes that are re-used, secondary or recycled materials	%			y	y	y	y		

				Relates to the following aspects of flood risk			General Suitability				
Ref	**Category**	**Indicator**	**Units**	**Economic**	**Social**	**Environmental**	**National**	**Regional**	**Local**	**Comments**	**Reference**
46		Proportion of hazardous waste materials produced throughout the life-cycle of the schemes	%			y		y	y		
47		Average distance between site and source material per ton construction material	Miles or Score			y	y	y	y	Score can be calculated using the Ecopoints estimator	
48		Carbon dioxide emission and/or other environmental impacts caused by the used means of transport per ton construction material	Score			y	y	y	y	Score can be calculated using the Ecopoints estimator	
49	**Knowledge**	Number of people on the register of Continued Professional Development (CPD) for training in sustainable flood risk management	Number		y	y	y	y	y		
50		Number of initiatives to increase knowledge on sustainable flood risk management issues	Number		y		y	y	y		
51		Existence and demonstration of a monitoring and review process to determine performance of schemes	yes / no	y	y	y	y	y	y		

				Relates to the following aspects of flood risk			General Suitability					
Ref	**Category**	**Indicator**	**Units**	**Economic**	**Social**	**Environmental**	**National**	**Regional**	**Local**	**Comments**	**Reference**
		and to report any lessons									

Appendix 3 Flood and coastal erosion risk management responses based on the Foresight Future Flooding project (OST, 2004)

Response Group	Response Measure, Policy or Intervention
1. Water retention and management of infiltration into the catchment	Changing tillage practice
	Worms
	Extensification
	Field drainage (to increase storage)
	Afforestation
	Buffer strips and buffering zones
2. Water retention through catchment-storage schemes	Detention ponds and bunds
	Rainwater harvesting
	Wetlands and washlands
	Riparian zone management
3. Managing conveyance	Management of hillslope connectivity
	Channel maintenance
	Channel realignment

Response Group	Response Measure, Policy or Intervention
4. Increase storage in urban areas	Building design
	Urban area development
	Detention ponds
	Source control
	Underground storage
	Temporary flood storage (e.g. in parkland)
	Storage along /adjacent to flood system
	Groundwater management
	Rainwater harvesting
5. Increase infiltration in urban areas	Permeable land cover
	Building design
6. Manage conveyance of land surface	Design of building drainage
	Urban drainage infrastructure
	Urban area development
	Source control and local sustainable water system management
	Controlling pathways of runoff
	multiple drainage systems
	water reuse and recycling etc
	Managing wrong connections
	Separating foul and storm sewers
	Off-site pumping
	aesthetic use of water in urban area
	Active dynamic real-time operation
	pumping off site
	Design of roads and gully pots
	Alter river channels to improve outfalls
	Reopen culverted watercourses (daylighting)

Response Group	Response Measure, Policy or Intervention
7. Pre-event measures	Flood preparedness planning: major incident plans for flooding
	Flood risk mapping
	Education and awareness raising
	Family/community flood plans, flood risk logbooks
8. Real-time forecasting and warming	Flood forecasting systems: improved sensing, forecasting, modelling, and updating of model predictions during the event
	Warning dissemination systems (including take-up)
9. Flood fighting: actions to manage flood waters and defences during the event	Demountable/temporary defences
	Water level control structures: controllable weirs and sluices
	Emergency repair/shoring up of failing defences
	Emergency diversions: cut through channels, breaking of dikes
10. Collective-scale damage-avoidance actions	Evacuation of floodplains and coastal areas at risk
	Demountable flood defences
11. Individual-scale damage-avoidance actions	Temporary flood proofing
	Moving assets to safety

Response Group	Response Measure, Policy or Intervention
12. Reduce current exposure to flood loss through land use management	Managed retreat
	Relocation of exposed structures
13. Reduce current exposure to flood loss through flood-proofing	Retro-fitted flood proofing
14. Limit increase in exposure to flood loss through land use planning	Land use planning
	Financial instruments: e.g. floodplain charging
	Locate critical facilities away from floodplain
15. Limit increase in exposure to flood loss through changing building codes/construction practices	Flood-proofing
	Property / structure design standards
16. Facilitate economic and financial recovery from flood loss	Insurance
	State aid / compensation
	Tax relief on losses
	Public relief
	Self-insurance
17. Lessen the health, social and practical impacts of flooding	Targeted health and counselling services
	Practical aid (clean up etc)

