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

Evaluating a multi-criteria analysis (MCA) methodology for application to flood management and coastal defence appraisals

Guidance for the MCA-based element of the current approach to appraisal

R&D Technical Report FD2013/TR

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Statement of use
This report provides guidance on the use of MCA and ASTs to assist in the appraisal of flood and coastal erosion risk management projects, strategies and policies. It should be noted that it does not constitute official government policy or guidance, which is unlikely to be available until work to develop the methodology and identify appropriate sources of data has been undertaken through pilot studies. In the interim it is expected that ASTs will be incorporated in the Project Appraisal Report template and it is suggested that any MCA application involving weighting and scoring or application of the extended decision rule should only be undertaken following consultation with Defra's Flood Management Division.

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Contents

1. Introduction

1.1 Overview

This guidance report provides advice on the application of the MCA-based element of the current methodology to the appraisal of flood management and coastal defence projects. It intends to complement and enhance the Government's Flood and Coastal Defence Project Appraisal Guidance on Economic Appraisal (FCDPAG 3).

The guidance has been developed by Risk & Policy Analysts (RPA) during the second phase of the R&D Project FD2013 'Evaluating a multi-criteria analysis methodology for application to flood management and coastal defence appraisals' on behalf of the Department for the Environment, Food and Rural Affairs (Defra).

1.2 Introduction to the MCA-based element of the current approach

Spending on flood and coastal defence is constrained (as is all government expenditure) and, hence, decisions have to be made ensuring that resources are used in an efficient manner. The use of cost-benefit analysis (CBA) for flood and coastal defence is well established and over the years guidance has been developed (FCDPAG 3, Multi-Coloured Manual, etc.) to provide a consistent approach to the monetary valuation of impacts. However, there is growing concern that CBA fails to take full account of social and environmental factors, many of which cannot be expressed in monetary terms.

Multi-criteria analysis (MCA) covers a range of appraisal techniques that have the potential to capture a wide range of impacts that may not be readily valued in monetary terms. MCA aims to establish preferences between options by reference to an explicit set of specified objectives and associated criteria for assessing the extent to which these objectives have been achieved. Two of the key advantages of MCA are that it can allow greater stakeholder involvement and provide greater transparency to the decisions being made at all levels of appraisal.

A MCA-based approach was developed to complement the current flood and coastal defence approach to appraisals to provide a decision-making methodology that includes both those impacts which can be readily valued in monetary terms and those that can not. The MCA-based method is used in parallel with the CBA method and the two are brought together by using a form of expanded decision rule. The MCA-based approach is systematic and makes use of Appraisal Summary Tables (ASTs) that are used for screening at different decision levels and provide the framework for scoring and weighting of impact categories.

For simplicity this MCA-based element to the current approach to appraisal is referred to as the MCA-based approach and/or MCA-based methodology, throughout this document.

1.3 Structure of the guidance

The structure of this guidance report follows the steps proposed for the MCA-based methodology (see Section 2), providing in each Section general guidelines on the aim of each step, the necessary data and analysis and the outputs of each step. The report is organised as follows:

- Section 2 briefly sets out the way in which the MCA-based element of the methodology sits within the current approach, identifies the steps involved in the approach, and defines the framework of the MCA-based element of the methodology, i.e. the Appraisal Summary Tables (ASTs) and the impact categories used within these;

- Section 3 describes the first stage of the approach, i.e. the Define Stage. This includes description of the definition of problem, objectives and management options and the screening out of unreasonable options;

- The Develop Stage is described in Section 4. This includes details on the structuring step of the approach (Step 3) and the qualitative and quantitative assessment of the impacts; and

- Section 5 sets out the Compare Stage of the methodology, where the valuation and scoring of impacts is undertaken, together with the weight elicitation and selection of the preferred option.

2. The MCA-based element of the current approach in context

2.1 Introduction

CBA is a well-established appraisal approach to flood and coastal defence project appraisal. However, this approach has been criticised because it fails to take into account those impacts that cannot readily be valued in monetary terms, in particular environmental and social impacts.

For this reason the need arose for the development of a new approach that, taking into account the many advantages of the CBA method, in particular its robustness, would also allow for other intangible impacts to be considered in the appraisal process and subsequently in the decision-making exercise. Multi-criteria analysis (MCA) presents itself as the solution to this issue, as it covers a variety of techniques that can capture a wide range of impacts including those that may not be readily valued in monetary terms.

MCA uses an explicit set of objectives and associated criteria as a framework for the comparative assessment of the impacts of alternative and competing options. It does this by assessing the extent to which the objectives and criteria have been fulfilled by each of the defined options. The key advantage of MCA is that it provides a framework that allows impacts measured in different units to be taken into account and be treated equally in the analysis. This is achieved through the use of scoring and weighting techniques, which convert measurements into a common scale to enable weighting and aggregation (as desired).

2.2 The MCA-based methodology in the context of the current approach

In order to complement the current approach to appraisal based on CBA, a component based on MCA techniques has been developed to supplement and improve the appraisal and -making processes.

Flood and coastal defence appraisal needs the ‘best of both worlds’, i.e. the appraisal approach should retain the rigour of CBA, particularly in regard to demonstrating that the chosen option is a good use of resources, whilst providing a framework within which social and environmental issues can be more explicitly included in the decision-making process.

In addition, the method should be applicable at a number of decision levels:

- high-level (such as SMPs and CFMPs);
- strategy-level (for defined lengths of river or coastline); and
- project-level (for individual defence projects on a river or coast).

2.3 Stages of the MCA-based element of the appraisal methodology

The methodology presented here is intended to complement and expand upon the current CBA methodology. This combined methodology follows very closely the current approach to appraisal, only deviating from it by adding new steps into the process.

As identified in the FCDPAG 3, the project appraisal process involves four discrete stages - Define, Develop, Compare and Select - within which are included various procedural steps[1]. The current approach to appraisal including the MCA-based element of the methodology comprises the following steps:

Step 1: definition of problem, the objectives and identification of all options;
Step 2: elimination of unreasonable options;
Step 3: structuring the problem, i.e. screening using the Appraisal Summary Table for High Level Screening (S-AST);
Step 4: qualitative assessment of impacts, using the Appraisal Summary Table for Main Assessment (MA-AST);
Step 5: quantitative assessment of impacts, using the MA-AST;
Step 6a: determination of the tangible benefits and costs of options (economic appraisal);
Step 6b: scoring of options;
Step 7: weight elicitation, as appropriate (with the use of a weight generation analysis as optional to determine the necessity for weight elicitation);
Step 8: comparison of options using expanded decision rules;
Step 9: testing the robustness of the choice; and
Step 10: selecting the preferred option.

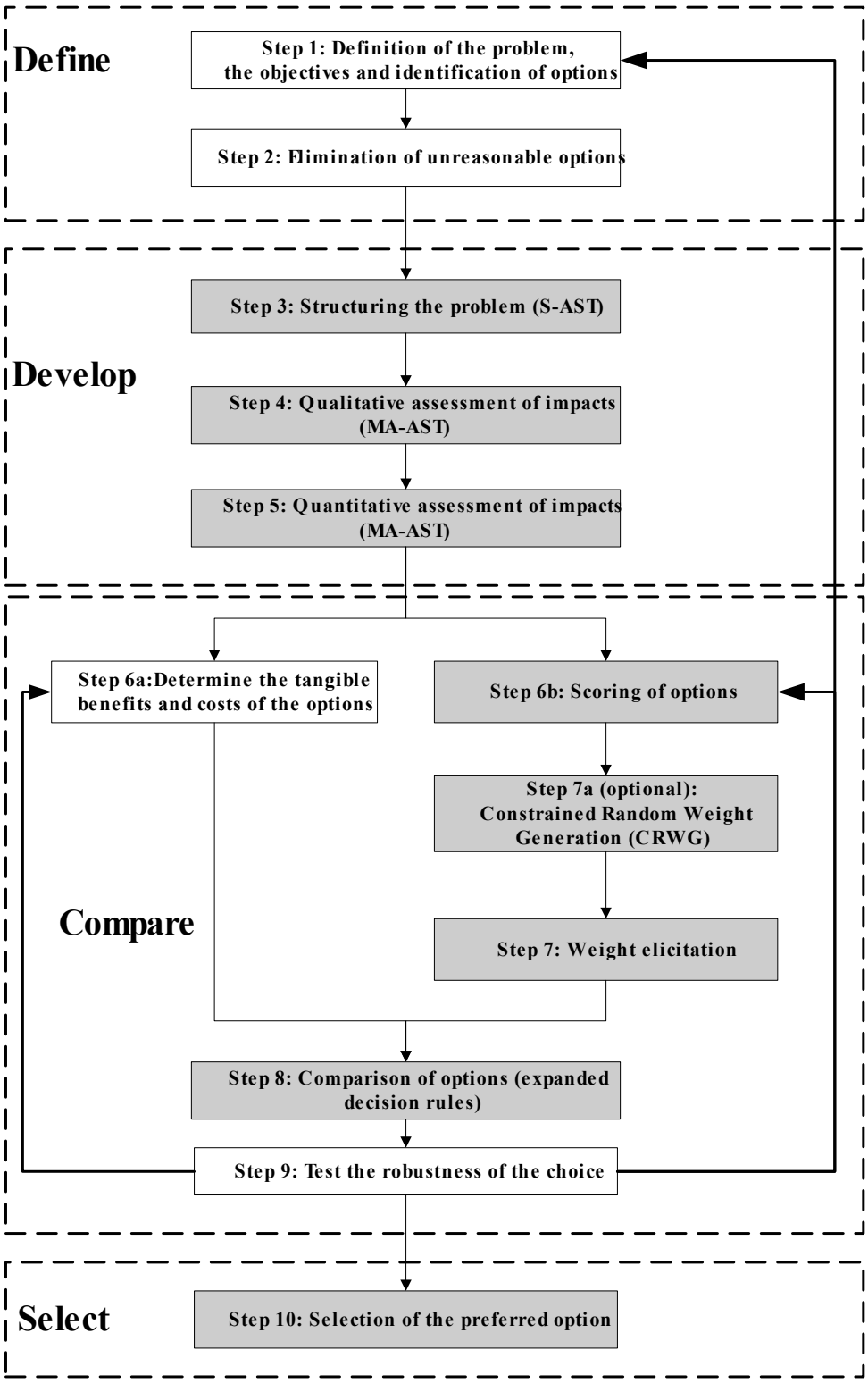
Figure 2.1 illustrates these steps. Those steps highlighted in grey are new to the approach and represent the MCA-based element. As can be seen by comparing this stepped approach to the process set out in FCDPAG 3, the MCA aspect of the approach is introduced in Step 3 - Definition of objectives and description of options. The Develop stage of the approach is not changed from the original one but further structured and enhanced by the use of Appraisal Summary Tables (ASTs). Steps 7 and 8, in the Compare stage, are new to the appraisal and they enable a more thorough consideration of the intangible impacts in the overall process. Steps 9, 10 and 11 have been slightly modified to include the new MCA-based element of the process. A description of how each of these new or transformed steps is carried out is given in the following Sub-Sections.

It was not thought necessary to describe those steps that are currently included in the CBA approach to economic appraisal as they are current practice. It is nonetheless important to reiterate that FCDPAG 3 guidance should be followed. In addition, other guidance documents, such as other volumes in the Flood and

[1] Further information on these four stages of the appraisal process is provided in FCDPAG 2 – Strategic Planning and Appraisal (MAFF, 2001).

Coastal Defence Project Appraisal Guidance series, the Procedural Guidance for Production of SMPs (Defra, 2003) and guidelines for the development of CFMPs (Defra, 2004), should also be used when carrying out a flood and coastal defence project appraisal.

Figure 2.1: New Methodological Approach to Economic Appraisal including the MCA-based Element



2.4 The framework of the approach

The MCA-based element of the methodology is built around the concept of Appraisal Summary Tables (ASTs), as well as the impact types and categories that form the framework of the appraisal process. The text below introduces the concept of ASTs and defines the impact types and categories that are used in the MCA-based element of the appraisal. Once these two aspects are clear, it is possible to proceed with the guidance of the various steps of the proposed approach to appraisal.

2.4.1 Introduction to Appraisal Summary Tables

An important element of the MCA-based element of the appraisal methodology presented in this guidance report is the use of Appraisal Summary Tables (ASTs) as a means of recording impact data. ASTs are tabular summaries of the main economic, environmental and social impacts of a proposed option, whether relating to a policy/programme, strategy or scheme. An AST is produced for each option, and it sets out simply and concisely the key consequences of the different options for addressing the problem.

The concept of an AST originated as a means of improving the approach taken to assessing the impacts of road construction schemes (namely "*New Approach to Appraisal*" (NATA)), in response to criticism that environmental and social issues were not adequately taken into account. Since then, the more recent guidance being developed by Defra, the Agency and other governmental organisations, has been taking this concept on board, in particular in relation to water resource management. The advantages of using of an AST-based methodology are that:

- it allows all options to be assessed in terms of the same criteria, and hence, ensures consistency in treatment across options;
- it ensures that a comprehensive range of impact categories is considered within the assessment, thus, ensuring consistency across appraisals;
- it allows information on impacts to be recorded in a consistent manner (as well as the assumptions behind them), thus aiding transparency;
- it helps in identifying which impacts are more important to the end decision and demonstrating how this decision was reached;
- it provides a means for others to audit the assessment accompanying the decision-making process; and
- it should aid in developing greater consistency across different levels of decision-making since the same AST structure can be used throughout the appraisal of a Plan or Policy, a related Strategy and related Schemes.

The aim of the AST is to ensure transparency, i.e. to provide a structure in which all of the reasons for choosing a preferred option are set out in a clear and intelligible manner. In this way, the decision-making process transforms from a 'black box' to a more auditable process.

Two main ASTs have been developed for the purposes of the MCA-based methodology. These are:

- the Appraisal Summary Table for High Level Screening (S-AST) (see Section 4.2); and
- the Appraisal Summary Table for Main Assessment (MA-AST) (see Section 4.3).

The High Level Screening AST (Table 2.1) identifies which impact types will need to be taken into account in the assessment, and includes cells for recording the following types of information:

- the project name with an indication of the level of decision being taken (i.e. policy/programme, strategy or scheme);
- an indication of whether the impact is likely or not;
- a detailed qualitative description of the likely impacts; and
- an indication, by means of ticks, of whether the impact will be evaluated in monetary terms or through scoring (qualitative or quantitative assessment).

The information included in the S-AST should correspond to the information necessary to appraise the 'do nothing' option.

Table 2.1: Appraisal Summary Table for High Level Screening (S-AST)

Project Name				
Impact Category	**Impact likely? (Y/N)**	**Impact Details**	**Qualitative or Quantitative Assessment**	**Monetary valuation**
Economic Impacts				
Assets				
Land use				
Transport				
Business development				
Environmental Impacts				
Physical habitats				
Water quality				
Water quantity				
Natural processes				
Historical Environment				
Landscape and visual amenity				
Social Impacts				
Recreation				
Health and safety				
Availability and accessibility of services				
Equity				
Sense of community				

The Main Assessment AST (Table 2.2) is used for the more detailed qualitative and quantitative assessment of the impacts of the project being appraised, and it includes cells for recording the following types of information:

- the project name with an indication of the level of decision being taken;
- a description of the option being assessed and the defence standard being provided;
- a brief description the area being affected by the project;
- qualitative descriptions of the effects of the option for each of the impact categories, including any assumptions specific to the impact assessments or comments on their robustness and validity;
- quantitative descriptions in physical or natural units of measure and/or monetary units of the effects of the option under each impact category, including any assumptions specific to the impact assessments or comments on their robustness and validity;
- the results of the scoring exercise, as appropriate, for each category; and
- the results of monetary valuation exercises, as appropriate, for each category.

Table 2.2: Appraisal summary table for flood management and coastal defence – main assessment (MA – AST)

Project Name	Project name (high, strategy or scheme level)
Description of Option	Description of option being assessed (do-nothing, maintained, improve, etc.)
Description of Area Affected by Option	Brief description of area affected

Impact Category	**Impact likely? (Y/N)**	**Qualitative Description of Impacts**	**Quantitative Assessment of Impacts (no. units / money)**
Economic Impacts			
Assets			
Land use			
Transport			
Business development			
Environmental Impacts			
Physical habitats			
Water quality			
Water quantity			
Historical Environment			
Landscape and visual amenity			
Social Impacts			
Recreation			
Health and safety			
Availability and accessibility of services			
Equity			
Sense of community			

2.4.2 Impact Types and Impact Categories

Both of the ASTs are constructed around the same impact types and categories. The definition of these was based on guidance provided by the FCDPAG series (MAFF, 1999-2001), the Environment Agency's Receptors and Resources Checklist, the Integrated Policy Appraisal Tool and other water resource management methodologies. The idea was to create a framework that includes and integrates all major appraisal tools that may be useful in flood and coastal erosion risk management.

The impact types and associated categories that form the basis for the ASTs are defined in Table 2.3.

Table 2.3: Types and Categories of Impacts Included in the Flood Management and Coastal Defence AST and their definitions

Types	Categories	Category Description
Economic Reflect impacts that affect goods and services that can be readily valued or that affect the local, regional and national economy.	Assets	Includes flood damages and/or losses relating to (permanent and temporary) private and public property such as residential, industrial and/or commercial property, caravan parks, public buildings (for example, schools, hospitals) sewage and water supply networks, pipelines, etc.
	Land use	Includes flood damages to land used for agricultural, industrial, urban, forestry, commercial fisheries purposes.
	Transport	Includes impacts to roads, bridges, railways and navigation.
	Business development	Includes regeneration/development and competitiveness. Regeneration includes impacts on the creation of sustainable communities, i.e. economic development and development or maintenance of social cohesion. Important indicators include: creation (or not) of jobs; enhancement of local environment; and enhancement of social and leisure opportunities. Competitiveness includes impacts to businesses (their costs, investment, market structure, etc.).
Environmental Reflect impacts that affect the natural and built environment.	Physical habitats	Includes impacts to terrestrial (including coastal), aquatic and marine habitats and biodiversity, its conservation designations, and its flora and fauna.
	Water quality	Includes impacts on biological and chemical quality of surface and groundwaters. Important indicators to consider include: chemical and biological GQA grades; river quality objectives; consented and un-consented discharges; and designated bathing waters.
	Water quantity	Includes impacts on the water levels and water supplies (such as drainage and run-off).
	Historic environment	Includes impacts on heritage, archaeological and geological features.
	Landscape and visual amenity	Includes impacts on the appearance of the land (its shape, colour, and particular features), its landscape designations as well as its agreeable nature.

Table 2.3: Types and Categories of Impacts Included in the Flood Management and Coastal Defence AST and their definitions

Types	Categories	Category Description
	Natural Processes	Includes impacts on flow dynamics, sediment transport, geomorphology, etc.
Social Reflect impacts that affect the general public and their way of life.	Recreation	Includes impacts on the processes or means of entertainment. It includes angling, informal recreation (walking, sunbathing, picnicking, sitting, swimming, etc.) and formal recreation (sports and other activities that require specific equipment).
	Health and safety	Includes impacts such as risk to life or serious injury, stress and anxiety (mental health and livelihood) and other health effects, such as those created during the construction phase of the project (noise and air pollution, for example).
	Availability and accessibility of services	Includes impacts on availability and accessibility to public services such as education, housing, emergency and cleaning services, health, cultural facilities and other.
	Equity	Includes distribution impacts (consideration of interest of all groups of stakeholders), impacts on vulnerable groups (such as the elderly, children, etc.) and social tensions (rise of serious divisions and conflicts within the community).
	Sense of Community	Includes impacts on the local community, level of satisfaction with neighbourhood, social networks and community expectations.

The ASTs presented here are not intended to constitute an inflexible framework, but a general framework for the assessment. The impact categories are not fixed and can be further subdivided into sub-categories as required for the area being assessed. This is particularly important in cases where an impact category includes different aspects of the same issue and positive impacts may coexist with negative ones. For example, under the physical habitat impact category, it may be the case that a specific habitat is lost but another (different) one is gained as a consequence of a particular option. Both of these sub-impacts must be accounted for, so the impact category can be divided into sub-categories referring to the distinct habitat types for the assessment.

3. Stage 1: Define

3.1 Step 1: Definition of the problem, the objectives and identification of all options

3.1.1 Aims

The aim of Step 1 is to identify and define the flood and coastal defence problem (without presupposing any particular outcome or solution), make explicit the objectives of the assessment and identify all reasonable and significant options to address the problem.

3.1.2 Data and analysis

According to FCDPAG 2 - Strategic Planning and Appraisal (MAFF, 2001), the process of identifying the problem and the key issues can be considered under the following broad headings:

- co-ordination with high level plans - it may be that key issues and broad solutions may have been identified in large-scale plans, they also contain relevant data and analysis work that does not need to be repeated;
- establishment of appropriate boundaries - these need to be set in relation to the objectives of the project, with the aim of ensuring that all major processes, impacts and consequences of the project are captured within the area considered;
- establishment of an appropriate time frame - it is usually appropriate to consider the projects extending over 100 years or reflect the physical life (with maintenance) of the longest-lived asset under consideration (Defra, 2003a);
- review of current data and knowledge - it is important to gather all the best knowledge available on both natural and man-made processes, using all available sources;
- evaluation of do-nothing scenarios - a realistic do-nothing scenario should be developed however inconceivable it may seem. This information will be used later on in the process, during the screening stage and the main assessment as a baseline; and
- identification of significant opportunities/constraints - it should be ensured that the constraints are real and do not limit the choice of possible options for further study.

The Procedural Guidance for preparation of SMPs (Defra, 2003b), in its Appendix B regarding data access and management, provides a good summary of basic data sources available that can used within the scope of SMPs.

If the FCDPAG 2 guidance is followed, the definition of the problem should have provided the necessary background information to be able to define the objectives and aims of the project appraisal and to describe all possible options.