Response Group	Response Measure, Policy or Intervention
River defences	
18. Increase conveyance of flow passed downstream	Channelisation
	Channel restoration
	Dikes and embankments
	Bypass channels / flood diversion channels
19. Increase storage	Dams
	Floodplain / wetland storage
	Floodplain restoration
	Temporary channel storage
20. Flood water transfer	Pumped diversions to storage areas
21. Flood defences	flood defence along the river channel
	ring dikes around vulnerable areas
	specialist structures such as flood gates that prevent flood water from entering specific areas
Coastal and estuarial defences	
22. Physical barriers	Flood barriers
	Dikes and embankments
23. Realignment of flood defence infrastructure	Change configuration of coastline
24. Reduce energy	Beach nourishment
	Offshore barriers
	Energy converters
	Modify morphology
25. Morphological protection	Promote formation of natural landforms to provide protection

Response Groups ranked by potential for flood risk reduction

Rank	World Markets	Global Responsibility	National Enterprise	Local Stewardship
1	Flood defences	Increased conveyance	Flood defences	Increase engineered flood storage
2	Increased conveyance	Increase engineered flood storage	Increased conveyance	Land use management
3	Increase engineered flood storage	Flood defences	Increase engineered flood storage	Flood defences
4	Flood proofing	Land use management	Flood proofing	Flood proofing
5	Physical barriers (coastal)	Catchment storage	Catchment storage	Individual damage avoidance
6	Forecasting and warning	Manage rural conveyance	Physical barriers (coastal)	Increased conveyance
7	Flood fighting	Increase urban infiltration	Reduce energy (coastal)	Catchment storage
8	Reduce energy (coastal)	Forecasting and warning	Realignment & Abandonment (coastal)	Forecasting and warning
9	Realignment (coastal)	Flood proofing	Morphological protection (coastal)	Pre-event measures
10	Morphological protection (coastal)	Pre-event measures	Flood fighting	Flood fighting
11	Pre-event measures	Flood fighting	Forecasting and warning	Manage rural conveyance
12	Individual damage avoidance	Individual damage avoidance	Pre-event measures	Increase urban storage
13	Building codes	Physical barriers (coastal)	Increase rural infiltration	Collective damage avoidance
14	Flood water transfer	Realignment (coastal)	Manage rural conveyance	Increase rural infiltration
15	Increase urban storage	Reduce energy (coastal)	Building codes	Manage rural conveyance
16	Collective damage avoidance	Collective damage avoidance	Increase urban storage	Land use planning
17	Land use planning	Morphological protection (coastal)	Land use planning	Building codes

18	Increase rural infiltration	Increase urban storage	Individual damage avoidance	Increase urban infiltration
19	Catchment storage	Increase rural infiltration	Flood water transfer	Flood water transfer
20	Manage rural conveyance	Manage rural conveyance	Collective damage avoidance	Physical barriers (coastal)
21	Increase urban infiltration	Flood water transfer	Land use management	Realignment (coastal)
22	Manage urban conveyance	Land use planning	Increase urban infiltration	Morphological protection (coastal)
23	Land use management	Building codes	Manage rural conveyance	Reduce energy (coastal)
24				Abandonment

Legend

Colour code	Interpretation
	Major reduction in flood risk (S < 0.7)
	Marked reduction in flood risk (0.7 < S < 0.9)
	Minor reduction in flood risk (0.9 < S < 1.0)
	No impact (S ~ 1)
	Increase in flood risk (S > 1.1)