It is suggested that definition of the project objectives should be undertaken in relation to the different impact categories listed in the appropriate Appraisal Summary Table (see Step 4 and 5). In this regard, it will be important to involve stakeholders in defining the project objectives. This will ensure that the objectives are comprehensive and it will make it easier to integrate them into the comparative assessment of the different options. Consultation will also ensure that the assessment addresses those issues of most concern to stakeholders. Nonetheless, a balance between the comprehensiveness of objectives and practicalities of assessment should be achieved. A very long list of objectives should be avoided by grouping and collapsing objectives whenever possible.

To ensure policy integration, it is suggested that particular attention is given to the identification and analysis of other policies, programmes and plans that also lay down objectives for the area. In this respect, the Draft Practical Guide to Strategic Environmental Assessment (ODPM, 2004) is a good source of information.

3.1.3 Outputs

The main outputs of Stage 1 should be a clear statement of the problem being appraised; a clearly defined set of objectives expressed in suitable terms; and a list of alternative options spelled out in sufficient detail to allow a preliminary assessment of the impacts, but not so firmly set that they cannot be modified as the appraisal progresses.

3.2 Step 2: screening of unreasonable options

3.2.1 Aims

The aim of Step 2 is to screen out unreasonable options, with reference to the objectives identified for the project. Unreasonable options are those options that are either not feasible for environmental, economic and/or technical reasons and/or are unacceptable/ unjustifiable, for example because they do not comply with existing legal requirements.

3.2.2 Data and analysis

The data and information necessary for this Step will have been collected during Step 1.

The screening of those options that are not feasible will be based on the set of objectives defined for the project, but also on the initial assessment of the technical, environmental and economic constraints. The selection of suitable options is not final and can be revisited during the development of the appraisal, namely during the testing of the robustness of the choice (Step 9).

3.2.3 Outputs

The outputs from Step 2 will be a clear statement identifying and describing the options selected to be carried forward to the assessment, as well as a list of options not carried forward to the appraisal and a justification for their abandonment, such as not complying with existing legislation or very high costs for provision of same level of benefits. Nonetheless, care is needed to only screen out those options where there are real and overwhelming reasons for them not to be considered further.

4. Stage 2: Develop

4.1 Introduction

This Section covers the 'Develop' stage (Steps 3, 4 and 5) of the appraisal approach, as presented in Figure 2.1. The screening, qualitative and quantitative assessment steps of the MCA-based elements of the appraisal methodology set out the background information on which the evaluation of impacts is based and, therefore, constitute very important stages within the appraisal process.

The approach described here is stepped, and every step is to be followed in a systematic manner. First, a screening exercise which sets the baseline should be undertaken, followed by the qualitative and quantitative assessment of each management option being considered. This is important for ensuring that the information required for the application of benefits transfer and/or the scoring of impacts is available as one moves to Step 6 of the methodology. Also, the success of the screening, the qualitative and quantitative assessment exercises, and of the appraisal in general, will depend significantly on the successful use and completion of the Appraisal Summary Tables (ASTs) that underlie this stage of the approach.

It is important to note at this point that although the qualitative assessment is dealt with in this guidance as separate, and as a precedent to the quantitative assessment, in practice they will be performed in conjunction for each impact category.

4.2 Step 3: Structuring the Problem – High Level Screening

4.2.1 Aims

The main aim of the screening exercise (Step 3) is to structure the problem that is being appraised. It breaks down the problem into its component parts, identifying the set of impacts and associated criteria that will be used to determine the relative performance of different options, and intends to assess the baseline, i.e. the 'do-nothing' option.

4.2.2 Data and analysis

The high level screening exercise is structured around the High Level Screening AST (S-AST) illustrated in Table 4.2, at the end of this section.

The information included in the S-AST should correspond to the information necessary to appraise the 'do-nothing' option, in both qualitative and quantitative terms. Furthermore, as information on the impacts under the 'do-nothing' option will form the baseline for the assessment and will be used in the

later stages of the appraisal, this approach ensures that time and resources are used efficiently.

Some of the necessary data and information for completing the S-AST should be readily available from the completion of Step 1 of the appraisal, which includes the evaluation of the 'do-nothing' scenario. This information will have to be complemented with additional data and information with the aim of fully describing the impacts of 'do-nothing' in order to have a detailed baseline from which to assess the remaining options.

In the S-AST (Table 4.1), under the column 'Impact Likely?', and for each impact category, a 'Y', for yes, or an 'N', for no, should be recorded as the first indication of the existence (or not) of the impact. Under the 'Impact Details' column, and for each impact category, a description of the impact under the do-nothing option should be given. This should effectively correspond to the baseline assessment. Finally, an indication of what evaluation method will be used in the appraisal should be given. For each impact category, this is done by ticking either the 'qualitative or quantitative assessment' cell or the 'monetary valuation' cell. This can usually be determined by considering if there are sufficient data to place a monetary value on the impacts (damage data from Multicoloured Manual (Penning-Rowsell, *et al* 2003) or through benefits transfer (see Annex 2)).

The definition and description of the baseline (the 'Impact Details' column of the S-AST) corresponds to the qualitative and quantitative assessment of the 'do-nothing' option, and should be approached in a stepped manner for each impact category, i.e. starting with the qualitative assessment and moving to the quantitative assessment.

Qualitative assessment of impacts

There is a tendency to avoid describing those impacts that are easily quantified in qualitative terms, as it is natural to start on the quantitative description straight away. The qualitative description is, however, useful as a scoping tool to ascertain which impacts should be considered on a case-by-case basis. Going straight to quantitative assessment may constrain the manner in which impacts are considered and valued particularly as not all impacts can be readily valued.

The qualitative description of predicted/expected impacts should include a list of effects that are expected to occur under the 'do-nothing' option, for each impact category, including the timing of the expected impact. For example, for the social impact categories, the qualitative description should include an indication of the types of population affected, how they will be affected and the timing of the expected impact.

As an example, the qualitative description for the 'recreation' impact category should include an answer for the following questions:

- will the recreational activity be able to continue if ‘do-nothing’ goes ahead?;
- will the access to recreational sites be affected by the ‘do-nothing’ option?; and
- is the quality/enjoyment of the activity likely to increase or decrease and why?

Quantitative assessment of impacts

The quantitative assessment should describe the expected change of status in quantitative terms, based on the number of units lost or gained or affected (with physical data providing the best basis for quantification).

The quantitative assessment of those impact categories that can be valued in monetary terms should focus on providing the information that will be needed for the monetary valuation. For example, the quantitative description for the ‘assets’ impact category should include an answer for the following questions:

- how many properties (residential and non-residential) are flooded under each return period flood?
- how many of these are considered totally lost, i.e. are affected by a 1 in 3 return period flood, flood less frequently, are flooded by overtopping of defences, and eroded; and
- in which year is a breach of the defences likely to occur?

For those impact categories that cannot be valued in monetary terms, the quantitative assessment should describe the change in status, expressed in number of units lost or gained. For example, for the ‘physical habitats’ impact category the assessment should include answers to the following questions:

- how many hectares of the conservation site will be affected by flooding and/or erosion?
- how many habitats and/or species will be affected by the ‘do-nothing’ option, and what is their significance?
- how many hectares of new habitat is going to be created by the ‘do-nothing’ option?

Types of information

Table 4.1 illustrates the type of information, qualitative and quantitative, to be included under each impact category for the ‘do-nothing’ option.

Table 4.1: Type of data and information to be included during the high level screening exercise

Impact Category	Impact Details
Economic Impacts	
Assets	• number of residential, non residential properties and temporary and semi-permanent structures at risk from flooding and/or erosion, including indication of what is written-off, flooded intermittently, affected by overtopping or eroded; • number of public infrastructures at risk such as sewage networks, water supply networks and public buildings, including number that are written-off, intermittently flooded, and flooded due to overtopping; and • indication of the timing of events such as year of breach, year when erosion starts and any other important data necessary for calculation of damages.
Land use	• area of land (agricultural, forestry, development, etc.) at risk from flooding and/or erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events such as year of breach, year when erosion starts and any other important data necessary for the calculation of the damages.
Transport	• number and type (M, A, B, etc.) of roads, railway and navigation networks and their length at risk from flooding and/or erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; • indication of the importance of transport network being flooded/eroded to the area being assessed; and • indication of the timing of events.
Business development	• description of (indirect) impacts on businesses, including number of business related properties being at risk from flooding/erosion, potential impacts from transport network disruption; • indication of the importance of such businesses to the area of study, including employment statistics, existence of similar businesses in the surrounding areas, etc; and • indication of the timing of events.
Environmental Impacts	
Physical habitats	• description of potential impacts and significance, such as damage and/or creation of habitats and species, damage or enhancement of areas of conservation, etc. • number, type, area and importance of nature conservation sites (including any designations) and/or habitat areas and species at risk from flooding and/or erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and eroded; and • indication of the timing of events.
Water quality	• description of types of water features being affected, types of effects being considered (biological, chemical, etc.), their relative importance, indication of the magnitude of the effect, and impact source type (agricultural fields, contaminated land, landfill sites, etc.); • length/volume/area of 'water feature/resource' at risk from impacts from flooding/erosion, and change in chemical and biological quality indicators, including indication of what is written-off, intermittently flooded, flooded due to overtopping and eroded; and • indication of the timing of events.
Water quantity	• indication of potential impacts and significance, such as number of water abstraction and discharge points being affected; • length/volume/area of 'water feature/resource' at risk from impacts from flooding/erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events.

Table 4.1: Type of data and information to be included during the high level screening exercise

Impact Category	Impact Details
Natural processes	• indication of type, size, significance and quantity of natural processes being affected by flooding/erosion, such as change in sediment transport rate, formation of tidal inlets, increased rate or erosion/accretion, landward migration, etc; and • indication of the timing of events.
Historical Environment	• description of potential impacts and significance, such as damage to conservation areas, and buildings; • number/area, classification and importance of historically and archaeologically important buildings/areas at risk from flooding/erosion, including indication of what is written-off, intermittently flooded, affected by overtopping or eroded; and • indication of the timing of events such as year of breach, year when erosion starts and any other important data necessary for the assessment of impacts.
Landscape and visual amenity	• description of potential impacts and significance, such as visual impacts on landscape and amenity, impacts on landscape character, etc. • area, type, classification of landscape and landscape features at risk from flooding/erosion including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events.
Social Impacts	
Recreation	• description of potential impacts on formal and informal recreation and significance (for example, local, regional, national), such as damage to recreation and leisure areas and buildings, numbers of visitors, types of activities affected, etc; • numbers/area, and importance of recreation features (e.g. promenade, amusement parks, caravan sites, etc.) at risk from flooding/erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events.
Health and safety	• description of potential impacts on health and safety and significance, such as potential sources of health and safety risk, for example frequency of risk, deteriorating defences, stress and anxiety, loss of appropriate access, etc; • numbers of people at risk from flooding/erosion; and • indication of the timing of events.
Availability and accessibility of services	• description of potential impacts on availability and accessibility of services and significance, such as impacts on patterns of daily life, impacts on the adequacy of public infrastructure (sewage systems, water supply, mobility, etc); • numbers and types of services disrupted (schools, hospitals, shops, businesses, roads) and magnitude of impact, population affected and potential alternative services (including distances to alternative services); and • indication of the timing of events.
Equity	• description of potential impacts on different population groups and significance, such as impacts on specific job types, deprived areas, specific economic sectors, etc; • numbers and types of population affected by flooding and erosion, including proportion of population in vulnerable groups (minorities, elderly, disabled); and • indication of the timing of events.
Sense of community	• description of potential impacts on the community and significance, such as impacts on social networks, rate of exodus from locality, levels of satisfaction with neighbourhood, etc.

Table 4.1: Type of data and information to be included during the high level screening exercise

Impact Category	Impact Details
	• numbers and types of population affected by flooding and erosion, including proportion of the community likely to be affected; and • indication of the timing of events.

4.2.3 Outputs

At the end of the screening exercise, one should have a completed S-AST, defining the baseline for the appraisal of the 'do-something', options. The screening AST provides:

- firstly, a screening checklist that identifies the range of potential impacts, with the aim of ensuring that all impacts of the project are consistently considered;

- secondly, an indication of whether appraisal of each impact category will be best undertaken using qualitative or quantitative assessment (MCA) or monetary valuation (CBA) techniques; and

- thirdly, and most importantly, it sets out, comprehensively, the expected/predicted impacts under the 'do-nothing' option against which the impacts of other options can be compared.

An illustrative example of a completed S-AST is presented in Table 4.2, below

Table 4.2: Example Appraisal Summary Table for Flood Management and Coastal Defence – High Level Screening

Project Name		Dymchurch Coastal Defence Strategy Case Study, from High Knocke to Dymchurch Redoubt.		
Assumptions		Breaching will occur approximately in year 5; Erosion would occur 5 years after breaching.		
Impact Category	**Impact likely? (Y/N)**	**Impact Details**	**Assessment of impact**	
			Other	**Money**
Economic Impacts				
Assets	Y	Flooding of residential and industrial properties, including car parks, schools, churches and other public buildings in Dymchurch village and nearby coastal strip due to breach (year 10) or heavy overtopping between High Knock and Dymchurch Redoubt (2471 dwellings will be flood damaged, 1147 of which would be written off). Flooding/loss of tourism business developments and holiday camps in Dymchurch village and nearby coastal strip due to breach or heavy overtopping between High Knock and Dymchurch Redoubt (3 holiday parks, 927 caravans) Flooding/erosion (year 15) of drains and sewers of the urban and countryside area, including the Marshland, Willtop and Grand Redoubt outfalls. Flooding/erosion (year 15) of High Knocke and Dymchurch slipway and of the Willtop pumping station.		✓
Land use	Y	7672 ha of agricultural land (Grade 3) will be at risk from flooding. In addition, 113 ha of the land in Romney Marsh SSSI will also be flooded (this is considered to be Grade 1 agricultural land).		✓
Transport	Y	Flooding of the A259, between High Knock and Dymchurch Redoubt.		✓

Table 4.2: Example Appraisal Summary Table for Flood Management and Coastal Defence – High Level Screening

Project Name		Dymchurch Coastal Defence Strategy Case Study, from High Knocke to Dymchurch Redoubt.		
Assumptions		Breaching will occur approximately in year 5; Erosion would occur 5 years after breaching.		
Impact Category	**Impact likely? (Y/N)**	**Impact Details**	**Assessment of impact**	
			Other	**Money**
		Flooding of a number of minor roads crossing Romney Marsh and connecting villages and farms.		
Business development	Y	Loss of beach and tourist facilities is likely to have knock-on impact on economy of the area (which relies to a large extent on tourism and recreation) such that business development is also likely to be reduced. The Dymchurch shopping area, for example, is close to the sea front. Along the coast there are also other businesses centres.	✓	
Environmental Impacts				
Physical habitats	Y	Flooding of the Site of Nature Conservation Interest (SNCI) located behind Dymchurch village, consisting of a small area of relic grazing marsh providing one of the only areas which has not been converted to arable and hosts several rare and scarce species of flora and fauna; Potential flooding of freshwater dykes that run through the marshy grassland, exhibiting fresh water flora, water voles, yellowhammer and sedge warbler; Flooding of the SNCI at Hythe Ranges (outside the study area but adjoins the northern boundary). The site comprises of shingle backed by grassland and scrub (used by MOD) and hosts several rare and scarce species of flora and fauna (vegetated shingle is a BAP priority habitat); Erosion (after breach) of vegetated shingle that constitutes a priority habitat under the Biodiversity Action Plan. Erosion (after breach) to the sandy shores of Dymchurch which are used by shorebirds for roosting sites. Impact to Romney Warren SSSI and pLNR. Impact on natural spawning and nursery grounds for many species of fish (for example, lemon sole, sole, sprat and mackerel).		✓
Water quality	Y	Deterioration of defences may impair water quality status. Impact to coastal waters quality during flooding due to increased flushing of agricultural land.	✓	
Water quantity	N	There are no abstraction points in the study area.		
Natural processes	N	No impacts expected on natural processes. It should be noted that due to increased erosion in year 15, there may be an increase in sediment load.		
Historical Environment	Y	Erosion (year 15) of Martello Tower and Dymchurch Redoubt both Scheduled Ancient Monuments (SAM). Flooding/erosion of 9 monuments listed on the Sites and Monuments Register;		✓

Table 4.2: Example Appraisal Summary Table for Flood Management and Coastal Defence – High Level Screening

Project Name		Dymchurch Coastal Defence Strategy Case Study, from High Knocke to Dymchurch Redoubt.		
Assumptions		Breaching will occur approximately in year 5; Erosion would occur 5 years after breaching.		
Impact Category	**Impact likely? (Y/N)**	**Impact Details**	**Assessment of impact**	
			Other	**Money**
		Flooding of two Conservation Areas within Dymchurch, the Church Area and High Street Area and 22 listed buildings. Erosion (year 15) of the sea wall that dates back to the 13th Century and of Fort Lodge, World War II underground operational post and Saxon site. Impact on site of high archaeological potential located near Dymchurch. Impact on ancient churches and evidence of Roman settlements in Romney Marsh.		
Landscape and visual amenity	Y	Erosion (after breach) of beach at Dymchurch, which is a key feature in the landscape and amenity of the area. Impact to cultural landmarks (such as churches, barns, etc.) (also considered in historical environment). Impact to Romney Marsh (also considered in land use).	✓	
Social Impacts				
Recreation	Y	Erosion of slipways (year 15) at Dymchurch and High Knocke, with impact on water activities such as sailing, fishing, etc. Impact to Romney, Hythe and Dymchurch Railway, MW's amusement park, Martello Tower 24, two caravan parks and an Holiday Village; Erosion (year 15) of promenade on top of sea wall with impact on recreational activities such as walking, sight seeing. In addition the access to the beach over the sea wall would be lost (assumed 160,000 visits to the town per year).		✓
Health and safety	Y	Risk to local population from flooding and breaching of defences; Stress and anxiety to local population from possibility of flooding and/or breaching of defences; Potential health and safety issues if defences deteriorate and no warning signs are out in place.	✓	
Availability and accessibility of services	Y	Potential loss of accessibility to services due to flooding of A259 and rural and local roads. Potential loss of availability of services due to flooding of local facilities (churches, schools, hospital, etc.). Loss of tourism facilities may have a knock-on effect on local shops, businesses, etc., that may result in loss of services to local people (and to visitors to the area).	✓	
Equity	Y	Loss of facilities, both for tourists and locals, is likely to result in local job losses and may increase deprivation in an area that relies on income from tourism. Loss of beach access would also affect	✓	

Table 4.2: Example Appraisal Summary Table for Flood Management and Coastal Defence – High Level Screening

Project Name		Dymchurch Coastal Defence Strategy Case Study, from High Knocke to Dymchurch Redoubt.		
Assumptions		Breaching will occur approximately in year 5; Erosion would occur 5 years after breaching.		
Impact Category	**Impact likely? (Y/N)**	**Impact Details**	**Assessment of impact**	
			Other	**Money**
		recreation in the area (again for visitors and locals) and would reduce the quality of life.		
Sense of community	Y	Loss of businesses, employment and some properties is likely to reduce the sense of community.	✓	

4.3 Step 4 and 5: qualitative and quantitative assessment of impacts (or assessment of the 'do-something' options)

4.3.1 Aims

Steps 4 and 5 of the approach constitute the main assessment, as it is at this stage that the main appraisal of the impacts of the management options being considered is undertaken. This is done through comparison with the baseline defined in the previous step, and should be undertaken with a view to the monetary valuation and scoring exercises (Step 6). Hence, Steps 4 and 5 of the approach are very similar to the screening exercise, but they refer to the 'do-something' options.

The aim of the main assessment is to set out clearly and concisely the impacts of each 'do-something' option on each impact category being considered and it should be based on the expected change of status in relation to the baseline. As for the 'do-nothing' option, both qualitative and quantitative steps are important and should not be skipped, this is because jumping straight into the quantitative assessment of impacts, for example, may constrain the manner in which impacts are considered and valued or scored, as well as reducing the transparency of the process.

It is important to note that the emphasis of the main assessment is on the differences between the options in relation to each impact criterion. This approach focuses the appraisal on the key impacts; as a result, the ASTs will only contain information that has a direct bearing on the decision to be made.

It is also important to note at this point that although the qualitative assessment is illustrated in the approach as separate and precedent to the quantitative assessment, in practice they will be performed in conjunction, for each impact category.

4.3.2 Data and analysis

The main assessment of the management options is structured around the Main Assessment Appraisal Summary Table (MA-AST) illustrated in Table 4.3, at the end of this section. An MA-AST is completed for each of the options being considered in the appraisal.

The information included in the MA-AST should correspond to the information necessary to appraise the option, in both qualitative and quantitative terms. The MA-AST includes cells for recording the project name with an indication of the level of decision being taken (i.e., high level, strategy or scheme), a description of the option being assessed and the defence standard being provided and a brief description the area being affected by the project. Under the column 'Impact Likely?', and for each impact category, a 'Y', for yes, or an 'N', for no, should be recorded as the first indication of the existence (or not) of the impact. Under the 'Qualitative Description of Impacts' column, a qualitative description of the impacts created by the option being appraised should be provided. Finally, under the 'Quantitative Assessment of Impacts' column, the quantitative evaluation of the effects should be recorded.

Qualitative Assessment of Impacts

As stated in Section 4.2, there is an inclination to avoid qualitative assessment of those impacts that are easily quantified. However, carrying out only the quantitative assessment may constrain the manner in which impacts are considered.

As for the 'do-nothing' option, the qualitative description of predicted/expected impacts should include a list of impacts that are expected to occur under each 'do-something' option. However, it should focus on the differences between each 'do-something' option and the 'do-nothing' option, i.e. the baseline (from the S-AST).

As an example, the qualitative description for the 'historical environment' impact category should include an answer for the following questions:

- what type of historical assets will be affected by the proposal?
- will the historical assets be protected if the proposal goes ahead? and
- is the quality/enjoyment of historical assets likely to increase or decrease and why?

Quantitative Assessment of Impacts

The quantitative assessment should describe the expected change of status in quantitative terms, based on the number of units lost or gained or affected (with physical data providing the best basis for quantification), and always focusing on the differences between the 'do-something' options and the baseline.

As before, the quantitative assessment of those impact categories that can be valued in monetary terms should focus on providing the information that will be needed for the monetary valuation. For those impact categories that can not be valued in monetary terms, the quantitative assessment should describe the change in status, and provide enough information so as to differentiate between the impacts of the different options being appraised. For example, for the 'sense of community' impact category the assessment should include answers to the following questions:

- what is the proportion of the community that will be affected by the proposal?
- is the level of exodus from the locality likely to increase or decrease and by how much? and
- what types of social networks will be affected by the proposal?

Types of Information and Potential Data Sources

Table 4.3 illustrates the type of qualitative and quantitative information and potential data sources that are useful during the main assessment of impacts.

Table 4.3: Types of Quantitative Information and Potential Data Sources for Each Impact Category

Category	Type of Qualitative Information	Type of Quantitative Information	Potential Data Sources
Economic Impacts			
Assets	Description of: • the areas and types of properties being affected (residential, non-residential, temporary structures, etc); • the types of public infrastructures being impacted (sewage and water networks, public buildings, etc); • their relative importance; and • indication of the magnitude of the effect in the area;	• number of residential, non residential properties and temporary and semi-permanent structures at risk from flooding and/or erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; • number of public infrastructures at risk such as sewage networks, water supply networks and public buildings, including number that are written-off, intermittently flooded, and flooded due to overtopping and/or eroded; and • indication of the timing of events such as year of breach, year when erosion starts and any other important data necessary for the calculation of the damages.	Maps, aerial photographs, site visit, Address-Point data
Land use	Description of: • types of land being impacted (agriculture, forestry, housing development, etc.); • their relative importance (at national, regional and/or local levels); and • indication of the magnitude of the effect in the area, including recoverability.	• area of land (agricultural, forestry, development, etc.) at risk from flooding and/or erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events such as year of breach, year when erosion starts and any other important data necessary for the calculation of the damages.	Maps, site visit, land planning reports
Transport	Description of: • areas/length and types of transport networks being affected (roads, railways, canals, rivers; ports, harbours, etc.); • their relative importance (at national, regional and/or local levels); and • indication of the magnitude of the effect in the area.	• number and length of roads, railway and navigation networks and infrastructures and their risk from flooding and/or erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events.	Maps, local plans, site visit
Business	Description of:	• numbers of non-residential	Maps, site visit,

Table 4.3: Types of Quantitative Information and Potential Data Sources for Each Impact Category

Category	Type of Qualitative Information	Type of Quantitative Information	Potential Data Sources
development	• types of businesses being affected; • types of effects being considered (employment, local business development, existence of similar businesses in the surrounding areas, etc.); • their relative importance (at national, regional and/or local levels); and • indication of the magnitude of the effect, recoverability.	properties (NRPs) that would face knock-on effects from flooding/erosion, by type of business; and • indication of the timing of events.	ODPM ward data, Valuation Agency office rateable value data, Address-Point
Environmental Impacts			
Physical habitats	Description of: • types of sites, habitats and/or species being affected; • their size, rarity, substitutability and other defining characteristics (including, designations); • change of state (creation and/or damage); • indication of the magnitude of the effect.	• number and/or area and importance of nature conservation sites, habitat and/or species at risk from flooding and/or erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events.	Maps, site designations, Wildlife Trust, BAP plans, English Nature records and reports, Countryside Agency records and reports
Water quality	Description of: • types of water features being affected; • types of effects being considered (biological, chemical, etc.); • their relative importance; • indication of the magnitude of the effect; and • impact source type (agricultural fields, contaminated land, landfill sites, etc.).	• length/volume/area/number of 'water feature/resource' at risk from impacts from flooding/erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; • change in chemical and biological quality indicators; and • indication of the timing of events.	Maps, site visit, Local Authority records, Environment Agency records, water companies records and reports
Water quantity	Description of: • types of water features/resources being affected; • types of effects being	• length/volume/area/number of 'water feature/resource' at risk from impacts from flooding/erosion, including indication of what is written-	Maps, Environment Agency data (main river), site visit, water companies' records and reports.

Table 4.3: Types of Quantitative Information and Potential Data Sources for Each Impact Category

Category	Type of Qualitative Information	Type of Quantitative Information	Potential Data Sources
	considered (low flow, water abstraction and discharge, etc.) • their relative importance; • indication of the magnitude of the impact, including recoverability.	off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events.	
Natural processes	Description of: • types of natural processes being affected (landward migration, erosion and/or accretion, sediment transport, etc); • their relative importance (national, regional and/or local levels); • indication of the magnitude of the effect, including recoverability; and • impact source type (increased water turbulence, change in wave direction, coastal squeeze, etc.).	• length/volume/area at risk from impacts from flooding/erosion (length of coastline affected, volume of sediment affected, etc.), including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events.	Maps, Shoreline Management Plans, Catchment Flood Management Plans, Local Authority records, site visits
Historical Environment	Description of: • types of sites and/or, properties being affected (Schedule Ancient Monuments, listed buildings, archaeological sites, etc.); • types of effects being considered (damage to historical and archaeological interest, damage to potential historical and archaeological interest, etc.) • their size, rarity, substitutability and other defining characteristics (including, designations); • indication of the magnitude of the effect, including recoverability.	• number/area of historical and archaeological assets at risk from flooding/erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events such as year of breach, year when erosion starts and any other important data necessary for the assessment of impacts.	Maps, Local Authority records, English Heritage records and reports, Countryside Agency records and reports, aerial photographs
Landscape and visual	Description of: • types of sites/areas	• area/number/type of landscape and landscape	Maps, Local Authority records, site

Table 4.3: Types of Quantitative Information and Potential Data Sources for Each Impact Category

Category	Type of Qualitative Information	Type of Quantitative Information	Potential Data Sources
amenity	and/or features being affected; • types of effects being considered (change in landscape character, visual effect on landscape, decrease in residential amenity, etc); • their size, rarity, substitutability and other defining characteristics (including, landscape designations) • indication of magnitude of effect and recoverability	and amenity features at risk from flooding/erosion including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events.	designations (e.g. AONB), Countryside Agency records and reports.
Social Impacts			
Recreation	Description of: • types of sites/areas and/or recreation facilities being affected (including formal and informal recreation); • types of effects being considered (change in recreation activities, levels of access, damage to recreation areas, etc); • their size, rarity, substitutability and other defining characteristics; • indication of magnitude of effect and recoverability.	• numbers/area/length of recreation sites, features, access points, visitors at risk from flooding/erosion, including indication of what is written-off, intermittently flooded, flooded due to overtopping and/or eroded; and • indication of the timing of events.	Maps, Local Authority records, site visit, local clubs and associations
Health and safety	Description of: • types of area, facilities and population being affected; • types of effects being considered (injury, stress and anxiety, etc); • source of risk (flooding, deteriorating defences, loss of appropriate access, etc); • indication of magnitude of effect and recoverability.	• numbers of people at risk from flooding/erosion; and • indication of the timing of events	Census (ward data), site visit

Table 4.3: Types of Quantitative Information and Potential Data Sources for Each Impact Category

Category	Type of Qualitative Information	Type of Quantitative Information	Potential Data Sources
Availability and accessibility of services	Description of: • types of facilities and population being affected; • types of effects being considered (limited access to schools, hospitals, adequacy of public infrastructure, etc); • indication of magnitude of effect, substitutability and recoverability.	• numbers/ types of services disrupted (schools, hospitals, shops, businesses, roads), population affected (based on no. of properties affected, for example); and • indication of the timing of events.	Maps, site visit, Valuation Agency office rateable value data, Address-Point
Equity	Description of: • types of population being affected (minorities, elderly, disabled, etc.); • indication of magnitude of effect and recoverability.	• numbers and types of population affected by flooding and erosion, including proportion of population in vulnerable groups; and • indication of the timing of events.	Census (ward data), Local Authority/District Council
Sense of community	Description of: • area, community facilities, types of population facing similar affects; • types of effects being considered (impacts on social networks, rate of exodus from locality, levels of satisfaction with neighbourhood, etc); • indication of magnitude of effect and recoverability.	• numbers and types of population affected (based on no. of properties affected, for example) by flooding and erosion, including proportion of the community likely to be affected; and • indication of the timing of events.	Census (ward data), Local Authority/District Council

4.3.3 Outputs

At the end of the qualitative and quantitative assessments, one should have a completed MA-AST for each of the options being assessed. An illustrative example of a completed MA-AST is presented in Annex 1 to this report.

Given the size and quantity of the MA-ASTs being produced during the stepped approach to the assessment of impacts, these tables are usually more suitable for an annex than for the main text of an appraisal report. For this reason, a Summary MA-AST is also produced as an output of the assessment.

The Summary MA-AST summarises, in one table, the key information from the assessment of each of the different options in relation to each impact category considered relevant for the assessment, i.e. it should focus on the differences between the different options. The type of information that should feature in the Summary MA-AST is presented in Table 4.4, below. As can be seen from the table, the key information should be of a quantitative nature as far as possible, should focus on the differences between the options, and should be able to give the reader a good overview of the impacts of the different options.

Table 4.4: Key information that should feature in a typical summary MA-AST

Impact Category	Key information about each option
Economic Impacts	
Assets	No. of properties and public infrastructure affected, by type
Land use	Area of land affected, by type
Transport	Area/Length of transport networks affected, by type
Business development	No. of non-residential properties affected, by type of business
Environmental Impacts	
Physical habitats	Area/no. of important sites, habitats and species affected
Water quality	Length/volume/area/no. of water bodies affected, by type
Water quantity	Length/volume/area/no of water bodies/resources affected, by type
Natural processes	Length/volume/area/no undergoing natural processes, by type
Historical environment	No/area of historical and archaeological assets affected, by type
Landscape and visual amenity	Area/no. of land and landscape features affected
Social Impacts	
Recreation	Area/no of sites and or visitors affected
Health and safety	Population and/or area of the community affected
Availability and accessibility of services	No. of services (hospital, school, medical centre, etc) and/or population affected
Equity	Proportion of the population affected, by type
Sense of community	Population and/or area of the community affected

The Summary MA-AST for the Humber Estuary SMP case study is presented overleaf (Table 4.5), as an example. It should be clear that the Summary MA-

AST does not intend to substitute the MA-AST. The Summary MA-AST should be used as a reference and it should not form the basis for the outcome of the assessment, as it does not give a detailed picture of impacts. The aim should be to keep the Summary MA-AST to two pages, whenever possible.

Table 4.5: Summary of the Main Assessment AST (Summary MA-AST)

Project Name:	**Humber Estuary Shoreline Management Plan**				
Description of Area Affected:	Management Unit 6 (South Ferriby Cliff to North Killingholme)				
Impact Category	**Option 1: Do-nothing**	**Option 2: Maintain**	**Option 3: Sustain**	**Option 4: Improve 1:50**	**Option 5: Improve 1:100**
Economic Impacts					
Assets	Inundation would write off 1,730 residential properties and 103 non-residential.	Almost 2,000 residences and more than 100 industrial properties would be flooded intermittently.	Assets will be protected.	Assets will be protected.	Assets will be protected.
Land use	1,221ha of agricultural land written off by year 99.	1,221ha of agricultural land flooded.	Impact on agricultural land following a breach.	Small impact on agricultural land following a breach.	Small impact on agricultural land following a breach.
Transport	Loss of A15 (including access to Humber Bridge), A1077, railway line and local access roads. Navigation channels in estuary could also be affected.	The A15, A1077, railway line and local access roads will be flooded fairly regularly. No impact on navigation channels.	Roads and railways protected but flooded every 20 years, which may lead to serious disruption.	Roads and railways and navigation channel would be protected.	Roads and railways and navigation channel would be protected.
Business development	Loss of so many residential and non-residential properties will mean that the area is no longer viable for many businesses.	Almost all businesses will be affected at some time by flooding.	The impacts on future business development only significant for businesses whose investment planning exceeds 20 years.	Business development should be largely unaffected.	Business development should be largely unaffected.
Environmental Impacts					
Physical habitats	Loss of 8 SNCIs, 6 Wildlife Trust sites and landward SSSI/SPA/Ramsar site. Development of new intertidal habitat.	Designated sites would be flooded fairly frequently. Loss of 60ha of intertidal habitat as a result of coastal squeeze.	Loss of 60ha of intertidal habitat as a result of coastal squeeze.	Loss of 60ha of intertidal habitat as a result of coastal squeeze. Potential impact on integrity of SPA.	Loss of 60ha of intertidal habitat as a result of coastal squeeze. Potential impact on integrity of SPA.
Water quality	Flooding of agricultural land and STW will result in reduction in water quality. Loss of 19 discharge points.	Water quality will generally be maintained, but release of pollutants every 10 years.	Water quality will generally be maintained but release of pollutants every 20 years.	Water quality will generally be maintained.	Water quality will generally be maintained.
Water quantity	Impact on aquifer. Loss of 7 abstraction	Protection of water abstraction and discharge	Potential saltwater contamination of	Protection of aquifer abstraction and	Protection of aquifer abstraction and

Table 4.5: Summary of the Main Assessment AST (Summary MA-AST)

Project Name:	**Humber Estuary Shoreline Management Plan**				
Description of Area Affected:	Management Unit 6 (South Ferriby Cliff to North Killingholme)				
Impact Category	**Option 1: Do-nothing**	**Option 2: Maintain**	**Option 3: Sustain**	**Option 4: Improve 1:50**	**Option 5: Improve 1:100**
	points.	points.	aquifer related to sea level rise. Protection of abstraction and discharge points.	discharge points.	discharge points.
Natural processes	Natural migration of intertidal habitats.	Landward migration of intertidal habitats will be prevented.	Landward migration of intertidal habitats will be prevented.	Landward migration of intertidal habitats will be prevented.	Landward migration of intertidal habitats will be prevented.
Historical environment	Loss of areas of high archaeological potential, 1 SAM and listed buildings.	SAM and listed buildings flooded on a regular basis. Archaeological sites likely to be affected.	SAM and listed buildings flooded every 20 years.	SAM and listed buildings flooded every 50 years.	SAM and listed buildings flooded every 100 years.
Landscape and visual amenity	Change from rural agricultural to mudflats, saltmarsh and open water.	Landscape generally maintained. Visual impact where crest levels are raised by up to 0.6m.	Landscape generally maintained. Visual impact where crest levels are raised by up to 0.6m.	Landscape generally maintained. Visual impact where crest levels are raised by up to 0.9m.	Landscape generally maintained. Visual impact where crest levels are raised by up to 0.9m.
Social Impacts					
Recreation	Loss of Barton Clay Pits recreation area and visitor centre.	Fairly frequent flooding may affect facilities at Barton Clay Pits.	Facilities at Barton Clay Pits will be protected.	Facilities at Barton Clay Pits will be protected.	Facilities at Barton Clay Pits will be protected.
Health and safety	Uncontrolled risk to people.	Risk to people would be 'high'.	Risk to people would be 'moderate'.	Risk to people would be 'low'.	Risk to people would be 'low'.
Availability and accessibility of services	Significant reduction in services and access to them.	Services flooded fairly frequently, with impact over time due to flood frequency.	Services would be protected.	Services protected and only flooded very infrequently.	Services protected and only flooded very infrequently.
Equity	Impacts on area with deprivation index of 3,556.	Frequency of flooding may affect job distribution.	Flooding 1 every 20 years is unlikely to affect people.	Area likely to retain current or improved status.	Area likely to retain current or improved status.
Sense of community	The loss of properties and jobs will result in loss of sense of community.	Risk to sense of community high due to frequency of flooding.	Risk to sense of community would be low due to frequency of flooding.	Sense of community would be largely unaffected.	Sense of community would be largely unaffected.

5. Stage 3: Compare

5.1 Introduction

This Section covers the 'Compare' stage (Steps 6, 7, 8 and 9) of the appraisal approach as presented in Figure 2.1 (Section 2). In essence, it is at this stage that the evaluation of the impacts is undertaken. Following on from the qualitative and quantitative assessment (and depending on the impact category) the appraisal can follow one of two routes:

- Step 6a: determine the tangible benefits and costs of options (economic appraisal) (Section 5.2); or
- Step 6b: scoring of options (Section 5.3).

The monetary valuation follows the current approach that uses cost-benefit analysis, the non-monetary evaluation can follow different scoring approaches which are described here. It is important to note that only one of these routes can be chosen for each impact category, so that double counting does not occur.

5.2 Step 6a: determining the tangible benefits and costs of options

5.2.1 Aims

The aim of Step 6a is to attach a monetary value to the impacts that are predicted for a particular option. These will constitute costs or benefits of a particular management option. A monetary value is a measure understood by all, and is used in ensuring that projects undertaken are good value for money.

At this stage it should be clear (from the screening exercise) which impact categories can be evaluated using economic appraisal. Some impact categories such as 'assets', have a market value and therefore can be evaluated using standard economic valuation techniques. Others, such as 'recreation' or 'environmental habitats', although not having a direct market value, can be evaluated using quasi-monetary valuation techniques, such as Benefits Transfer (BT).

5.2.2 Data and analysis

For those impact categories that can be valued in monetary terms, their valuation should follow the usual process using CBA techniques as recommend in Government guidance. For impact categories such as those relating to impacts on property, other assets and agriculture, for example, the guidance given in the FCDPAG 3 - Economic Appraisal should be followed. FCDPAG 3 and 5 - Environmental Appraisal also provide guidance on more specific valuation of intangible costs and benefits. Table 5.1 gives examples of

monetary and non-monetary techniques that can be used for evaluation of environmental type impacts.

Table 5.1 Examples of monetary valuation techniques for assessment of environmental impacts

Impact sub-categories	Valuation methods
Physical Habitats	Cost of replacement
Water Quality	Treatment costs, cost of maintaining standards
Water Quantity	Cost of lost licences, treatment costs
Heritage Sites	Cost of protecting the site or the cost of moving it to another location can be used as a lower bound economic value (FCDPAG 5 – environmental appraisal)
Archaeological Sites	The cost of excavating and recording a site can be used as a lower bound economic value (FCDPAG 5 - environmental appraisal)

FCDPAG 3 also identifies benefits transfer (BT) as a viable method[2] for valuation of impacts during the appraisal process. In addition, the Green Book has acknowledged the increasing scope for using BT methods as databases expand (HM Treasury, 2003).

The use of BT has been steadily increasing in recent years, the underlying assumption being that existing valuation studies can provide a reasonable indicator of the value of an environmental change for another site and decision context. In this context, the application of a benefits transfer approach structure should be based on the following steps:

Step i: identification of the impact category of concern (from S-AST);
Step ii: description of the nature of any impact in terms of the physical changes that will take place under a given option (from MA-AST);
Step iii: selection of a relevant BT estimate by examining the set of available values for the type of change under consideration; this should take into account the applicability of the original study and, hence, value to the option being assessed;
Step iv: adjustment of the benefit estimate(s) as appropriate to suit the decision context;
Step v: quantification of the affected population (user and/or non-user);
Step vi: calculation of the benefits by multiplying the transfer value by the affected population and aggregating; and
Step vii: undertaking sensitivity analysis.

More detailed guidance on how to apply the benefit transfer method in flood and coastal erosion risk management was developed as part of this study. This is presented in Annex 2 to this report.

[2] FCDPAG 3 identifies benefits transfer as a viable option at the pre-feasibility stage of the appraisal of options. The purpose of the pre-feasibility study is to determine whether a scheme is likely to be justified, and whether it is worth investing in more detailed studies (MAFF, 1999).

5.2.3 Outputs

Once the costs and benefits of each of the options are known, they should be introduced in the FCDPAG 3 Spreadsheets as indicated in the government guidance. One of the main outputs from this should be a 'Summary Project Sheet', such as the one illustrated in Figure 5.1. Also, a description of the methods of quantification and timing of the 'do-nothing' and 'do-something' damages has to be provided, together with the description of any assumptions made.

Figure 5.1: Summary Project Sheet (FCDPAG 3) for the Economic Appraisal for the Humber Estuary Case Study

	Costs and benefits £k				
	Do-nothing	**Maintain (1:20 reducing to 1:5)**	**Sustain (1:20)**	**Improve (1:50)**	**Improve (1:100)**
PV costs (include optimism bias at 60%)	-	16,715	25,000	30,000	37,050
Optimism bias adjustment	-	10,029	15,000	18,000	22,230
Total PV Costs for appraisal PVc	-	26,744	40,000	48,000	59,279
PV damage PVd	164,163	20,881	2,781	556	247
PV damage avoided		143,282	161,381	163,607	163,916
PV assets Pva					
PV asset protection benefits		-	-	-	-
Total PV benefits PVb		143,282	161,381	163,607	163,916
Net Present Value NPV		116,538	121,381	115,607	104,637
Average benefit/cost ratio		5.36	4.03	3.41	2.77
Incremental benefit/cost ratio			1.37	0.28	0.03

5.3 Step 6b: Scoring of options

5.3.1 Aims

The aim of Step 6b is to assign a number value to the impacts that are predicted for a particular option, based on information specific to a particular impact category. Scoring is applied to those impact categories that cannot be valued in monetary terms. Hence, scoring of impact categories has two main objectives:

- to allow all of the intangible impacts caused by options to be reflected in the appraisal; and
- to reflect the proportional differences in impacts between options.

Scoring allows all the impacts to be presented in the same units and combined (through weighting) to give an indication of the overall intangible impacts of

each option, allowing all of the intangible impacts to be taken into account in decision-making.

5.3.2 Base data

The base data used for scoring is that collected during Steps 4 and 5 of the approach, i.e. the qualitative and quantitative assessment of the options, and recorded in the MA-ASTs.

For scoring to be robust, the data upon which the scores are based must be able to identify the impacts of each option and the differences between them. In practice, this can be difficult to achieve, with many impacts being uncertain and only describable in qualitative terms. In such cases, it will be necessary to make judgements as to how the scores should be assigned, or to look for related quantitative information upon which the scores can be based.