Appendix 4 Tools for sustainable flood and coastal erosion risk management

Scale	Tool	Description (* taken directly from "*Securing the future")*
National & Policy	Integrated policy appraisal	Assessment of potential impacts of policy proposals by linking together a number of existing appraisal requirements and commitments which would otherwise need to be carried out separately
	Planning Policy Statements	PPG 25 Planning policy guidance, development and flood risks Guidance how local authorities should consider flood risk at all stages of the planning and development process
	Sustainability appraisal	Assessment process against sustainability indicators
	Guiding Principles for sustainable development	The UK Government, Scottish Executive, Welsh Assembly Government and the Northern Ireland Administration have agreed upon a set of shared principles that bring together and build on the various previously existing UK principles to set out an overarching approach to sustainable development.*
	Regulatory Impact Assessment (RIA)	Where regulations or alternative measures are introduced, this should be done in a light touch way, with decisions informed with a full regulatory impact assessment, which includes details of not only the obvious costs and benefits of the proposal but also the wider economic, social and environmental impacts. *
	Equity and fairness checklist	In addition to the costs and benefits of a policy, you may also be interested in the distributional impact of the policy - in particular if it disproportionately affects a vulnerable or already disadvantaged group. *
	Communications toolkit	Defra is developing toolkits and awareness raising materials in partnership with Futerra to help their staff deliver sustainable development better through all of its policies and services. Once trialled within Defra, these will be made available to all government departments and others groups as part of this page. *
	Changing behaviours	Government has produced a Summary model addressing behaviour change that can be applied to policy making, where the intention is to help people make better choices. *
	Peer review tool	The Improvement and Development Agency will roll out a Leadership Academy module on Sustainable Communities which develops local leadership on sustainable development issues. It will also offer a peer review tool on 'Sustainable Communities'. *
	Local Strategic Partnerships toolkits (LSP)	During 2005 the Government will work with its partners to develop toolkits and other materials to support Local Strategic Partnerships in developing and delivering sustainable community strategies which help deliver sustainable development in the UK . *

Scale	Tool	Description (* taken directly from "*Securing the future")*
	UKCIP Climate change scenarios	A consistent set of climate change scenarios for the UK developed from the Hadley Centre Global and Regional Climate Models.
Regional & Strategic	Climate change allowances	Current Defra guidance provides precautionary allowances that cover the ranges of impacts expected for the 2050s
	Climate change scenarios	Currently precautionary allowances are used in FCDPAG, use of scenarios offers an alternative approach
	Socio-economic scenarios	Using scenarios to explore the consequences of different FCM options. The Foresight project provides a description and interpretation of
	Flood risk assessment	Consideration of risks inherent in flooding. Project FD2320 provides a set of procedures for flood risk assessment of new development.
	PAMS	The Defra/EA research project 'Performance-based Asset Management System (PAMS) will provide the Environment Agency with an improved risk-based method for deciding how to manage its flood defence assets; to manage flood risk as efficiently and effectively as possible by inspecting, maintaining, repairing and if necessary replacing flood defences in order to achieve the required performance and to reduce risk to people, property and habitats.
	Sustainability appraisal/indicators	Assessment process against sustainability indicators
	Stakeholder tools	Tools to improve the efficiency and effectiveness of stakeholder engagement
	Project appraisal	Process of identifying and then evaluating options in order to select the one that most closely satisfies the defined project objectives. Details of Project
	Shoreline Management plans (SMP)	Large-scale planning document that identifies policies for coastal defence for a specified length of coast taking account of natural coastal processes and human and other environmental influences and needs
	Catchment Flood Management Plan (CFMP)	Large scale planning document that identifies long-term sustainable policies for the holistic management of flood risks in a defined river catchment or group of related catchments
Regional & Strategic	Strategy plan	Long term documented plan for river or coastal management, including all necessary work to meet defined flood or coastal defence objectives for the target area
	Multi criteria analysis (MCA)	Appraisal technique to capture a wide range of impacts that may not be readily valued in monetary terms
	Cost benefit analysis (CBA)	Comparison of present value scheme benefits and costs as part of an economic appraisal
	CHaMPs	Management plan that identifies the flood and coastal defence works that are likely to be required in a given area to conserve the nature conservation interest

Scale	Tool	Description (* taken directly from "*Securing the future")*
	Environmental impact assessment (EIA)	Specified process for undertaking environmental appraisal, findings are set out in an Environmental Statement
	ICZM	Integrated coastal zone management
	Sustainability appraisal	Assessment process against sustainability indicators
	Stakeholder tools	Tools to improve the efficiency and effectiveness of stakeholder engagement
Local & Community	Timber procurement framework	Flow diagram to assist in the procurement process of timber
	Whole life costing	Total costs associated with a scheme for its full design and potential residual life span, taking proper account of all aspects of design, construction, maintenance and external impacts
	Ecopoints	Score that measures impact on environment of scheme and material options
	Sustainability appraisal	Assessment process against sustainability indicators
	Stakeholder tools	Tools to improve the efficiency and effectiveness of stakeholder engagement
	Local Agenda 21 action plans	Local government-led, community-wide, and participatory effort to establish a comprehensive action strategy for sustainability
	Sustainability appraisal	Assessment process against sustainability indicators
	Stakeholder tools	Tools to improve the efficiency and effectiveness of stakeholder engagement