5.3.3 Overview of the scoring systems

A range of different approaches can be used in the scoring of impacts. Numerical ranges can be developed based on quantitative/physical data on the different impacts and scores assigned against these. Alternatively, qualitative descriptors and associated scores can be used in cases where there are no natural units of measure. Owing to the flexibility of MCA systems, quantitative and qualitative descriptors can be used alongside one another, with the scores building upon the description of impacts given in the MA-AST.

In general, a balance must be struck between the level of detail and the need for simplicity. This means that the measure upon which scoring is based should be sufficiently detailed to enable a robust appraisal, but simple enough to allow easy application. In addition, the complexity of the scoring system should be in line with the level of certainty surrounding the data used as the basis for assigning the scores.

In the context of flood and coastal erosion risk management, the most appropriate scoring approaches are:

1. **Zero to 100**: a score of 100 is assigned to the best performing option for each category. The worst performing option is assigned a score of zero. All other options are scored relative to the best performing option.

2. **Relative to 100**: the best performing option is given a score of 100. All other options are then scored relative to the best performing option such that the worst performing option is not fixed at a score of zero.

3. **Likert Scale**: an approach that is similar to the Analytical Hierarchy Process (AHP) using a score of 1 for the worst option and all other options scored relative to this up to a maximum score of 9. The scores are assigned based on a series of qualitative descriptors (based on definitions

given in DETR (2000) here modified to reflect their use in a scoring, rather than a weighting, system):

1: equal impact;
3: moderately more beneficial;
5: strongly more beneficial;
7: very strongly more beneficial; and
9: overwhelmingly more beneficial.

4. **Across Unit System**: an approach based on zero to 100, above, but adapted for use across different geographic assessment units, with the aim being to highlight differences between units at the scoring level and which, as a result, may reduce the number of sets of weights required.

Table 5.2 presents an overview of the advantages and disadvantages of the four scoring systems. These advantages and disadvantages should be kept in mind when choosing which scoring system to use.

Table 5.2: Advantages and disadvantages of scoring systems

Scoring System	Advantages	Disadvantages
1. Zero to 100	reduces the number of options for which scores have to be derived; and links the scores to a numeric basis (even one which is uncertain) and ensures that transparency is maintained.	where there are only a small number of different options the scores are polarised (which may not always reflect the actual situation in terms of differences between the impacts); and where impacts can only be described in qualitative terms, it is difficult to find a basis upon which to score the impacts.
2. Relative to 100	allows better reflection of proportionality between all options in terms of their impacts; and links the scores to a numeric basis (even one which is uncertain) and ensures that transparency is maintained.	where impacts can only be described in qualitative terms, it is difficult to find a basis upon which to score the impacts; and requires relative scores to be derived for all options (except the best option).
3. Likert Scale	all scores for all categories are based on the same definitions, which avoids the need to find a numeric basis for assigning scores.	some options should score more than 9 to retain proportionality between options; difficult to determine a score based on the qualitative definitions used; difficult to ensure that the definitions are used in the same way for each category (e.g. 'strongly' more beneficial always relates to the same level of additional benefit from one category to the next); and difficult to maintain transparency and auditability when using the definitions as there is often no recordable basis for assigning one definition over another.

Table 5.2: Advantages and disadvantages of scoring systems

Scoring System	Advantages	Disadvantages
4. Across Unit System	allows the scores to better reflect differences between the assessment units (this could be picked up by having different sets of weights for each unit - but use of a relative scoring system across assessment units will reduce burdens on stakeholders); and links the scores to a numeric basis (even one which is uncertain) and ensures that transparency is maintained.	where there are only two different options the scores are polarised (which may not always reflect the actual situation); where impacts can only be described in qualitative terms, it is difficult to find a basis upon which to score the impacts; and the units used to measure impacts in one assessment unit are not always the same as for another assessment unit, making comparisons and relative scoring more difficult.

Recommended systems for different levels of appraisal

Each scoring system has its own advantages and disadvantages and the most appropriate system may depend upon whether it is a policy, project or scheme that is being scored. This may mean that a different system could be used according to the level of decision that is required:

- at the high level/policy, where the level of detail of information can be low (mostly qualitative) and the number of assessment units being considered is usually high, it may be preferable to use a qualitative scoring system, if the level of detail is low, or a 'zero to 100 across unit' system, if there is quantitative information available but the number of assessment units is high. This will maintain proportionality between the units and would allow one set of weights generated for the whole policy to be applied to all of the scores. If one of the other scoring systems is used, it is likely that different sets of weights will be required for each assessment unit to ensure that differences between them are picked up in the appraisal;

- at the strategy level, where the number of options is likely to be quite large (at least five[3]), the use of a scoring system where the best performing option scores 100, the worst performing option scores 0 and all other options are scored relative to these may be preferred. This is because the scoring system ensures a good spread of scores and reduces the effort required to assign scores to all options. Also, the impacts caused by the options are likely to be very different, such that a range of scores from 0 to 100 is likely to reflect the overall range of impacts; and

- at the scheme level, where the decision is how to provide the standard selected at the strategy level, the most appropriate approach may be to use a system where the best performing option scores 100 and all other options are scored relative to this. Such an approach will avoid polarisation

[3] Assuming that do-nothing, maintain, sustain and a minimum of two improve options are assessed.

of options as many of the impacts are likely to be of a similar magnitude. In addition, the amount of detailed information at this level is likely to be greater, making this scoring approach easier to apply.

5.3.4 Methods and approaches for assigning the scores

Two methods can be used for assigning the scores, each including two different approaches:

- scoring by appraiser:
  - paper-based scoring; and
  - scoring using spreadsheets.

- scoring by committee:
  - paper-based scoring; and
  - scoring using FCDPAG 3 based spreadsheets

In the scoring by appraiser method, the scores for each impact category and for each option are estimated by the practitioner (or practitioners) undertaking the appraisal. This method relies on one person assigning the scores, on an individual basis. In the scoring by committee method, the scores are assigned by a committee composed of the practitioners in charge of the appraisal and experts on different impact categories as required. This method relies on a group of individuals getting together to discuss the scores and assigning scores that should represent the common view.

It should be noted that the scoring by committee should not include stakeholders as the objective here is to assess the impacts of the different options and not to weigh up the priorities.

As stated above, both the scoring by practitioner and scoring by committee methods can use paper-based or spreadsheet-based scoring techniques.

The paper-based techniques can be used with the ‘zero to 100’, ‘relative to 100’, and qualitative scoring approaches. The spreadsheet-based technique although based on a ‘0 to 100’ approach, requires the estimation not of scores but of characteristics reflecting the assets within each category to allow the calculation of scores using a risk-based approach. The processes by which the scores are assigned are explained below.

Paper-based approach to scoring

The paper-based process of scoring is structured around the completion of the Scoring AST, illustrated in Table 5.3. Although the Scoring AST illustrated here includes all impact types and categories, it is likely that in practice some of the impact categories will not be present. For example, the 'assets' and 'land use' impact categories are generally assessed in monetary terms, so they cannot be scored as that would constitute double counting.

Table 5.3: Table Summarising Scores and Scores Justifications

Project Name				
Category	**Option 1:**	**Option 2:**	**Option 3:**	**Scores Justification**
Economic Impacts				
Assets				
Land use				
Transport				
Business development				
Environmental Impacts				
Physical habitats				
Water quality				
Water quantity				
Natural processes				
Historical environment				
Landscape and visual amenity				
Social Impacts				
Recreation				
Health and safety				
Availability and accessibility of services				
Equity				
Sense of community				

Equipped with the information recorded in the MA-ASTs for each option being appraised, the practitioner (s) should start by selecting the scoring system that is going to be used. The selection of the scoring system should consider the level of appraisal being undertaken and the level of detail of the information available as well as the advantages and disadvantages discussed in Table 5.2. It should be noted that owing to the flexibility of MCA systems, quantitative and qualitative descriptors can be used alongside one another.

Once the scoring system has been selected, the practitioner starts scoring each impact category across all options being considered. For each impact category, a justification for the scores needs to be provided in a clear and intelligible manner, even when it may seem obvious to the practitioner why the scores were assigned in such a way. It is also important, that the assumptions behind all scores assigned are recorded in the Scoring AST so that the appraisal is fully

auditable and transparent. This approach will also allow changes in the scores to be assessed more easily in any sensitivity analysis undertaken as part of the assessment.

When using a paper based approach to scoring it is important to take into account the following points:

- the scores should try, as far as possible, to reflect the quantitative data provided in the MA-ASTs. This will make the scores more justifiable and robust, but also more objective;

- the scores should reflect the differences between the options and not necessarily all of the effects produced by the options in each category. This does not mean that the appraisal is being restricted, but that it focuses on those aspects that make one option superior to another;

- the scores should reflect the proportional differences between the options, i.e. it has to be able to reflect that one option may be twice or three times as good as another;

- an effort should be made to take a risk-based approach to scoring, even if in an informal way. When scoring, one should consider not only the impacts of each option, but also the probability of their occurrence and the magnitude of the effect. For example, a 1 in 100 year flood is likely to have a more devastating effect that a 1 in 10 year flood, however the former is much less likely to occur than the latter; and

- timing of impacts is also important and should be considered. For example, do impacts occur immediately, or not until sometime in the future, and how long lived are the impacts?

Table 5.4, overleaf, provides a hypothetical example of scoring of two different impact categories, using a ‘relative to 100’ scoring system.

As can be seen in Table 5.4, an attempt was made to focus on the differences between the options as well as to ensure the proportionality between options. The information used for the scoring of the two different impact categories was the same, as no other information was available at the time. It is important that when similar situations occur, attention is given to the issue of double counting. In the example, although the data used was the same, it was used to reflect two different angles of the same problem. Under ‘business development’, the visitors were the proponents of business in the area, and their absence would implicate an effect on business development. Under ‘landscape and visual amenity’, visitor numbers were used as a surrogate measure of approval of the landscape and amenity of the area. If the options were having a negative impact on the landscape not so many people would want to visit.

In the example, the scores reflect the differences between the options based on the effects that changes in numbers of visitors would have on business, in one case, and on the landscape on the other. The scores also reflect the

proportionality between the options as they are based on the expected increase or decrease in numbers of visitors to the area.

Given the wide range of options being considered, it could be argued that the ‘zero to 100’ scoring system would be more appropriate here. This would mean that the ‘do-nothing’ option would score zero in both impact categories. However, given the type of information available, giving a score of zero to the ‘do-nothing’ option would not reflect the proportionality between this option and the maintain and sustain options. For this reason the ‘relative to 100’ system was preferred.

In relation to consideration of the risk associated with each option, it could be argued that the ‘maintain’ option is not the same as the ‘sustain’ option, as the standard of defence provided by the ‘maintain’ option will much closer to the ‘do-nothing’ option with time. However, if one assumes that people prefer to firstly deal impacts that will occur now, than with impacts that will occur in the future, i.e. apply some kind of time discount factor, the ‘maintain’ option can be assumed to closer to the ‘sustain’ option than the ‘do-nothing’ option.

All scores assigned to the options will have uncertainty associated with them (as will any monetised estimates of damages). Thus, the scores should be subject to sensitivity analysis. Uncertainty within the scores can also be represented by the way in which the scores are presented. Thus, the ‘improve with shingle’ option was assigned a score of 70. The calculation (given in the justification of the score) shows that the option is 33 points away from the ‘best’ option. It is considered that a score of 66 (100 – 33) would indicate that it was more precise than the assumptions upon which the calculation is based would suggest, such that it is reported as 70. This approach indicates that the score is ‘correct’ to the nearest ten (i.e. could range from 60 to 80), giving a range that can be tested in the sensitivity analysis. It is recommended that all scores be given to the nearest 5 or 10 points, so that uncertainty within the estimated scores is not lost.

Another way of dealing with uncertainty is by assigning ranges of scores rather then one score. For the example given above, the ‘improve with shingle’ option would score 60-70, instead of 70 (or 66). The ranges can then be tested in the sensitivity analysis.

Table 5.4: Table summarising scores and monetary estimates

Project Name	Dymchurch Coastal Defence Strategy, from High Knocke and Dymchurch Redoubt					
Category	**Do-nothing**	**Maintain (1:10 to 1:3)**	**Sustain (1:10)**	**Improve Shingle (1:50)**	**Improve Sand (1: 50)**	**Scores Justification**
Business development	55	85	85	86	100	Tourism has been identified as a major contributor to the local economy. It is estimated that between 7% and 14% of all employment in Shepway District is provided by tourism (HR Wallingford, 2001). Considering that the quality status of the coast, in particular the beach, will significantly influence tourism, it is assumed that any change (positive or negative) to the coast will have a significant impact on business development. According to the Beach Users Survey (HR Wallingford, 2002), 30% of visitors would not visit another beach in the area if the beach amenity was lost. In addition, the same study indicates that in the beach was improved with sand 15% more visitors would visit the beach, whilst if the beach was improved with shingle the rise in visitors numbers would only be of 1%. From these data, it can be concluded that the Improve with sand Option is the best option, therefore it scores 100. It is also known that, the Improve with sand Option represents an improvement of 45 points in relation to Do-nothing (30 from loss of amenity and 15 for improvements), which means that Do-nothing scores 55. It can also be concluded that the Improve with shingle option represents 30 points more that the Do-nothing options, relative to the loss of amenity, but also 1 point more for improvements in the flood defence, therefore it scores 86 (55 + 31). In relation to Do-nothing, the Maintain and Sustain Options (which are assumed to be the same) only represent improvements of 30 points relatively to visitor's numbers, therefore they score 85.
Landscape and visual amenity	55	85	85	70	100	Dymchurch landscape is characterised by its sandy shore. Hence, the landscape and visual amenity will be impacted mostly through the change in the nature of the sandy beach; and these scores should reflect the changes in characteristic. The number of visitors to the beach will be used here as a surrogate measure of approval of the landscape and amenity status. According to the Beach Users Survey (HR Wallingford, 2002), 30% of visitors would not visit another beach in the area if the beach amenity was lost. In addition, the same study indicates that in the beach was improved with sand 15% more visitors would visit the beach. it is known that if the beach were to be nourished with shingle instead of sand, 33% of visitors would visit the beach less often then if it was nourished with. In this context, The Do-nothing is the worst option and Improve with sand is the best Option, scoring 100. The Improve with sand option represents an increase in 45 points in relation to Do-nothing (30 from loss of amenity and 15 for improvements) which means that Do-nothing scores 55. In relation to Do-nothing, the Maintain and Sustain Options (which are assumed to be the same) represent improvements of 30 points relatively

Table 5.4: Table summarising scores and monetary estimates

Project Name	Dymchurch Coastal Defence Strategy, from High Knocke and Dymchurch Redoubt					
Category	**Do-nothing**	**Maintain (1:10 to 1:3)**	**Sustain (1:10)**	**Improve Shingle (1:50)**	**Improve Sand (1: 50)**	**Scores Justification**
						to visitor's numbers, as they prevent the loss of amenity; therefore they score 85. Finally, the Improve with shingle option represents 30 points more that the Do-nothing option, relative to the loss of amenity, but also 1 point more for improvements in the flood defence, therefore it scores 86 (55 + 31). However, this score needs to be balanced by the knowledge that if the beach was to be nourished with shingle instead of sand, 33% of visitors would visit the beach less often. In this context, the score of Improve with shingle would be reduced to 70 (approximately 100-33).

The number and type of categories that are to be assigned a score will vary from appraisal to appraisal, as the screening exercise should eliminate those impacts that are not relevant to decision-making and the range of impacts that can be valued in monetary terms will also vary. Table 5.5 sets out the type of information that could be used as the basis for assigning a score to each category. The Table draws on that presented in Section 4, above, and is designed to provide an indication of the type of information that could be used to assign a score to each category. Where reliable site specific data are available, they should be used in preference to the more general approaches described in Table 5.5.

Table 5.5: Basis for assigning scores

Category	Type of Quantitative Information	Potential Data Sources
Economic Impacts		
Assets	Number of properties affected	Maps, aerial photographs, site visit, Address-Point
Land use	Hectares of agricultural fields, industrial/commercial/residential land use (development)	Maps, site visit
Transport	Length of roads, railways, canals, rivers; number of ports, harbours	Maps, local plans
Business development	Number of non-residential properties (NRPs) that would face knock-on effects	Maps, site visit, ODPM ward data, Valuation Agency office rateable value data, Address-Point
Environmental Impacts		
Physical habitats	Hectares of different habitat types (loss/creation)	Maps, site designations, Wildlife Trust, BAP plans
Water quality	Area of contaminant source (e.g. agricultural fields, contaminated land, landfill sites, etc.)	Maps, site visit, Local Authority records
Water quantity	Number/area of lakes, ponds; length of rivers, streams, etc.	Maps, Environment Agency data (main river) , site visit
Natural processes	Length of coastline affected, volume of sediment affected	Maps, SMP, Local Authority records
Historical environment	Number of Scheduled Ancient Monuments, listed buildings, archaeological sites (archaeological potential)	Maps, Local Authority records, English Heritage, aerial photographs
Landscape and visual amenity	Area with landscape designations, landscape character	Maps, Local Authority records, site designations (e.g. AONB)
Social Impacts		
Recreation	Number of recreational sites, length of footpaths, access points for water sports, etc.	Maps, Local Authority records, site visit, local clubs and associations
Health and safety	Population at risk	Census (ward data), site visit
Availability and accessibility of services	Number/type of services (public buildings, utilities, etc.)	Maps, site visit, Valuation Agency office rateable value data, Address-Point
Equity	Population within most vulnerable groups	Census (ward data), Local Authority/District Council
Sense of community	Local population facing similar impacts	Census (ward data), Local Authority/District Council

Scoring using FCDPAG 3-based spreadsheets

The spreadsheet-based approach to scoring is based on a '0 to 100' system, but requires the estimation not of scores but of characteristics reflecting the assets within each category to allow the calculation of scores using a risk-based approach. This approach attempts to calculate the scores using a more risk/flood-focussed basis, and via a spreadsheet. The process of scoring using spreadsheets is explained below.

For each impact category, it is necessary to determine two factors in order to be able to assign a score:

- the characteristic of the category that is affected by flooding; and
- the measure of the vulnerability of the characteristic to damages from different flood events.

The characteristic represents a surrogate for a measure of the amount of a particular category affected and could relate to an area, a number, etc. The characteristic does not necessarily represent the absolute 'extent' of the impact but instead should represent the relative differences between the different options being appraised.

The measure of vulnerability is linked to the number of years after the flood that the effects would continue to be felt, and it will be slightly different depending on the type of impact being considered:

- for economic type impacts it is the time that the characteristic needs to recover from the flood. For example, for the 'business development' impact category, a particular business took *X* years to recover to its pre-flood profit levels;

- for environmental type impacts it is the time that the characteristic needs to be restored. For example, a Scheduled Ancient Monument takes *X* years to be restored to a condition similar to that before the flood; and

- for social type impacts it is the time that the characteristic needs to bounce back from the flood. For example, a community take *X* years to bounce back to a condition similar to that before the flood.

Two important points should be noted at this time:

- first, the time needed to recover/restore/bounce back is not intended to represent the time required to regain its pre-flood conditions; in fact this may never be possible (for example, some historical assets may never recover from flood damage). The time factor intends to represent the time required for the characteristic to regain a similar condition to that had prior to the flood event; and

- a characteristic that can not recover/restore/bounce back is represented in this approach as requiring an infinite time to recover/restore/bounce back. This is usually represented by more than 100 years which is the time frame generally used for appraising projects.

In this context, the spreadsheet approach to scoring is structured around two tables, the Characteristic Summary Table (Table 5.6) and the Time to Recovery/Restore/Bounce Back (depending on the impact type) Summary Table (Table 5.7) illustrated at the end of this Section.

Starting with the characteristic factor, for each impact category the practitioner(s) needs to define the characteristic that is going to be used as surrogate measure of the impact caused by the options. Then, the practitioner(s) has to assess what happens to the characteristic under different return period flood events (see Table 5.6). In the assessment of the characteristic, the practitioner(s) needs to consider how much of the characteristic would be affected by each flood event if no defences existed (i.e. in a situation similar to the do-nothing option). It is important to note here that when assessing the characteristic the various flood events should not be confused with the different standards of protection provided by the 'do-something' management options (the different options will be considered later on in the process).

For example, consider the Humber Estuary Strategy (Management unit 6: South Ferriby Cliff to North Killingholme) as a case study. For the 'physical habitats' impact category, the characteristic will be defined as the area of freshwater habitat flooded under the different return period flood events. This information is recorded under the 'Details of Characteristic' column of the Characteristic Summary Table (Table 5.6). Under the 'Return Period Flood Events' column, the hectares of habitat flooded under a 1 in 3-year flood, 1 in 5-year flood, 1 in 10-year flood, etc. is noted.

Table 5.6: Characteristic Summary Table for Physical Habitats and Historical Environment for the Humber Estuary Case Study

Impact Category	Details of Characteristic	Return Periods of Flood Events							
		3	5	10	20	50	100	300	500
Environmental Impacts									
Physical habitats	Area (ha) of freshwater habitat flooded	122	488	757	818	989	1147	1184	1221
Historical Environment	Number of historical sites flooded	1	1	1	1	2	2	3	3

According to Table 5.6, 122 ha of freshwater habitat are flooded in a 1 in 3-flood event if no flood defences are present. This amount increases to 1,147ha in a 1 in 100-flood event and to 1,221ha in a 1 in 500-flood event. Table 5.6 also provides the assessment of the characteristic for the 'Historical Environment' impact category. In this case, the characteristic is defined as the number of historical sites flooded. The Table shows that whilst the 1 in 3 return period event only floods one historical site, the 1 in 300-year event floods 3.

It could be argued that neither of these characteristics represents the 'absolute' magnitude of the impact caused by the flood events, since, for example, of those historical sites flooded one can be more historically valuable than another. Just as with the economic assessment of costs and benefits, it is impossible to assess the impacts of an option to the infinite detail, as this would take a very large amount of both time and resources. It is common sense that the extra expenditure on time and resources is unlikely to be balanced by the small improvements in the decision-making process. For these reasons, some generalising assumptions are useful in order to focus the appraisal on the real and relevant differences between the different options. The same generalising assumptions are commonplace during the economic appraisal. For example, it is common to assume an average residential property size and value in order to calculate the benefits arising from protecting a residential area from flooding. Nonetheless, and since three different levels of appraisal are being considered in this guidance (i.e. high level, strategy and scheme) the detail and specificity of the characteristic should increase as one goes 'down' the appraisal level scale.

For each of the impact categories for which a characteristic has been defined, the next step is to identify the measure of vulnerability of the characteristic to the flood events. In the Humber Estuary case study example, this means identifying the time that the freshwater habitat and the historical sites require to be restored to a similar condition to that prior to the flood event. Table 5.7 illustrates the Time to Restore Summary Table for the Humber Estuary example.

Table 5.7: Time to Restore Summary Table for Physical Habitats and Historical Environment for the Humber Estuary Case Study

Impact Category	Details of the Time to Restore	Return Periods of Flood Events							
		3	5	10	20	50	100	300	500
Environmental Impacts									
Physical habitats	Time for the freshwater habitats to be restored (Years)	5	5	5	5	10	10	10	10
Historical Environment	Time for the historical sites to be restored (Years)	3	3	3	4	4	4	7	7

For both the 'physical habitats' category and the 'historical environment' category the time required to restore has been defined in years (and noted under the 'Details of the Time to Restore' column). Under each of the 'Return Period for Flood Events' column the practitioner(s) should record the time, in years, that it would take the characteristic to be restored after a 1 in 3-year flood, 1 in 5-year flood, 1 in 10-year flood, etc., if no defences existed (i.e. in a situation similar to the do-nothing option). For example, if no flood defences existed, it would take 5 years for the area of freshwater habitat flooded under a 1 in 3 return period flood to be restored to a similar conservation value as had been prior to the flood event.

One of the draw backs of this system is that there is little information in which to estimate the times that the characteristics take to recover/restore/bounce back

for the different flood events. However, tests show that the scores are not very sensitive to changes in the vulnerability factor of the equation. It is therefore suggested that the practitioner(s) should endeavour to find information on which to base the recover/restore/bounce back times, but if this information is not available, the practitioner(s) should attempt to infer a time, based on common sense and experience, and then test it during sensitivity analysis.

Another issue that generally arises when estimating the time required to recover/restore/bounce back is whether to account for intervention or not, i.e. when determining how long it takes to restore a church, should the intervention of a team of restorers be considered or not. The intervention factor should be included in the estimation of the time if the economic costs (or damages) also include intervention, i.e. if the costs of such intervention are included in the costs of the project.

An indication of the factors that could be used as the basis for the defining the characteristic and time required for recover/restore/bounce back for all impact categories (based on the Humber Estuary Case Study) is given in Table 5.8.

Table 5.8: Potential Basis for the Characteristic and Times Required to Recover/Restore/Bounce back

Category	Characteristic	Time Required for Recover	Comments
Economic Impacts			
Assets	In most cases, assets will be valued in monetary terms. Where a score is applied, the same numeric bases would be used, i.e. number of residential and non-residential properties (NRPs) affected under different return period flood events.	Based on the time it takes for a property to be repaired such that it can be lived in or worked from.	
Land use	Hectares of land affected under different return period flood events.	Time taken for land to recover to a similar condition as had prior to the flood.	
Transport	Length (km) of roads, railways, etc. affected under different return period flood events.	Time taken to return the transport infrastructure to standard similar to pre-flood standard.	

Table 5.8: Potential Basis for the Characteristic and Times Required to Recover/Restore/Bounce back

Category	Characteristic	Time Required for Recover	Comments
Business development	Number of NRPs affected.	Time it would take for a business to return to its pre-flood levels of production, output, etc.	The score needs to reflect the indirect impacts of a flood on non-residential properties. Such an approach would allow impacts such as lost markets to be included in the scoring.
Environmental Impacts		**Time Required for Restore**	
Physical habitats	Linked to the number of sites and/or area affected by flooding.	Needs to be linked to the time it would take for the conservation interest (or value) to be restored to a level similar to its pre-flood level.	This does not necessarily mean that the original site would have to return to its pre-flood condition as there may be occasions when a change in habitats may increase conservation value.
Water quality	Relate to number of waterbodies (rivers, lakes, etc.) or their length.	Needs to reflect the time required for the water quality to be restored to a level similar to its pre-flood level.	
Water quantity	Number of waterbodies (including aquifers).	Needs to reflect the time required for water sources (availability) to be restored to a level similar to its pre-flood level.	
Natural processes	Based on the hectares or tonnage of land that would be undergoing natural processes.	Linked to the time it would take for natural processes to be to be restored to a condition similar to its pre-flood condition.	Does not lend itself to being easily scored on a characteristic restoring time approach. Similar to the approach used in the 'erosion' worksheet of the FCDPAG 3 spreadsheets, with the restore rate based on the 'delay' in the onset of erosion.
Historical environment	Related to the number of sites/buildings (e.g. Scheduled Ancient Monuments)	Number of years required to restore the site to a condition (conservation interest) similar to its pre-flood condition.	There is the potential for importance to also be taken into account as a multiplier of the number of sites (i.e. three sites of international importance (3 x 5) and two sites of local importance (2 x 2).

Table 5.8: Potential Basis for the Characteristic and Times Required to Recover/Restore/Bounce back

Category	Characteristic	Time Required for Recover	Comments
Landscape and visual amenity	Number of hectares changed/affected by the flood.	Based on the time for the landscape to be restored to a level similar to its pre-flood level.	Difficult to place in the characteristic and restoration time approach. However, would allow potential improvements in landscape quality to be incorporated into the scoring.
Social Impacts		**Time Required to Bounce Back**	
Recreation	Where recreation is not valued, based on the number of recreational sites affected, numbers of visitors affected, etc	Time required for recreational uses to bounce back to pre-flood levels.	As with some of the other categories, the type of recreation could change, it is the quality of the recreational experience that the score should attempt to capture.
Health and safety	Relate to the population whose health may be affected. This is likely to be linked to the area flooded.	Linked to the time required for the health of those affected to bounce back to level similar to that pre-flood.	
Availability and accessibility of services	Linked to the number of services affected and would include hospital, schools, utilities, etc.	Amount of time required for those services to bounce back to level similar to that pre-flood.	
Equity	Relate to changes in the vulnerability of particular groups, hence, populations within these more vulnerable groups.	Time taken for these groups to bounce back to level similar to that pre-flood of relative deprivation, etc.	
Sense of community	The population of the area.	Linked to the time that it would take for activities in the community to bounce back to level similar to that pre-flood..	Population may not reflect community activities such that participation in particular events may be a more appropriate characteristic.

Once these characteristics and time to recover/restore/bounce back have been identified (or estimated), the scores can be calculated automatically using the same approach as is used in the Asset AAD worksheet of the FCDPAG 3 spreadsheets. The AAD worksheet allows the average damages to be calculated by considering damages caused over a number of different return period flood events. The worksheet itself allows damages on eight different events to be entered, from which the average damages can be calculated. This approach was extended into a scoring system by calculating the average annual damages for all options. The worst option (that with the highest level of

damages) is assigned a score of zero while the best option (that with the lowest level of damages) is assigned a score of 100. The intermediary options are then assigned a score in relation to the level of damages caused by that option and the proportion that this represents of the worst and best options. The scores obtained through use of the AAD worksheet can then be fed through the Damage Calculation worksheets to allow the equivalent of Present Value scores for each impact category to be calculated.

A full description of how the scores are calculated, including the formulas used is presented in Box 5.1. To calculate the scores in the manner described in Box 5.1, it is necessary to have a good understanding of the FCDPAG 3 spreadsheets.

Box 5.1: The approach to calculating the scores

The scores are estimated in the same way as the average annual damages are calculated using the FCDPAG 3 spreadsheets. This is an appropriate approach as the number of characteristics affected multiplied by the total time spent 'recovering' 'restoring' or 'bouncing back' gives an indication of damages for each category in the same way that monetary damages are estimated, except the units relate directly to time and the characteristic rather than money. The AAD calculation brings in the probability of flooding by considering the damages that would occur under eight different return period events, as included in the AAD worksheet of the FCDPAG 3 spreadsheets, where the events are 1:5, 1:10, 1:15, 1:25, 1:50, 1:100, 1:150 and 1:250 (FCDPAG 33NGB.xls).

The damages for each flood event are calculated by multiplying the characteristic and the total time over which impacts are expected to be felt (out of the 100 year time horizon). The time over which the impacts are felt is calculated by dividing the time period over which the appraisal is being undertaken (usually 100 years) by the return period event (e.g. 5 years for the 1:5 event) and multiplying by the recovery time for each flood event. For example, if the recovery time for the 1:5 event was one year, the time over which the impacts extend is calculated as:

Time over which impacts are felt = 100 ÷ return period event x recovery time for that flood event

Time period over which impacts are felt = 100 ÷ 5 x 1 = 20 years of impacts over the 100 year time horizon

This is done for each return period event. The damages occurring under each option differ according to the standard of defence that the option provides. Hence, for do-nothing, damages are incurred under all return period events. For example, if a sustain option provides a 1:25 standard of defence, damages only occur on events that are greater than 1:25. The first damages are, thus, entered into next flood event above 1:25 (in the default AAD worksheet, this is 1:50). This is the same approach as is taken when estimating flood damages in monetary values using the AAD worksheets. Damages occurring between the 1:25 and 1:50 events are included as a result of the calculation of AAD, which uses the following formula:

$$AAD = \frac{(damages_{1\ in\ 50} + damages_{1\ in\ 25})}{2} \times (probability_{1\ in\ 25} - probability_{1\ in\ 50})$$

The same calculation is used for damages occurring between each return period event, up to infinity. The damages are then summed to give the AAD.

The next step is to take the calculated AAD and include it in the Damage Calculation worksheets, where it can be used alongside the standard of defence and the discount factors to provide an estimate of 'Present Value (PV) damages' for each option by each impact category. Again, the approach used is the same as when damages are being estimated in monetary terms, except a separate Damage Calculation worksheet is needed for each impact category as well as for each option.

Box 5.1: The Approach to Calculating the Scores (continued)

The next step is to use the 'PV damages' calculated for each option from the Damage Calculation worksheets to estimate scores for that category. This is done by assigning the 'worst' option (i.e. the option with the highest damages) a score of zero. The 'best' option (i.e. the option with the lowest damages) is assigned a score of 100. The scores for the remaining options are calculated using the following formula:

$$Score = 100 - \frac{(damages_{option} - damages_{best\ option})}{((damages_{worst\ option} - damages_{best\ option}) \div 100)}$$

For example, an option which has 'PV damages' of 56 compared with damages under the best option of 3 and the worst option of 540 would score:

$$Score = 100 - \frac{(56 - 3)}{(540 - 3) \div 100} = 100 - 9.9 = \mathbf{90}$$

To reflect some of the uncertainty within the scores, they are given to the nearest whole number, such that the option would score 90 (not 90.1). Modifications can be made to the AAD and Damage Calculation worksheets such that the scores are automatically calculated once the characteristic and time to recover/restore/bounce back have been identified (or estimated).

5.3.5 Outputs

Once the scoring exercise is complete, depending on the type of approach chosen, there are potentially two types of outputs:

- if a paper-based approach is pursued, the output will be a completed Scoring AST, presenting the scores assigned to each impact category for each of the options being appraised as well as the justifications and assumptions made when assigning the scores; and

- if the spreadsheet-based approach is pursued, the outputs will be three fold:

  - a completed Characteristic Summary Table, as illustrated in Table 5.9, overleaf;
  - a completed Time to Recovery/Restoring/Bounce Back (depending on the impact type) Summary Table, as illustrated in Table 5.10, overleaf; and
  - Scores Summary Table, as illustrated in Table 5.11, overleaf.

Table 5.9: Characteristic Summary Table (Humber Estuary Case Study Example)

Impact Category	Details of Characteristic	Return Periods of Flood Events							
		3	5	10	20	50	100	300	500
Economic Impacts									
Land use	Area (ha) flooded under each event	122	488	757	818	989	1147	1184	1221
Transport	Length of roads affected within area (%) affected under each event	0.71	2.84	4.402	4.757	5.751	6.674	6.887	7.1
Business development	Number of NRPs flooded on each event	100	100	103	103	106	110	106	110
Environmental Impacts									
Physical habitats	Area (ha) flooded under each event	122	488	757	818	989	1147	1184	1221
Water quality	Area (ha) flooded under each event	122	488	757	818	989	1147	1184	1221
Water quantity	Number of abstraction points flooded on each event	7	7	7	7	7	7	7	7
Natural processes	Length of coastline affected (km)	15	15	15	15	15	15	15	15
Historical environment	Number of sites flooded on each event	1	1	1	1	2	2	3	3
Landscape and visual amenity	Area (km^2) flooded under each event	2.7	10.8	16.74	18.09	21.87	25.38	26.19	27
Social Impacts									
Recreation	Number of sites flooded on each event	3	3	3	3	3	3	3	3
Health and safety	Number of properties flooded under each event	1730	1730	1823	1823	1829	1829	1829	1829
Availability & accessibility of services	Number of services flooded on each event	10	10	10	10	10	10	10	10
Equity	Number of vulnerable people flooded (by % area flooded under each event)	397	397	419	419	420	420	420	420
Sense of community	Number of properties flooded under each event	1730	1730	1823	1823	1829	1829	1829	1829

Table 5.10: Time to Recovery/Restoring/Bounce Back Summary Table (Humber Estuary Case Study Example)

Impact Category	Details of Recovery/Restore/ Bounce back time	Return Periods of Flood Events							
		3	**5**	**10**	**20**	**50**	**100**	**300**	**500**
Economic Impacts									
Land use	Time taken by agricultural land to recover (years).	3	3	3	3	5	5	5	5
Transport	Time taken to repair infrastructure (years)	0.5	0.5	0.5	1	1	1	1	1
Business development	Time taken to recover markets, production, etc. (years)	1	1	1	1	2	2	2	2
Environmental Impacts									
Physical habitats	Time taken to restore similar conservation value (years)	5	5	5	5	10	10	10	10
Water quality	Time taken to reduce salinity and restore water quality (years)	0.5	0.5	0.5	0.5	1	1	1	1
Water quantity	Time taken to restore abstraction to level similar to pre-flood (years)	1	1	1	1	1	3	3	3
Natural processes	Time taken to restore natural coastline (years)	5	5	5	5	5	5	5	5
Historical environment	Time taken to restore to condition similar to pre-flood (years)	3	3	3	4	4	4	7	7
Landscape and visual amenity	Time taken to restore to condition similar to pre-flood (years)	1	1	1	1	3	3	3	3
Social Impacts									
Recreation	Time taken for sites to bounce back to condition similar to pre-flood (years)	5	5	5	5	10	10	10	10
Health and safety	Time taken for people's health to bounce back to condition similar to pre-flood (years)	1	1	1	3	3	5	5	5
Availability & accessibility of services	Time taken for services to bounce back to operation levels similar to pre-flood (years)	1	1	1	1	2	2	2	2
Equity	Time taken for people in vulnerable groups to bounce back to condition similar to pre-flood (years)	3	3	3	3	5	5	5	5
Sense of community	Time taken for activities to bounce back to levels similar to pre-flood (years)	1	1	1	1	2	2	2	2

Table 5.11: Scores Summary Table Using a Spreadsheet Based Approach (Humber Estuary Case Study Example)

Category	Do-Nothing	Maintain	Sustain	Improve 1:50	Improve 1:100
Land Use	0	80	96	99	100
Transport	0	70	96	99	100
Business development	0	88	98	100	100
Physical habitat overall	100	23	3	1	0
Water quality	0	76	96	99	100
Water quantity	0	89	99	100	100
Natural processes	0	87	99	100	100
Historical environment	0	87	99	100	100
Landscape and visual amenity	0	74	94	99	100
Recreation - terrestrial	0	86	98	100	100
Recreation - intertidal	100	20	3	0	0
Recreation overall (terrestrial: 40%; intertidal: 60%)	100	24	3	1	0
Health and safety	0	81	97	99	100
Availability and accessibility of services	0	88	98	100	100
Equity	0	88	98	100	100
Sense of community	0	87	98	100	100

5.4 Step 7: Weight elicitation

5.4.1 Aims

Weighting allows the scores to reflect people's preferences for one impact category over another. For example, people may place greater importance on 'recreation' than on 'natural processes' (or vice versa). Weighting allows these preferences to be identified and taken into account, and enables the relative importance of changes in one impact category to be compared to changes in another category. The use of weights allows the scores assigned to impacts within each category to be aggregated such that the overall impact of an option can be identified and compared with other options. This then allows decision-makers to take into account the variations in the importance that stakeholders attach to different impacts; the overall process can be one that enhances stakeholder involvement.

The process of gathering weights for input to the MCA-based element of the appraisal process is arguably the most time consuming and controversial part of the process. In addition, depending on the scores, there are occasions where one option will always be preferred over another regardless of the relative weights placed upon the categories. In such cases, the gathering of weights is an unnecessary 'formality'. This suggests that, rather than ask the question of 'what are the relative weights for these criteria?' at the outset, useful information may first be gained from considering 'what would the weights have to be for this option to be the preferred option'?

5.4.2 Methods and approaches to weight elicitation

Two approaches of eliciting weights are suggested:

- passive methods, where weights are gathered indirectly from documentation and reports, responses/reports of stakeholders and any other records that might provide useful information; and

- active methods where the weights are elicited from the stakeholders. Elicitation is direct from stakeholders using focus groups or through the use of paper-based (or computer-based) techniques.

A range of approaches can be used to derive relative impact weights, with the most simple being ranking[4], swing weighting procedures involving the development of subjective ratings on a proportional scale of 0 to 100, trade-off assessments and the development of utility functions, and the analytical hierarchy process (which relies on the use of a series of pair wise comparisons)[5].

In this guidance, three approaches are suggested:

- the use of stakeholder responses to formal consultation to develop weights that reflect relative (and proportional) differences in importance;
- the use of rankings of objectives (or categories); and
- the use of swing weighting procedures through either focus groups or computer-based methods.

The first approach is used when applying passive methods of weight elicitation, whilst the second and third approaches are used when applying the active methods of weight elicitation.

Stakeholder responses to formal consultation

This approach identifies weights indirectly from information provided by stakeholders to formal consultation on proposed options. For example, such information can be taken from written responses of statutory consultees. There can e several drawbacks to this approach

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4 Ranking methods are sometimes thought of as mathematically invalid. This is not necessarily the case as mathematical validity should not be confused with precision. There are ranking methods that are considered mathematically valid, such as the expected value method and the random weights method. For more detail see Janssen (1992) for example.

5 The Analytical Hierarchy Process (AHP) can become impractical when it involves a large number of pair wise comparisons. In addition, the interpretation of the weights can become ambiguous.

- stakeholder responses do not always provide sufficient information to allow weights to be identified (although it may be possible to rank categories, objectives or options depending upon the amount of information available);
- the stakeholders themselves may not capture the views of all interested parties (particularly the general public); and
- the review of stakeholder responses can be time-consuming and it is often difficult to identify reasons for conflicts.

However, these potential problems could be addressed by adopting an approach to formal consultation that is aimed at drawing out the rankings that stakeholders would place on different impact criteria, and asking them to provide information supporting their position. Stakeholders could also be asked to indicate who they believe they represent. Analysts could then develop alternative weighting systems aimed at reflecting the perspectives of those stakeholders not responding to the consultation to test whether adopting these perspectives would affect the choice of options.

Ranking of objectives

The aim of the ranking exercise is to ask stakeholders to organise the objectives, categories and/or types of impacts into their order of importance. This can be done as a group, with discussions as to which is most important with the objective being to achieve consensus, or individually, such that the responses are combined to give an overall rank. The output of the ranking exercise would be a list of the objectives, categories and types organised from most to least important.

Depending on the number of categories (etc.) available, stakeholders may be asked to rank them all, or to identify a subset of the most and least important. This information can then be used in two manners.

1. In some cases, the rankings may provide sufficient information to determine which option would be preferred. For example, from the scoring exercise, it may be apparent from inspection that a particular impact category, such as landscape, must be given the highest weights for a particular option to be preferred over others. If the rankings indicate that landscape is viewed as being of much less importance than other impact categories, then that option will never be preferred.

2. Ranking also acts as the first step in deriving swing weights. Thus, where rankings alone are insufficient to determine whether one option outperforms the others with regard to the intangible impacts, then the process can proceed to the elicitation of weights from the group/individual.

Ranking can be undertaken at three levels: type, category or objective level. Table 5.12 (overleaf) summarises the breakdown of the Appraisal Summary Table into these different levels, where the types (e.g. ‘economic impacts’ are made up of a number of categories, e.g. ‘assets’, ‘land use’, etc.). Each

category is likely to have a number of objectives associated with it, where these would include the objectives of the stakeholders who are being asked to provide ranks.

The involvement of stakeholders in ranking the importance of intangible impacts should help make clear the trade-offs involved in selecting one option over another to be discussed. However, on its own, the generation of rankings may not provide stakeholders with enough information on the implications of their judgements as to what impacts are most important. As part of a more iterative process, this could be achieved by feeding information back to stakeholders to help allows trade-offs to be discussed, but there is no method by which stakeholders can review the implications of their ranking on the identification of the preferred option.

Table 5.12: The different levels at which weights can be elicited

Economic Impacts	Environmental Impacts	Social Impacts
Assets Land use Transport Business development	Physical habitats Water quality Water quantity Natural processes Historical environment Landscape and visual amenity	Recreation Health and safety Availability and accessibility of services Equity Sense of community

Identification of swing weights

Swing weights are elicited directly from stakeholders, either individually or as part of a group. As indicated above, the first step is to rank the impact categories (and/or objectives) and, thus, this step can follow on from the ranking exercise, as required. The category (etc.) ranked as being of greatest importance is assigned a weight of 100. The second most important category is then weighted in relation to this; stakeholders are asked how important the second ranking category is compared to the first ranked category. For example, if it is considered half as important, it would be assigned a weight of 50.