Annex: Tools for climate change impacts assessment

UKCIP02 Climate change scenarios

The UKCIP02 climate change scenarios are a standard tool for more detailed hydrological impacts assessment. The scenarios are based on the Hadley Centre's HadCM3 model and a downscaling technique called "dynamical downscaling" that uses the global model to provide boundary conditions for several more detailed models. The most important of these models is the Hadley Centre's Regional Climate Model (RCM) HadRM3 that provides outputs on a 50km grid over the UK.

Rainfall-runoff models

Rainfall-runoff models can be used to estimate runoff based on daily or sub-daily rainfall time series. As part of a more detailed study rainfall-runoff models may be used to estimate the impacts of changes in rainfall and evaporation on peak flows, typically using the UKCIP02 climate change scenarios and applying these to a "continuous simulation" of 1961-1990 river flows. However, there are other legitimate methods for deriving rainfall series that involve using other Global Climate Models such as using statistical downscaling tools that are being used in a number of Environment Agency research projects[49]. There is considerable uncertainty related to the methods used for preparing the rainfall data sets and choice of model. Therefore, advice should be sought from EA hydrologists and climate change experts in order to review any assessments that use these approaches.

UKCIP Risk and Uncertainty Framework

The UKCIP Risk and Uncertainty framework provides guidelines on how to incorporate climate change into risk assessment and decision-making.[50] The overall approach or individual risk assessment tools described in the report may be useful for more detailed climate change and flood risk assessment, for example in major development in "Growth Areas" such as the Thames Estuary.[51]

Combined probability analysis

A series of research reports have been completed on joint probability analysis that are relevant to assessments where there is more than one source of flood risk, e.g. in estuaries from fluvial and tidal flooding or "tide-locked" storm-water drains. The approaches are fairly complex but many of the outputs, such as "joint dependence" maps provide useful information on whether there is a strong correlation between sources of flooding, which is an issue that should be addressed in a detailed level FRA.[52]

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[49] For example: Wilby, R.L. and Dawson, W. (2001) Using SDSM – A decision support tool for the assessment of regional climate change impacts. User Manual. Department of Geography, King's College London, Strand and Department of Computer Science, Loughborough University, Leics.

[50] Willows, R. and Connell, R.K. (Eds.) (2003) Climate adaptation: Risk, uncertainty and decision making. UKCIP Technical Report. UKCIP, Oxford.

[51] For more information see: http://www.ukcip.org.uk

[52] Further information can be found in the following references:

River conveyance calculator

The River Conveyance Calculator was developed to estimate the capacity of river channels and their associated floodplains. It provides simple methods for converting flows to levels and provides information on the level of uncertainty related to this calculation. In cases where some cross-section information is available but detailed hydraulic models are not, it can be used to estimate floodplain levels for a 20% increase in flood flow.[53]

The Flood Estimation Handbook

The Flood Estimation Handbook[54] (FEH) gives guidance on rainfall and river flood frequency estimation in the UK. It does not include information on how to account for climate change but it does provide a range of tools used in assessments that could also help to understand the impact of an increase in 20% of river flow. In particular it could be useful for understanding the difference between the 1% and 0.1% EA flood maps in terms of volume and, therefore, place these maps in the context of the precautionary allowance for river flow of +20%.

HR Wallingford (2004a) *Joint probability issues within estuaries – A numerical case study for the tidal Thames*, Report TR 143, August 2004, HR Wallingford
HR Wallingford (2004b) *Joint Probability: Dependence Mapping and Best Practice*, Technical Report on Dependence Mapping, R&D Technical Report FD2308/TR1
HR Wallingford (2004c) *Use of Joint Probability Methods for Flood and Coastal Defence, A Guide to Best Practice*, R&D Interim Technical Report FD2308/TR2, May 2004

[53] For more information see http://www.river-conveyance.net/

[54] Institute of Hydrology (1999) *The Flood Estimation Handbook* http://www.nwl.ac.uk/ih/feh/

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