Consistency between the weights of each category can be obtained by asking stakeholders to rank all categories against each other. In practice, this can be very time-consuming. An alternative is to identify the weight of the most important against the second most important, then the second most important against the third most important, and so on until all categories have been assigned a weight. A key step is then to allow stakeholders to review the weights, so that they can see the overall distribution and, if necessary, make changes so that the final pattern of weights reflects their desired distribution.

Eliciting weights within a group rather than individually allows the trade-offs and conflicts to be discussed, such that the final set of weights should provide a consensus. In this case, the general approach is as follows:

1. Rank the categories as a group;
2. Each member of the group then assigns a weight of the most important category against the second most important;
3. Each member of the group then reveals their weight and a frequency of weights is recorded (usually within groups of ten, or 100, 90s, 80s, 70s, etc.);
4. Those members of the group giving extreme weights are asked to explain their reasoning;
5. The whole group discusses what the weight should be, and the weights are revised accordingly; or different sets of weights are developed to reflect the varying perspectives with the group.

As there is a risk that a consensus cannot be achieved, it may be important to carry different sets of weights forward within the assessment.

Box 5.2 details and illustrates the process involved in the elicitation of swing weights.

Box 5.2: The elicitation of relative importance weights

The process of eliciting weights from respondents comprises four steps:

Present scoring systems and details of impacts associated with maximum and minimum possible scores;
Step 2: Rank and weight each of the sub-categories that make up a category;
Step 3: Rank and weight each of the categories;
Step 4: Review ranks and weights; and
Step 5: Provide optional documentation of reasons for ranks and any problems encountered.

Starting with Step 2, for each set of attributes which makes up a category (e.g. the sub-categories making up a category), the process involves putting the named attributes in rank order of importance. For example, using five sub-categories A, B, C, D and E that, together, make up the category of 'environment', the respondent is asked to rank them in order of importance. The end result would be something similar to the following:

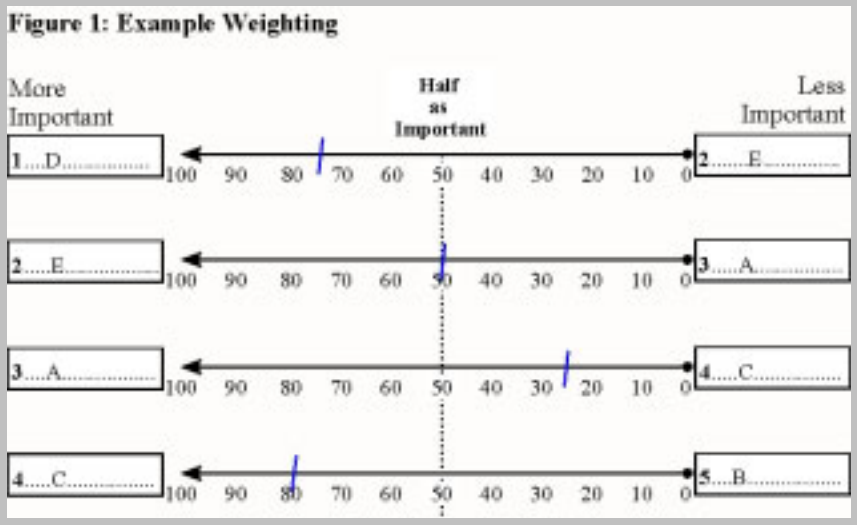
Sub-Category	**Rank**
A	3
B	5
C	4
D	1
E	2

The next stage is determining the 'distance' between each of the rank positions. This reflects how much more important one type of impact is over another. To do this, respondents were asked to undertake a series of pairwise comparisons:

how important rank 2 (E) is relative to rank 1 (D);
how important rank 3 (A) is relative to rank 2 (E);
how important rank 4 (C) is relative to rank 3 (A); and
how important rank 5 (B) is relative to rank 4 (C).

To make the process simple and understandable for the respondent, a recording form was provided for completion. Figure 1 provides an example completed form for the sub-categories A, B, C, D, and E that might make up the category of 'environment'. The respondent is then asked to enter their rank order into the appropriate 'boxes' and to record the relative importance of each sub-category relative to the next highest ranking one by marking a slash on the measurement scale.

Box 5.2: The elicitation of relative importance weights (continued)



From these pairwise comparisons, information was developed on individuals' views on the relative importance of each of the sub-categories. Once all responses were received, each set of pairwise comparisons is converted into weights for use in the scoring system. In each case, weights are calculated by 'awarding' a weight of 100 to the most important sub-category i.e. that ranked number 1. Following the example above, this would be sub-category D. The next most important sub-category is then awarded a weight relative to this. From Figure A, E is 75% as important as D, so it receives a weight of 75. The next most important sub-category (A) is awarded a relative weight. In this case, as A is 50% as important as E it receives a weight of 50% of 75, i.e. 38. The process continues until weights have been calculated for each sub-category.

The Table provided below illustrates the resultant weights for the preferences expressed in Figure 1. These weights are then normalised, with this involving converting weights to a relative importance scale based on a percentage. The process involves totalling all of the weight values and expressing each value as a percentage of the total, making subsequent manipulation with the impact scores easier. The normalized weights for this example are also given below.

Sub-category	Relative importance	Meaning	Weight	Normalised LPF
D		D is most important	100	43

5.4.3 Data and analysis (applying weights)

As discussed above, weights can be elicited at a number of different levels:

- type level;
- category level; and
- objective level.

The level at which weights have been elicited will determine how they are to be applied. For example, where weights have been elicited at the type of impact level, the approach assumes that all of the categories falling into that impact type have equal weight. The steps to applying the weights to obtain a weighted score are then as follows.

1. Sum the scores for each type;
2. Normalise the scores so the maximum score within each type is 100 (this is done by dividing the sum of the scores by the number of categories within that type that have been scored, for economic impacts this is four, hence the sum of the scores for economic impacts is divided by four[6]);
3. Apply the weight for each type of impact to the normalised score to provide a weighted score for each type;
4. Sum the weighted scores for each type to give an overall weighted score.

Where weights have been elicited at the category level, the application of weights is undertaken earlier in the process. It is assumed here that weights are available at both the category and type level (i.e. stakeholders have first considered the importance of each category within one type of impact, and then weighted the relative importance of the types against each other).

1. Apply the weight for each category to the score for that category;
2. Sum the weighted category scores to give a weighted total for each type;
3. Normalise the weighted total scores by dividing the weighted total scores by the number of categories within that type that have been scored;
4. Apply the weight for each type to the normalised weighted total scores to provide a weighted score for each type;
5. Sum the weighted scores for each type to give an overall weighted score.

If weights have been elicited at the objective level, a further level of calculation will be required, following the same pattern as for the application of type and category weights.

Once the overall weighted score has been calculated, it needs to be taken forward into the decision-making process, alongside the monetised benefits and costs.

5.4.4 Stakeholder involvement

Another issue when creating the weighting system is whose weights should be used. There are several different approaches that can be taken:

- allowing decision makers to specify the weights;
- allowing independent experts to specify the weights;
- developing different sets of weights to reflect different stakeholder viewpoints;
- using survey techniques to develop a statistically representative set of weights; or

[6] Note, however, that if one or more of the sub-categories is given as a monetary value, the maximum score reduces. For economic impacts, assets and land use may be estimated in monetary terms in which case the sum of scores would be divided by the number of categories that are scored (i.e. 2).

- calculating what weights would have to be applied to different impacts for one option to be preferred over another and discussing these with decision makers and stakeholders.

However, the questions of which stakeholders should be consulted is considerably influenced by the level of appraisal being undertaken:

- at the high level of appraisal, the weights should be elicited from correspondingly high level stakeholders. These include, operating authorities, planning authorities, Defra, English Nature, Countryside Agency, Internal Drainage Boards, etc;

- at the strategy level of appraisal, the weights should be elicited from 'mid' level stakeholders. These should include representatives regional authorities, the activities (economic and otherwise) relevant to the area, the regional environmental interests, etc;

- at the scheme level, the weights should be elicited from local stakeholders, i.e. organisations and individuals representing the local interests. It is worth noting that the local stakeholder weights will potentially be overridden by national stakeholder weights when it comes to prioritising scheme development at the national level.

5.4.5 Step 7a: Streamlining the weight elicitation

There may also be occasions where one option will always be preferred over the others regardless of the weights applied. In some cases, this is due to one option always scoring less across every category or because only one or two scores are marginally higher with the rest being less. In such cases, there is no benefit to be gained from undertaking the weighting exercise since the preferred option is clear-cut.

In other cases, the situation will not be so clear-cut and it may be of value to ask 'what would the weights have to be for one option to be the preferred over another?' This type of approach focuses the assessment on determining what the weights would have to be for different options to be preferred, such that the driving forces behind the decision can be identified. This process can be used to simplify the number/set of weights required from stakeholders, as it may highlight that the decision is determined by only a few impact categories.

In this way, the approach can be focused on determining *prior* to eliciting weights answers to the following questions:

- is it possible for the option to be preferred over another?
- if it is mathematically possible for the option to be preferred over another, does this occur within reasonable limits?
- if it is possible for the option to be preferred within reasonable limits, what are the conditions for this and are they reasonable?

Table 5.13 provides a simple example to demonstrate the basic principles. The table presents hypothetical scores for two options (1 and 2) against five criteria (A, B, C, D and E). As can be seen from these, Option 2 performs worse than Option 1 in all cases except under Category B (where it scores much more highly) and Category C (where it scores the same).

Table 5.13: Example of basic principles

Category	Option 1	Option 2	Weighted Score Option 1	Weighted Score Option 2	Magnitude of $Weight_{ABCDE}$ for Total Option 1 Score to be Minimised	Magnitude of $Weight_{ABCDE}$ for Total Option 1 Score to be Maximised
A	80	40	80 x $Weight_A$	40 x $Weight_A$	$Weight_A$ = Very Low	$Weight_A$ = Very High
B	10	80	10 x $Weight_B$	80 x $Weight_B$	$Weight_B$ = Very High	$Weight_B$ = Very Low
C	70	70	70 x $Weight_C$	70 x $Weight_C$	$Weight_C$ = Immaterial	$Weight_C$ = Immaterial
D	60	20	60 x $Weight_D$	20 x $Weight_D$	$Weight_D$ = Very Low	$Weight_D$ = Very High
E	55	45	55 x $Weight_E$	45 x $Weight_E$	$Weight_E$ = Low	$Weight_E$ = High
			Total Score Opt 1	**Total Score Opt 2**		

To obtain a total score for the value of benefits, one multiplies category scores by a weight expressing their relative importance compared to the other categories. However, a simple visual inspection of the data in Table 5.13 reveals that, if the total score for Option 1 is ever going to be smaller than that for Option 2, the relative weight applied to Category B is going to have to be very large compared to the weights for the other categories.

It is important to understand here that, once scoring for an appraisal is complete, the unweighted scores for each of the options under each of the criteria are static and constant. As a result, it is only variations in the weights applied to these criteria that produce variations in the total weighted scores for the options (i.e. not the unweighted scores themselves).

This type of reasoning should also be combined with the results from the economic assessment of the options. If the scores for one option are always higher than for all other options and the economics are also clear-cut (the option has the highest benefit-cost ratio), then it is not possible for the other options to be preferred. A similar situation may occur where one option has the highest benefit-cost ratio and the incremental benefit-cost ratio of the next best alternative option is not sufficient to change the decision. If the intangible scores of the next best alternative option are lower than those of the option with the highest benefit-cost ratio, then it will be mathematically impossible for the next best alternative option to be preferred. On such occasions, weighting is not required as its inclusion in the process would not change the decision.

However, if the next best alternative option has higher intangible scores across some or all impact categories, then it may be mathematically possible for the preferred option to change on the basis of the magnitude and importance of the

intangible effects. An indication of what the difference in scores must be 'worth' (in monetary terms) can be identified by considering what the additional net benefits of the next best alternative option must equal (as a minimum) for the incremental benefit-cost ratio to be sufficient to change the preferred option. Table 5.14 provides an example illustrating this.

Table 5.14: Example illustrating when an option *may* be preferred

	Option 1	Option 2	Option 3	Option 4
Costs	£0	£100,000	£150,000	£175,000
Benefits	£0	£230,000	£300,000	£350,000
Benefit-cost ratio	-	2.3	2.0	2.0
Incremental benefit-cost ratio	-	-	1.4	2.0
Required incremental benefit-cost ratio to change the decision	-	-	1.5	3.0
Additional benefits required to meet the required incremental benefit-cost ratio	-	-	£5,000	£25,000

From Table 5.14, it can be seen that the additional benefits of Option 3 (those represented by the scores) must be worth at least £5,000 (in total) for Option 3 to be preferred over Option 2 and/or that the additional benefits of Option 4 must be at least £25,000, for Option 4 to be preferred. If this is considered reasonable, then the conditions determining whether one option would be preferred over another can be identified.

Examination of the differences in intangible scores across the categories will highlight which impact categories must be most important to maximise the score of Options 3 and 4 compared with Option 2 and provide an indication of the conditions required for the Options 3 and 4 to be preferred. Table 5.15 provides an example illustrating how this would work for the category of 'environmental impacts'.

Table 5.15: Example illustrating which categories must be most important

Environmental Impacts	Option 1	Option 2	Option 3	Option 4
Physical habitats	100	40	20	0
Water quality	0	70	90	100
Water quantity	0	50	75	100
Natural processes	100	50	25	0
Historical environment	0	50	90	100
Landscape and visual amenity	0	40	100	80

Table 5.15 shows that, for Option 3 to be preferred over Option 2, those categories where Option 3 scores higher than Option 2 would have to be more important. These categories are: water quality, water quantity, historical environment and landscape and visual amenity. For Option 4 to be preferred,

the most important categories must be: water quality, water quantity and historical environment. Therefore, the stakeholder group could be asked if physical habitat and natural processes are more or less important than water quality, water quantity, historical environment and landscape and visual amenity. This is a simplified example and the assessment of all combinations of categories and scores may require calculation using a spreadsheet. However, asking and answering questions such as these can provide important information on the conditions that determine the relative preferences of options. This information can then be used to guide stakeholder consultation and to highlight specific questions concerning trade-offs. It may only be necessary to then ask stakeholders to consider these particular trade-offs or rank the particular impact types or categories. Only where the ranking exercise is inconclusive, would it be necessary to elicit weights on the relative importance of two (or more) categories.

5.4.6 Outputs

The output of the weight elicitation exercise is a table specifying the score, the relative weight and the weighted score for each impact category, as illustrated in Table 5.16, for a few impact categories.

Table 5.16: Example illustrating the outputs from weight elicitation

	Scores			Weights	Weighted Scores		
Environmental Impacts	**Option 1**	**Option 2**	**Option 3**	**Weights**	**Option 1**	**Option 2**	**Option 3**
Physical habitats	100	40	20	$Weight_{ph}$	100 x $Weight_{ph}$	40 x $Weight_{ph}$	20 x $Weight_{ph}$
Water quality	0	70	90	$Weight_{wql}$	0 x $Weight_{wql}$	70 x $Weight_{wql}$	90 x $Weight_{wql}$
Water quantity	0	50	75	$Weight_{wqt}$	0 x $Weight_{wqt}$	50 x $Weight_{wqt}$	75 x $Weight_{wqt}$
Natural processes	100	50	25	$Weight_{np}$	100 x $Weight_{np}$	50 x $Weight_{np}$	25 x $Weight_{np}$
Historical environment	0	50	90	$Weight_{he}$	0 x $Weight_{he}$	50 x $Weight_{he}$	90 x $Weight_{he}$
Landscape and visual amenity	0	40	100	$Weight_{lv}$	0 x $Weight_{lv}$	40 x $Weight_{lv}$	100 x $Weight_{lv}$

5.5 Step 8: comparison of options (extended decision rules)

5.5.1 Aims

The aim of Step 8 of the proposed methodology is to combine the results of the assessment of impacts through scoring and weighting with the results of impacts assessed in monetary terms, in order to decide which is the preferred option in terms of both tangible and intangible benefits.

Step 8 - Comparison of Options (expanded decision rules) - as illustrated in Figure 2.1 involves combining information from the MCA element of the analysis with the CBA component. The inclusion of those impacts that are assessed

using weighted scores (resulting from Step 6b and 7) with those that are valued in monetary terms (resulting from Step 6a) requires an extension to the decision process given in FCDPAG 3.

The decision-making process for flood and coastal erosion risk management given in FCDPAG 3 is based around selection of the option with the highest benefit-cost ratio, with options delivering higher levels of protection only being selected if their incremental benefit-cost ratio exceeds a set threshold. The decision process for the MCA-based approach is based on the same principles, but involves extending the decision rules to allow inclusion of the intangible benefits. This requires a logically rigorous decision rule, which allows the monetary benefits and costs to be directly combined with the weighted scores. There are two ways of doing this:

- converting the monetary benefits to a score; or
- converting the weighted scores to an implied monetary value.

Conversion of monetary benefits to a score can be undertaken using the same approaches as used to score the non-monetised impacts. However, there is a requirement to show that a flood defence option is economically justified, which means that the benefits must outweigh the costs. Since costs are given in monetary terms, it is more appropriate to also convert the benefits to monetary terms. This means it is necessary to transform the weighted score to a measure that can be considered alongside the monetary benefits.

5.5.2 Derivation of decision rules

As described above, the accepted methodology for prioritising flood and coastal defence projects is based on maximising the benefit-cost ratio, where the benefits are the estimated reduction in tangible damages from the 'do-nothing' option.

For this approach to be extended to incorporate a weighted score for intangibles (over a range 0 to 100), we would need to maximise the expression:

$$\frac{\{\text{Monetary Benefits (in £s)} + \text{Intangible Benefits (in £s)}\}}{\text{Monetary Costs (in £s)}}$$

Clearly, however, the value of intangible benefits is not a monetary value (i.e. in £s) but is a unitless weighted score in the range of 0 to 100. To incorporate the weighted scores into the decision-making process, therefore, it is necessary to consider what the magnitude of any additional benefit would have to be to change the preferred option and whether the weighted scores indicate that sufficient additional benefits are likely to be delivered.

This requires consideration of the magnitude of the additional benefit required (if any) to increase the incremental benefit-cost ratio such that it meets the required threshold (given by FCDPAG 3). For example, Option 4 has an incremental benefit-cost ratio of 1.3 and the required incremental benefit-cost

ratio to make Option 4 preferred over Option 3 is 1.5. If the benefits of Option 4 are £1.3 million and the costs are £500,000 and the benefits of Option 3 are £1.1 million and the costs are £350,000, the incremental benefit-cost ratio is 1.33[7]. For Option 4 to be preferred over Option 3, the incremental benefit-cost ratio must be at least 1.5. This means that the additional benefits required must be equivalent to a monetary value of £25,000[8].

5.5.3 Data: outcome of the appraisal

Including all intangible and monetary benefits should mean that the selection of the preferred option is more rigorous and robust, while the use of ASTs and the FCDPAG 3 spreadsheets ensures that the appraisal is fully auditable and transparent.

Together, the approaches set out in FCDPAG 3 and in this Guidance will have provided the following outputs:

- economic information contained in the FCDPAG 3 spreadsheets;
- completed ASTs containing the qualitative, quantitative and scored impacts; and
- total weighted scores for each option.

The next step is to combine the economic information in the spreadsheets with the total weighted scores. This is undertaken using an amended Summary worksheet from the FCDPAG 3 spreadsheets, as shown in Figure 5.2. The additional rows are shown in full colour; the original rows are shown as uncoloured cells.

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[7] Calculated as IBCR = $\frac{\text{benefits}_{\text{Option 4}} - \text{benefits}_{\text{Option 3}}}{\text{costs}_{\text{Option 4}} - \text{costs}_{\text{Option 3}}}$ = $\frac{\text{£1.3m - £1.1m}}{\text{£0.5m - £0.35m}}$ = $\frac{\text{£0.2m}}{\text{£0.15m}}$ = 1.33

[8] Calculated as IBCR x $(\text{costs}_{\text{Option 4}} - \text{costs}_{\text{Option 3}}) + \text{benefits}_{\text{Option 3}} - \text{benefits}_{\text{Option 4}}$

Additional benefits required = 1.5 x (£0.5m - £0.35m) + £1.1m - £1.3m = £0.025m

Figure 5.2: Amended Summary Worksheet

Project Summary Sheet

Client/Authority				Prepared (date)	
				Printed	01/11/2004
Project name				Prepared by	
				Checked by	
Project reference				Checked date	
Base date for estimates (year 0)					
Scaling factor (e.g. £m, £k, £)			(used for all costs, losses and benefits)		
Principle land use band			(A to E)		
Initial Discount rate	3.50%				
Optimism bias adjustment factor	60%				
Costs and benefits of options					

Scaling factor (e.g. £m, £k, £)	**Costs and benefits**				
	Do nothing	Maintain	Sustain	Improve 1	Improve 2
PV costs PVc					
PV damage PVd					
PV damage avoided					
PV assets Pva					
PV asset protection benefits					
Total PV benefits PVb					
Net Present Value NPV					
Average benefit/cost ratio					
Incremental benefit/cost ratio (IBCR)					
Required Incremental benefit/cost ratio (IBCR)					
Required additional benefits to meet IBCR					
Weighted score					
Additional Intangible Benefit of Moving to the next option					
Implied additional benefits per point required to meet the IBCR					

The first new row is entitled 'required incremental benefit/cost ratio'. This row is used to record the incremental benefit-cost ratio required to make the next highest option the preferred option. The value to be entered will be either 1.5 or 3, depending upon whether the next highest option is below or within the indicative standard (see Figure 5.3 for the extended decision process). This should not be confused with the incremental benefit-cost ratio calculated by the spreadsheet, as this only includes those benefits given in monetary values.

The second new row is entitled 'required additional benefits to meet the required IBCR'. This row is calculated by the spreadsheet[9] and identifies what minimum monetary value would have to be assigned to the benefits to provide the required incremental benefit-cost ratio.

The third new row is entitled 'weighted score' and is used to record the total weighted score for each option.

The fourth new row is entitled 'additional intangible benefit of moving to the next option'. Here the spreadsheet records the gain (positive) or loss (negative) of intangible benefits of moving to the next option. This row is calculated automatically by the spreadsheet, by subtracting the weighted score of the lower option from the weighted score of the higher option.

[9] Additional benefits required = IBCR x ($costs_{Option\ 4} - costs_{Option\ 3}$) + $benefits_{Option\ 3} - benefits_{Option\ 4}$

The fifth new row is entitled 'implied additional benefits per point required to meet the IBCR', and it is calculated automatically by the spreadsheet and indicates how much the intangible benefits must be worth (at least) per point difference in the weighted scores between two options. This information may be required when selecting the preferred option as an approach to justifying the move to a higher option.

5.5.4 Analysis: extended decision process

The extended decision rule follows the same principles as given in FCDPAG 3 (Section 6.2: The Decision Process). The starting point is the option with the highest benefit-cost ratio as shown on the Summary worksheet of the FCDPAG 3 spreadsheet. A flowchart setting out the extended decision process is given as Figure 5.3, at the end of this Section.

If the benefit-cost ratio is less than unity (1), it is necessary to consider if the intangible benefits are sufficient to increase the benefit-cost ratio such that it would exceed one. This is done by calculating the additional monetary value for the intangible benefits required to justify the option economically. It is important to note that this implicit valuation of the intangible benefits represents a minimum value (since larger values would increase the benefit-cost ratio even further). A judgement has to be made as to whether the implicit value of the intangible benefits is considered reasonable or not. There are three possible outcomes:

- YES: the implicit value of the intangible benefits appears reasonable. This may be the case where there are important intangible benefits that could not be monetised;

- NO: the implicit value of the intangible benefits required does not appear reasonable. This may be the case where there are only minor/insignificant benefits that could not be monetised; and

- UNCERTAIN: it is unclear whether the implicit value of the intangible benefits are reasonable or not. This may be the case where there are some significant benefits that could not be monetised but it is not obvious that these have a value equal to or exceeding the implicit value required.

In those cases where there is uncertainty whether the implicit value of the intangible benefits required is reasonable, it may be useful to consider the additional benefits per point. This requires consideration of the types and description of impacts recorded in the AST. Table 5.17 (at the end of this section) sets out some examples of the financial or economic value associated with different impacts or activities. The values can be compared against the impact category scores (and other information recorded in the AST) to provide a context for deciding whether or not the implicit value of the intangible benefits would appear reasonable (or not). Box 5.3 provides an example of how the comparator table was used in the Humber Estuary case study. It should be noted, however, that the values given in Table 5.17 are to aid the decision only

and are not intended to be used as valuations for inclusion in the cost-benefit analysis.

Box 5.3*:* Use of the comparator table for the Humber case study

To move from maintain to sustain, the intangible benefits must by worth at least £1.8 million. Sustain scores an additional 11 points over maintain on the weighted score. Each of these 11 points has to be worth £155,000 for sustain to be preferred over maintain. The additional points are made up as follows:

- economic impacts: 3 points (land use, transport and business development);
- environmental impacts: 2 points (water quality, water quantity, natural processes and historical environment); and
- cross-cutting impacts: 6 points.

The two options have the same weighted score for social impacts.

The score calculator sheet shows that drainage is likely to be affected on 256 ha-yrs under sustain and (one average) 1,649 ha-yrs for maintain[1]. If the damages relate to a change from bad to very bad drainage, or a value per ha of £100 to £200 from the comparator table, the benefits provided by the sustain option can be calculated as £139,000 to £279,000. This is the lowest value change from the comparator table and indicates that the benefits for sustain over maintain are likely to be at least equal to the minimum value required to make sustain the preferred option.

Damages under maintain for transport are given as 2.075 km-yrs, while for sustain the damages are 0.3 km-yrs [1]. The comparator table does not give an indication of costs in kilometres, but, if delays are proportional to the length of railway track affected, the sustain option would have to reduce delays compared with maintain by, at least, 1,940 minutes (or 32.3 hours). This is equivalent to 19 minutes per year. The Multi-Coloured Manual gives approximate delays of:

- up to and including 10 year return period: 0 hours;
- up to and including 25 year return period: 12 hours;
- up to and including 50 year return period: 24 hours;
- up to and including 100 year return period: 48 hours; and
- up to and including 200 year return period: 96 hours.

Sustain provides a 1 in 20 standard of defence while maintain provides 1 in 20 standard falling to 1 in 5. Therefore, three events greater than 1 in 10 and less than (or equal to) a 1 in 20 year return period would account for the required difference between the two options. This is not unreasonable within a 100 year time horizon.

The comparator table suggests that indirect damages to industrial and commercial premises may be 30% of direct losses. The damages to NRPs are estimated at 50% of the residential damages, such that damages to NRPs from the maintain option can be estimated at £10.4 million and from the sustain option at £1.4 million. If the indirect damages are 30% of the direct losses, the indirect damages would be worth an estimated £3.1 million under the maintain option and just £0.4 million under the sustain option – a difference of £2.7 million. This far exceeds the £155,000 required per point and even the £1.8 million difference between the two options. Thus, it appears that the sustain option is likely to be preferred over the maintain option when the additional intangible benefits are taken into account.

Further benefits relate to the environmental impacts, particularly water quality and landscape, and to cross-cutting impacts. The difference in cross-cutting impacts is the most significant (accounting for 6 weighted score points). Sustain is likely to be in line with most policies whereas maintain also most certainly will not be. However, no comparator value is available here.

If the implicit value of the intangible benefits is considered reasonable, then it is assumed that the benefit-cost ratio exceeds one. The selection of the preferred option then moves onto comparing the other options in the appraisal. If the implicit value of the intangible benefits is not considered reasonable, then there is no economic justification for undertaking flood defence or erosion risk management and it will be necessary to reconsider the project and/or whether there are significant additional benefits that have not been included in the appraisal.

If the benefit-cost ratio is greater than unity (with or without the intangible benefits), the next step is to consider whether this option would provide a standard of defence that is below, within or above the indicative standard (as shown in Table 6.1 of FCDPAG 3). This is important as it determines what the incremental benefit-cost ratio must be to make the next option preferred.

For those options providing a standard **below the indicative standard**, consideration is given to whether the next highest option has an incremental benefit-cost ratio robustly greater than one (usually taken as 1.5).

For those options providing a standard **within the indicative standard**, consideration is given to whether the next highest option has an incremental benefit-cost ratio greater than three.

For those options providing a standard **above the indicative standard**, consideration is given to whether the next highest option has an incremental benefit-cost ratio that is 'exceptional' when compared with other schemes competing for funds.

If the answer to these questions is yes, the process is the same as given in FCDPAG 3, but consideration should also be given to the potential that the higher option would result in intangible disbenefits (i.e. costs or negative benefits).

If the answer to these questions is no, consideration should be given to whether the intangible benefits are sufficient to raise the incremental benefit-cost ratio such that it is robustly greater than one. A judgement has to be made as to whether the monetary or implicit value of the additional benefits required to increase the incremental benefit-cost ratio to 1.5, 3 or 'exceptional' is considered reasonable or not. There are three possible outcomes:

- YES: the additional implicit monetary value of the benefits required are considered reasonable. This may be the case where the additional benefits are only a small proportion of the tangible benefits, and/or where there are important intangible benefits that could not be monetised;

- NO: the additional implicit monetary value of the benefits required is not considered reasonable. This may be the case where the additional benefits are a large proportion of the tangible benefits, and/or there are only minor/insignificant benefits that could not be monetised; and

- UNCERTAIN: it is unclear whether the additional implicit monetary value of the benefits required is reasonable or not. This may be the case where the additional benefits required are a moderate proportion of the tangible benefits, and/or there are some significant benefits that could not be monetised but it is not obvious that these have a value equal to or exceeding the additional implicit monetary value required.

Again, in those cases where there is uncertainty whether the implicit monetary value of the additional benefits required is reasonable, it may be useful to consider the additional benefits per point. As indicated above, this is calculated from the additional benefits required (in £) divided by the additional intangible benefit (from the weighted score) and thus gives an indication of the implicit value of the per point difference in weighted score between the two options. The composition of the weighted scores should be examined to identify those key impact categories where the higher option has additional benefits over the lower option. These benefits can then be compared with the comparator values given in Table 5.17 to help determine if the additional benefits are likely to be reasonable, or not.

There may also be cases **where the higher option would result in intangible disbenefits** (i.e. costs or negative benefits). For example, this could result from visual disamenity from the construction of a higher wall along a river or seafront, from reduction in periodic flooding of an environmental site or from defence works separating communities.

If an option achieves the necessary incremental benefit-cost ratio, but there are intangible disbenefits, consideration may need to be given to whether the implied value of these scored disbenefits is likely to be sufficiently high to reduce the incremental benefit-cost ratio to a level below that required, such that it changes the relative preference of the options. Any such cases will need to be supported by consultation with all stakeholders, including the local population, as it is likely to result in a standard of defence being proposed that is below the economically justifiable level.

Figure 5.3 The extended decision process

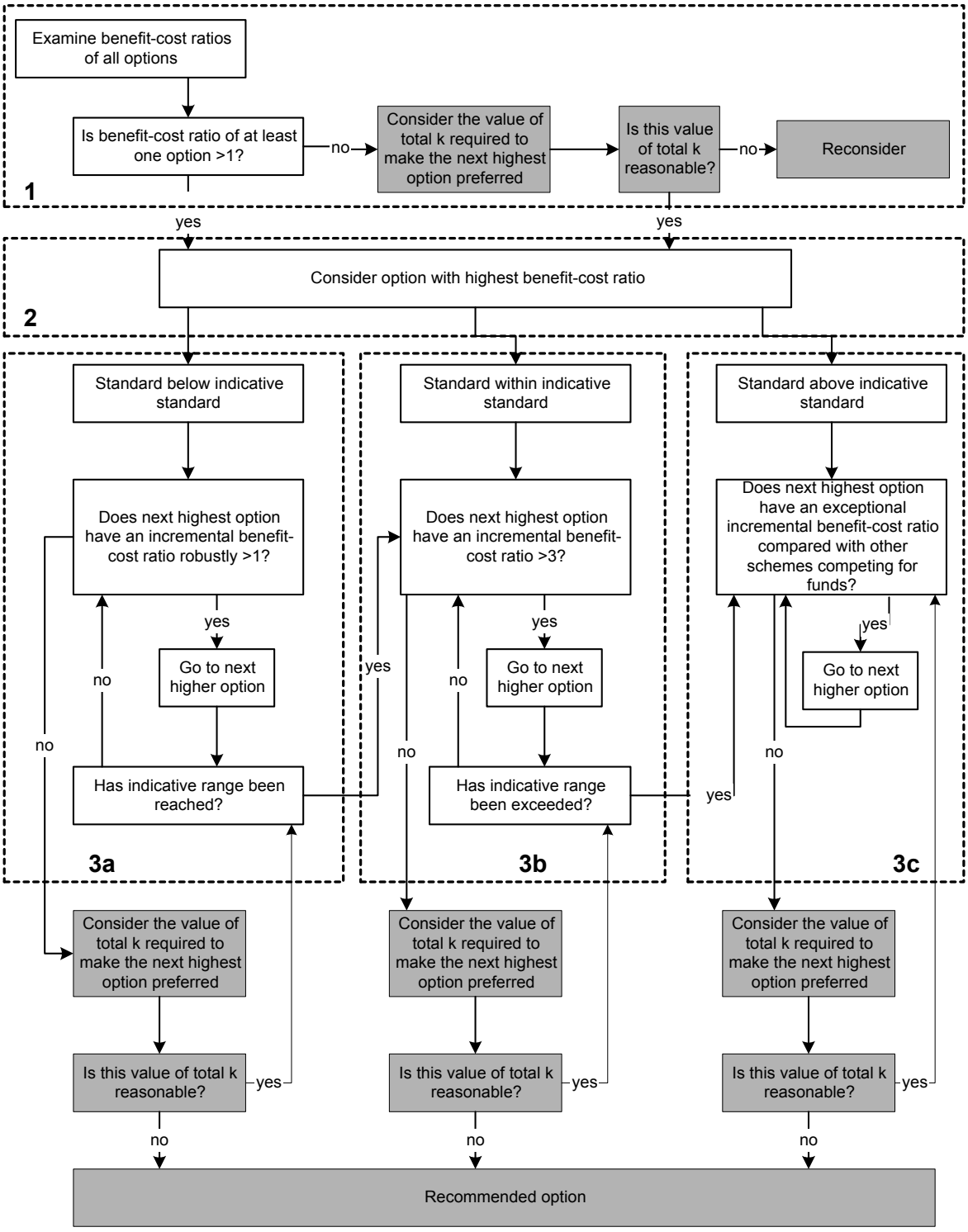

Table 5.17: Values for comparison with the value of total k required

Impact Type and Category	Comparator Value			Source
Economic Impacts				
Assets	Likely to be valued			
Land use	**Good drainage**	**Bad drainage**	**Very bad drainage**	Based on typical financial gross margins from grassland (Penning-Rowsell *et. al*., 2003).
	£600 to £1,400 per ha	£300 to £400 per ha	£200 per ha	
	Good drainage	**Bad drainage**	**Very bad drainage**	Based on typical financial gross margins from arable (wheat) (Penning-Rowsell *et. al*., 2003).
	£550 per ha	£440 per ha	£270 per ha	
Transport	Railway disruption costs: £80 per minute			Penning-Rowsell *et. al*. (2003).
Business development	Indirect damages based on direct damages: - farming: 28% of direct losses - infrastructure: 30%-50% of direct losses - industrial and commercial: 30% of direct losses			Based on paper for Yangtze River, but which includes estimates of indirect damages from worldwide studies (including UK, US and Australia).
Environmental Impacts				
Physical habitats	**Habitat Type**	**Value of Recreation**		
	Coastal grazing marsh	£800 to £1,200 per ha		Penning-Rowsell *et. al*. (2003).
	Coastal lagoons	£4,200 to £57,000 per ha		
	Reed beds	£2,800 to £7,300 per ha		
	Saltmarsh	£1,100 to £90,000 per ha		Spurgeon J (1998)
Water quality	Cost of removing nutrients: £40 to £4,000 per kg (low cost relate use of constructed wetland, high costs to sewage works at limit of technology)			O'Sullivan (2002)
Water quantity	Replacement of Public Water Supply resource: £1.8 million/Ml/day Costs to farmers from loss of water source: £3.50/m^3 Costs to industry from replacement of own source with Public Water Supply: £0.75/m^3			RPA (2002)
Natural processes				
Historical environment	Relocation costs: £150,000 to £200,000 (Grade 2* structure to Martello Tower) £3.20 per household per year for flood protection			RPA (2003)

Table 5.17: Values for comparison with the value of total k required

Impact Type and Category	Comparator Value		Source
Landscape and visual amenity	Preservation of ESA landscape (from conversion to more intensive agriculture): - general public: £3.05 per household per year - visitors: £14.80 per household per year - residents: £21.90 per household per year		RPA (2003)
Social Impacts			
Recreation	**Change**	**Value (Loss)**	Penning-Rowsell *et. al*. (2003).
	Deterioration in beach, promenade	£2.34 to £3.74 per visit	
	Cliff erosion, very reduced access	£1.89 to £4.84 per visit	
	Breach, reduced access	£2.82 to £3.72 per visit	
	Change	**Value (Gain)**	
	Nourishment of beach	£1.08 to £1.49 per visit	
	Rock groynes/rock	£1.06 to £1.61 per visit	
	Managed retreat	£1.30 per visit	
	Renewed seawall, access onto all beach	£8.40 per visit	
Health and safety	Spend per household per year on: - health: £3,600 - law and security: £1,160		Government's Pre-Budget Report 2003 and based on 25 million households.
Availability and accessibility of services	**Average Speed**	**Cost to Health (per mile)**	Based on value of a life of £1 million and an increased risk of death from a heart attack for each 5 minutes extra travelling time to a hospital.
	10 mph	£15,000	
	20 mph	£7,500	
	30 mph	£5,000	
	40 mph	£3,750	
	50 mph	£3,000	
	60 mph	£2,500	
Equity			
Sense of community	Grants for community activities approx. £15 per household per year		Based on grants from the Community Fund of the Lottery and Awards for All in 2003.

5.5.5 Outputs

Following the extended decision rule (as given in Figure 5.2) will provide an indication of the preferred option based on the main assessment. This can be tested through sensitivity analysis before a final option is selected. Where the implicit value of the intangible benefits has been used to select a higher (or lower) option than is justified by the tangible benefits, a description of the

reasoning behind this should also be provided. This will ensure that the appraisal is fully transparent and auditable.

5.6 Step 9: Test the robustness of the choice

5.6.1 Aims

The process of sensitivity analysis is used to test the robustness of the appraisal by altering key parameters and determining the impact on the selection of the preferred option. The aim is to determine whether the option selected is justified as the preferred option. FCDPAG 3 focuses on the importance of ensuring the selected option is economically worthwhile, whether the economic return is likely to be achieved and whether the option choice is robust. Where scores and weights have been applied in the MCA component of the appraisal, it is also necessary to test the sensitivity of the assumptions made during scoring and weighting to ensure that the choice of preferred option is robust.

5.6.2 Data and analysis

The robustness of the choice of preferred option in the main assessment is tested through the sensitivity analysis. FCDPAG 3 (Section 6.4) discusses the importance of identifying the key factors that impact upon the investment decision and includes a range of possibilities for some of these factors. For the MCA component, the key factors are likely to include:

- scores assigned to each option: consideration should be given to likely lower and upper scores that could have been assigned based on the data available and uncertainty that is inherent within it;
- weights assigned to each impact category: consideration should be given to the range of weights provided by stakeholders to assess the impact of lower/upper weights on the weighted score; and
- where the decision rule requires consideration of the implicit value of intangible benefits, it is important to incorporate this into the sensitivity analysis of economic (tangible) benefits. Changes to the costs and monetised benefits may require a larger or smaller implicit value for intangible benefits; this may also have an effect on the choice of preferred option under alternative scenarios.

It is important, therefore, to identify where different assumptions would have resulted in different numeric inputs. It is not always necessary to quantify the uncertainty surrounding an assumption, but to make a judgement as to the impact of uncertainty on scores and weights.

Sensitivity analysis is usually undertaken by varying one parameter at a time in order to identify the sensitivity of the decision to that particular change. In the MCA component, in particular, it may be necessary to combine changes. For

example, a new scenario with different assumptions may result in both the scores and weights being changed. It can then be difficult to identify the key factor that results in the change of preferred option (i.e. is it the changes in scores or changes in weights, and for which impact category?). It is important, therefore, that all changes in assumptions are recorded such that the scenario being tested and the changes that have been made are clear.

Also important is the consideration of switching values. These are points at which a change in assumptions (and numeric scores and weights) would result in a change in the preferred option. The identification of switching values provides useful information as it gives an indication of the range of scenarios under which one option is preferred. The selection of the preferred option can then be based on a judgement as to which set of scenarios is considered most likely.

5.6.3 Outputs

The outputs of the sensitivity analysis should be a set of alternative scenarios (covering both the CBA and the MCA component) with a discussion of the preferred option under each scenario. Any changes in the preferred option from the main assessment should also be noted, with reasons why, described where possible.

The results of the sensitivity analysis can be very useful for discussion with stakeholders, particularly where the preferred option is shown to be very robust to changes in scores and/or weights. The sensitivity analysis can also be used to show that different stakeholders' weights have been taken into consideration and how they affect the choice of the preferred option.

One further advantage is that the sensitivity analysis may help to identify ways in which the option could be improved, maximising its benefits. Also, it may highlight the need to revisit the appraisal process (feed-back loops) in order to better deal with the uncertainties. This can be done through:

- inclusion of new and improved options (Step 1);
- changes to the valuation of tangible impacts (Step 6a); and/or
- changes to the scoring of intangible impacts (Step 6b).

The feedback loops are also shown in Figure 2.1.

5.7 Step 10: Selection of the preferred option

The aim of Step 10 is to integrate the results from Step 8, where the preferred option was chosen, and Step 9, when the sensitivity testing is undertaken. The objective is to have a clear statement of the preferred option, together with a summary of the reasons behind the preference, supported by the results of the sensitivity analysis.

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Annex 1:

Illustrative example of a completed appraisal summary table for main assessment (MA-AST)

Table A1 Appraisal summary table for flood management and coastal defence – main assessment

Project Name		Dymchurch Coastal Defence Strategy Case Study, from High Knocke to Dymchurch Redoubt.	
Description of Option		MAINTAIN - DO MINIMUM (current annual maintenance reactive works to sea wall, and groyne field to maintain a standard of defence of 1 in 10, reducing over time to 1 in 3).	
Description of Area Affected by Option		Residential, commercial and recreational areas of Dymchurch currently protected by seawall. There are also old timber groyne fields, which are generally in poor condition. The beach and foreshore are sandy although the former is only present over the southern half of the frontage. Under the current defence policy the standard of defence provided is less than 1 in 10 years. Without the present level of maintenance some sections of the seawall are likely to fail within 5 years. (***Some of the information provided here does not correspond to reality. It was added for illustrative purposes only***)	
Impact Category	**Impact likely? (Y/N)**	**Qualitative Description of Impacts**	**Quantitative Assessment of Impacts (no. units/monetary)**
Economic Impacts			
Assets	Y	Protection of residential and industrial properties, including car parks, schools, churches and other public buildings in Dymchurch village and nearby coastal strip to a standard of 1 in 10 years, reducing to 1 in 3 over time. Protection of important tourism business developments and holiday camps in Dymchurch village and nearby coastal strip to a standard of 1 in 10 years, reducing to 1 in 3 over time. Protection of drains and sewers of the urban and countryside area, including the Marshland, Willtop and Grand Redoubt outfalls to a standard of 1 in 10 years, reducing to 1 in 3 over time. Protection of erosion of High Knocke and Dymchurch slipway and of the Willtop pumping station, although level of maintenance will have to increase over time to prevent the onset of erosion. .	Intermittent flooding of: 2471 dwellings; 3 holiday parks; 927 caravans; 2 car parks
Land use	Y	No change in current land use in the medium term, but progressively more frequent flooding of Grade 3 agricultural land and Romney Marsh SSSI (considered Grade 1 agricultural land) due to overtopping of defences could mean land use change in the long term. Likely to take longer to recover with time as standard reduces to 1 in 3 – such frequent flooding may force farmers to abandon land towards the end of the 100 year time horizon.	Intermittent flooding of 7600 ha of grade 3 agricultural land and 113 ha of grade 1 agricultural land due to overtopping of defences. Potential loss of this land for farming over time.

Table A1 Appraisal summary table for flood management and coastal defence – main assessment

Project Name		Dymchurch Coastal Defence Strategy Case Study, from High Knocke to Dymchurch Redoubt.	
Description of Option		MAINTAIN - DO MINIMUM (current annual maintenance reactive works to sea wall, and groyne field to maintain a standard of defence of 1 in 10, reducing over time to 1 in 3).	
Description of Area Affected by Option		Residential, commercial and recreational areas of Dymchurch currently protected by seawall. There are also old timber groyne fields, which are generally in poor condition. The beach and foreshore are sandy although the former is only present over the southern half of the frontage. Under the current defence policy the standard of defence provided is less than 1 in 10 years. Without the present level of maintenance some sections of the seawall are likely to fail within 5 years. (***Some of the information provided here does not correspond to reality. It was added for illustrative purposes only***)	
Impact Category	**Impact likely? (Y/N)**	**Qualitative Description of Impacts**	**Quantitative Assessment of Impacts (no. units/monetary)**
Transport	Y	Protection of the A259, between High Knock and Dymchurch Redoubt to a standard of 1 in 10 years, reducing to 1 in 3 over time. Protection of a number of minor roads crossing Romney Marsh and connecting villages and farms.	Protection of 2 km of one A road and of 1.8 km of minor roads.
Business development	Y	The beach and tourist facilities would be protected to the current level of protection with no significant impacts. Over time, however, due to increased frequency of flooding of tourism facilities there may be some knock-on impacts on economy of the area (which relies to a large extent on tourism and recreation) such that business development is also likely to be reduced. The businesses will find it more and more difficult to recover between floods. Some businesses may be lost.	Intermittent flooding of 3 holiday parks and 113 ha of Romney Marsh SSSI like to have significant knock-on effects on tourism and recreation businesses.

Table A1 Appraisal summary table for flood management and coastal defence – main assessment

Project Name		Dymchurch Coastal Defence Strategy Case Study, from High Knocke to Dymchurch Redoubt.	
Description of Option		MAINTAIN - DO MINIMUM (current annual maintenance reactive works to sea wall, and groyne field to maintain a standard of defence of 1 in 10, reducing over time to 1 in 3).	
Description of Area Affected by Option		Residential, commercial and recreational areas of Dymchurch currently protected by seawall. There are also old timber groyne fields, which are generally in poor condition. The beach and foreshore are sandy although the former is only present over the southern half of the frontage. Under the current defence policy the standard of defence provided is less than 1 in 10 years. Without the present level of maintenance some sections of the seawall are likely to fail within 5 years. (***Some of the information provided here does not correspond to reality. It was added for illustrative purposes only***)	
Impact Category	**Impact likely? (Y/N)**	**Qualitative Description of Impacts**	**Quantitative Assessment of Impacts (no. units/monetary)**
Environmental Impacts			
Physical habitats	Y	Protection of the Site of Nature Conservation Interest (SNCI) located at Dymchurch and the SNCI at Hythe Ranges to a 1 in 10 standard of defence, reducing to 1 in 3 over time. In the long term there may be some impacts to the small area of relic grazing (providing one of the only areas which has not been converted to arable and hosts several rare and scarce species of flora and fauna) due to more frequent flooding. Protection of freshwater dykes to a 1 in 10 standard of defence, reducing to 1 in 3 over time. In the long term there may be some impacts to the freshwater dykes, which exhibit fresh water flora, water voles, yellowhammer and sedge warbler, due frequent flooding. Dykes are likely to increase in brackishness, with potential impacts on the range of species supported. Protection of the Romney Warren SSSI and pLNR. Protection of vegetated shingle that constitutes a priority habitat under the Biodiversity Action Plan. Because this option does not include replacement of the groyne fields there may be some erosion of the sandy shores of Dymchurch and the vegetated shingle in the long term, as well as impacts on the natural spawning and nursery grounds for many species of fish (for example lemon sole, sole, sprat and mackerel).	Protection to 1 in 10 standard, reducing to 1 in 3 with time, of 2 SNCI (approximately 10 ha), 1 ha of relic grazing marsh, 5 km of fresh water dykes, Romney Warren SSSI (approximately 100 ha) and 2 km of vegetated shingle (BAP). Potential erosion of 2 km of vegetated shingle (BAP).

Table A1 Appraisal summary table for flood management and coastal defence – main assessment

Project Name		Dymchurch Coastal Defence Strategy Case Study, from High Knocke to Dymchurch Redoubt.	
Description of Option		MAINTAIN - DO MINIMUM (current annual maintenance reactive works to sea wall, and groyne field to maintain a standard of defence of 1 in 10, reducing over time to 1 in 3).	
Description of Area Affected by Option		Residential, commercial and recreational areas of Dymchurch currently protected by seawall. There are also old timber groyne fields, which are generally in poor condition. The beach and foreshore are sandy although the former is only present over the southern half of the frontage. Under the current defence policy the standard of defence provided is less than 1 in 10 years. Without the present level of maintenance some sections of the seawall are likely to fail within 5 years. (***Some of the information provided here does not correspond to reality. It was added for illustrative purposes only***)	
Impact Category	**Impact likely? (Y/N)**	**Qualitative Description of Impacts**	**Quantitative Assessment of Impacts (no. units/monetary)**
Water quality	Y	There will be some small chemical impact on the coastal (bathing) water quality due to overtopping of defences and flushing of agricultural land.	If one assumes that the water quality will be only influenced by the occurrence of overtopping, the impact existence will depend on the probability of flooding, which in this case is 0.1 (increasing to 0.33 by year 99).
Water quantity	N	There are no abstraction points in the area	
Natural processes	N	No impacts expected on natural processes. It should be noted that due to increased erosion in year 15, there may be an increase in sediment load. Some erosion of sandy shores and vegetated shingle will increase sediment supply	
Historical Environment	Y	Protection to a 1 in 10 standard of defence, reducing to 1 in 3 over time of Martello Tower and Dymchurch Redoubt both Scheduled Ancient Monuments (SAM), monuments listed on the Sites and Monuments Register, Conservation Areas within Dymchurch, listed buildings, site of high archaeological potential located near Dymchurch and of ancient churches and evidence of Roman settlements in Romney Marsh. In the long term there may be some impacts to these structures due to more frequent flooding. This option will repair the sea wall as and when necessary, however it still may lose some of its historical interest as the 13th century material is substituted by present day cement.	Protection to a 1 in 10 standard, reducing to 1 in 3, (intermittent flooding) of : • 2 SAMs; • 9 Listed Monuments; • 2 conservation areas (approximately 0.5 ha); • 22 listed buildings; • 1 site of high archaeological potential; and • 2 ancient churches and evidence of Roman settlements.

Table A1 Appraisal summary table for flood management and coastal defence – main assessment

Project Name		Dymchurch Coastal Defence Strategy Case Study, from High Knocke to Dymchurch Redoubt.	
Description of Option		MAINTAIN - DO MINIMUM (current annual maintenance reactive works to sea wall, and groyne field to maintain a standard of defence of 1 in 10, reducing over time to 1 in 3).	
Description of Area Affected by Option		Residential, commercial and recreational areas of Dymchurch currently protected by seawall. There are also old timber groyne fields, which are generally in poor condition. The beach and foreshore are sandy although the former is only present over the southern half of the frontage. Under the current defence policy the standard of defence provided is less than 1 in 10 years. Without the present level of maintenance some sections of the seawall are likely to fail within 5 years. (***Some of the information provided here does not correspond to reality. It was added for illustrative purposes only***)	
Impact Category	**Impact likely? (Y/N)**	**Qualitative Description of Impacts**	**Quantitative Assessment of Impacts (no. units/monetary)**
Landscape and visual amenity	Y	Because this option does not include replacement of the groyne field, in the long term there may be erosion of beach at Dymchurch, which is a key feature in the landscape and amenity of the area. Protection of cultural landmarks (such as churches, barns, etc.) (also considered in historical environment) and of Romney Marsh (also considered in land use), maintaining the landscape character and visual amenity of the area.	Potential erosion of 7 km beach starting in year 5.
Social Impacts			
Recreation	Y	Protection of slipways at Dymchurch and High Knocke, preventing impact on water activities such as sailing, fishing, etc, in the short and medium term. Protection of Romney, Hythe and Dymchurch Railway, MW's amusement park, Martello Tower 24, two caravan parks and a Holiday Village; Protection of promenade on top of sea wall preventing/reducing impact on recreational activities such as walking, sight seeing. In addition the access to the beach over the sea wall is also maintained (assumed 160,000 visits to the town per year).	With reduction of standard with time and erosion of beach there will be intermittent flooding of the 2 slipways, the Railway and amusement park, the Martello Tower, 2 caravan parks (927 caravans) and Holiday Village.
Health and safety	Y	Protection of the local population to a 1 in 10 standard reducing to 1 in 3 with time. Increase in stress and anxiety to local population from possibility of flooding due to reduced protection over time.	Local population at risk from flooding is approximately 6, 000.

Table A1 Appraisal summary table for flood management and coastal defence – main assessment

Project Name		Dymchurch Coastal Defence Strategy Case Study, from High Knocke to Dymchurch Redoubt.	
Description of Option		MAINTAIN - DO MINIMUM (current annual maintenance reactive works to sea wall, and groyne field to maintain a standard of defence of 1 in 10, reducing over time to 1 in 3).	
Description of Area Affected by Option		Residential, commercial and recreational areas of Dymchurch currently protected by seawall. There are also old timber groyne fields, which are generally in poor condition. The beach and foreshore are sandy although the former is only present over the southern half of the frontage. Under the current defence policy the standard of defence provided is less than 1 in 10 years. Without the present level of maintenance some sections of the seawall are likely to fail within 5 years. (***Some of the information provided here does not correspond to reality. It was added for illustrative purposes only***)	
Impact Category	**Impact likely? (Y/N)**	**Qualitative Description of Impacts**	**Quantitative Assessment of Impacts (no. units/monetary)**
Availability and accessibility of services	Y	Protection of the A259 and rural and local roads, local facilities (shops, health centres, schools, etc.) to a 1 in 10 standard, reducing to 1 in 3 over time. As the flooding becomes more frequent in the long term, the availability and accessibility of services may become an issue once more.	Population protected is approximately 6,000.
Equity	Y	Facilities, both for tourists and locals will be protected. Over time, however, the increased frequency of flooding, is likely to result in some local job losses and increased deprivation in an area that relies on income from tourism. It is also likely that the elderly population would suffer more from the increased flooding, with recoverability becoming more difficult due to reduced standard of protection.	Types of population likely to be affected: • 10% retired; • 3% unemployed;
Sense of community	Y	Sense of community will be protected as businesses, properties and services will be protected to a 1 in 10 standard reducing to 1 in 3 with time. However, as the flooding becomes more frequent in the long term, sense of community may become an issue once more.	80% of the area will be affected by intermittent flooding.

Annex 2:

Preliminary guidance on the use of benefits transfer for riverine recreation and angling and coastal recreation

A1. Introduction

In this Annex we provide an example of preliminary guidance on the use of benefits transfer (BT) for the following impact categories:

- rivers:
  - informal recreation
  - angling
- coastal:
  - recreation.

The above impacts categories have been selected on the basis of the transferability of the studies to the flood management and coastal defence context. Overall, recreation benefits (both formal and informal), depending on the nature of the problems and the options chosen to address them, will have the following components (based on Penning-Rowsell *et al.*, 2003):

1. The prevention of further deterioration: **losses** associated with the 'do-nothing' option when compared to the existing scenario. Almost all coastal protection projects and some riverine and coastal flood defence ones will have this component. Options that only prevent further deterioration and simply reinstate the site to its current condition will involve this component. Note, however, that benefits can also arise under the 'do-nothing' option if, by walking away for instance, the river is restored to a more natural state and, as a result, attracts more visitors.

2. The improvement of the condition of the site from the current state to a better one: **gains**. For example, the replacement of hard river flood defence structures reaching the end of their life with more soft engineered defences may enhance the recreational value of a river site. Beach nourishment for coastal protection purposes may result in a 'better' beach in recreational terms. In coast defence and river management schemes, for example off-shore reefs, new sea walls with promenades or river flood banks or retention lakes, may also change sites in ways that may provide new recreational opportunities and thus may enhance the recreational potential of the sites.

The BT approaches for river and coastal sites are described in turn. The AMP4 Guidance (RPA, 2003) distinguishes between recreational users for river and coastal sites. For fluvial flood defence, studies from the AMP4 Guidance have been deemed applicable.

Angling is considered separately, because of the special nature of this type of users. For coastal sites the applicability of most existing valuation is much more limited. The most relevant are the values from the Multi-Coloured Manual (Penning-Rowsell, *et al* 2003), although coastal recreation for the more specialised user has also been looked at.

Other impact categories are being further investigated (we are currently reviewing the scope for BT for valuation of landscape impacts and in-stream recreation for rivers. We also expect to include a section on the valuation of stress related effects in the future).

A2. Rivers

A2.1 Informal recreation

Overview

The term informal recreation covers a wide range of different activities, such as:

- walking and hiking;
- picnicking;
- dog-walking; and
- nature appreciation related activities such as birdwatching and photography.

Flood management and coastal defence schemes could potentially impact informal recreational users. For example, the construction of a concrete floodwall could lead to the loss of footpaths whereas soft engineering defences or a carefully designed hard defence could enhance the recreational value of a site. Options that provide habitat creation in addition to flood defence (such as managed set back or washlands) can also provide additional recreation benefits for users such as birdwatchers.

Qualitative description of impacts

Identifying the impacts on recreation from flood management and coastal defence options involves identifying the impacts of changes to the physical environment under the 'do-nothing' and the 'do something' options. The qualitative description of impacts should be recorded in the AST, with this including the following aspects:

- is there access to the river? Is this good, moderate or poor? (identify possible access sites, car parks, footpaths, etc.)?
- does informal recreation take place along the river or within the wetland area now (look at provision of facilities, aesthetic quality of the site, etc)? and
- would the option result in significant changes, e.g. visual intrusion, loss of footpaths, new walks, etc. such that they would be perceived by informal recreation users?

The decision to proceed with the monetary valuation of informal recreation related impacts should thus include consideration of the degree to which users would perceive the impacts arising from the different options to be important. If impacts are not likely to be perceived as important by users, then they should

be considered negligible. If the opposite happens, i.e. impacts are expected to be important, the number of users needs to be estimated. The approach set out below is based on the AMP4 methodology for calculating participation rates, and has been adjusted for the flood management and coastal defence context.

Calculating the population affected

In preparing the monetary valuation, it is important to estimate the number of users likely to be affected by the options. Sources of information on participation rates include:

- **Site visits or visitor surveys:** counts of visitors along the affected stretch or at a given site at different times during the day and year to give the basis for an estimate of annual number of visits;
- **Consultation-based estimates:** number of trips to affected site per year or as a point estimate based on consultation with recreation officers, District Council car park officers, tourist offices and ramblers club, etc.; and
- **Default data:** reliance on standard formulae of estimates.

The most robust approach is to collect site-specific data based on visitor counts. The least robust approach to developing estimates of likely visitor numbers is the use of default values as site specific factors are less likely to be taken into account. Note that this assessment is based on estimating current levels of use. Reliable methods do not exist for predicting changes in informal recreation visitor numbers.

Site visits or visitor surveys

The results of counts carried out during site visits or as part of visitor surveys can be used directly to calculate annual visitor rates to informal recreation sites. The approach to take will depend upon the format that the site count is in. If the site count is given as a spot count, or number of visitors per day, the steps below should be followed in order to derive an estimate of the annual number of visitors. If the count is of weekly visitors, this should be multiplied by four, to estimate monthly trips and then follow Steps 2 and 3. Where the site count gives monthly visitors, Step 3 will have to be followed. If the count is of car park numbers, this will need to be converted into number of visitors by multiplying by 2.3 (as 2.3 is the number of adults per household, from National Statistics); if the site count gives annual number of visits, there is no need to make any adjustments.

Visitors (from car park numbers) = number of cars parked x 2.3

Where several different counts have been undertaken both the mean and median values can be taken. If these are similar, estimates are likely to be fairly robust. If these two values differ significantly, then both values should be carried

forward as a lower and upper bound, as they will provide a range and an indication of the uncertainty surrounding the visitor rates estimates.

Step 1: Converting a daily count into weekly visit numbers

The most appropriate adjustment factors are given in Table A2.1.

Table A2.1: Proportion of visits made on weekdays and weekend days

Day of Week	Percentage of Trips Made
Weekday (per day)	12%
Weekend (per day)	20%

Source: CRN (1996), in Environment Agency (2003)

The daily estimate should be divided by the appropriate percentage to give a weekly estimate. Multiplying the weekly estimate by four will then provide the number of visits per month.

$$\text{Weekly estimate of visits} = \text{daily estimate} \div \frac{\text{percentage (from Table 5.1)}}{100}$$

$$\text{Monthly estimate} = \text{weekly estimate} \times 4$$

Step 2: Converting a monthly estimate into an annual estimate

Factors for typical monthly variations in informal recreation activities are given in Table A2.2. The Table shows participation rates by month and by importance of a site. In using these, the characteristics of the site as described in the qualitative assessment should be considered.

Once it has been selected which level of importance best reflects the site, the monthly estimate should be divided by the percentage of visits made in that month. For example, if 2,300 visits are made in May to a site with good accessibility and some facilities, which is expected to be of 'moderate' importance, the monthly adjustment factor is 16%, which gives an estimate of annual visits of 14,375 (from 2,300 divided by 0.16).

$$\text{Annual visits} = \text{monthly visits} \div \frac{\text{percentage (from Table 5.2)}}{100}$$

Table A2.2: Adjustment factors for monthly variations in visit patterns

Month	Importance of Site		
	HIGH[1] (likely to draw visitors from >30 km)	MODERATE[2] (likely to draw visitors from 15-30 km)	FAIR[3] (likely to draw visitors from up to 15 km)
January	3%	9%	14%
February	3%	3%	9%
March	8%	6%	7%
April	10%	8%	7%
May	16%	16%	9%
June	10%	11%	7%
July	17%	13%	6%
August	16%	7%	10%
September	5%	10%	8%
October	4%	8%	9%
November	4%	3%	7%
December	4%	6%	6%

Source: Environment Agency (2003)

Consultation-based estimates

A range of different organisations may hold data on the number of visitors to a given river or wetland site. Some of these organisations may have undertaken their own site surveys, or may hold data on car park usage, etc. that can be used to form the basis for developing visitor estimates. This includes:

- District Councils, which may hold data on levels of car park usage or which may have undertaken some counts of users of local parks;
- British Waterways, which hold data on average visit rates to different canals and navigable rivers;
- Wildlife Trusts, which may hold data on visitor numbers to different wetland sites
- Tourist Offices, which may have carried out surveys of the activities undertaken by visitors to an area and the location of those activities;
- Ramblers' Clubs, where a footpath runs along or across a site that is used for longer walks and hiking; and
- other local clubs, such as birdwatching clubs, who may regularly visit.

Club secretaries may only be able to give an indication of the number of visits likely to be made by their members, or may be able to provide guesstimates of visit rates more generally.

The format in which the data are provided will determine the steps to derive an annual estimate of number of visits. This may involve following the appropriate step(s) above.

One other factor that may affect the accuracy of consultation-based data relates to member and non-member activities. For example, clubs may be able to provide good estimates of numbers of member trips to the site, but have no data on non-member trips. Table A2.3 gives an indication of the number of trips that may be made by members to rivers or canals that provide good sites for informal recreation (this is based on only a few studies and, hence, may introduce uncertainty).

Table A2.3: Adjustment figures for taking non-member visits into account

Club/Activity Type	Percent of Trips Made up by Members
Birdwatching (RSPB)	12%
Nature conservation	6%
Waterways associations	1%

Source: British Waterways (1994), in Environment Agency (2003)

$$\textit{Total number of visits} = \textit{number of member trips} \div \frac{\textit{percentage (from Table 5.3)}}{100}$$

Default data

If no site specific data are available, the alternative is to use default data to estimate visitor numbers. In using the default data provided below, the qualitative assessment concerning accessibility, the provision of facilities and the general attractiveness of the site should be taken into account. Two different sets of default assumptions have been developed by Green *et al.* (1992). These are set out in Table A2.4 overleaf, with the definitions of a local park and honeypot site being as follows (FWR 1996):

- **Local Park**: visitors travel mainly by foot and the site has no special attractions. Relevant population in terms of a multiplier is that living within 1 km of the site; and
- **Honeypot Site**: visitors travel by car, there is some special attraction and there are facilities such as a car park and toilets at the site. The relevant population (in terms of a multiplier) lives within 3 km of the site.

These definitions apply to local sites only. The use of the population within these distances as a multiplier takes into account the fact that not everyone within these distances will visit the site, but also that people further away will visit the site; the two are assumed to balance each other out. Regional and national sites are likely to attract visitors from much greater distances. Such sites may include long distance footpaths, be connected to tourist sites or be in National Parks, Areas of Outstanding Natural Beauty (AONB), etc. However, only a proportion of the population is considered likely to make such trips each year.

The standard values presented in Table A2.4 are based on research on a series of rivers in the Thames Region of the Agency and from the Day Visits Survey undertaken by the Countryside Recreation Network.

In order to use the above equations, estimates on the appropriate visitor population should be obtained by:

- drawing a circle around the river with a radius equal to the most appropriate distance shown in Table A2.4. GIS-data, census data or an OS map could help in determining the population (number of adults) within the circle (for regional/national sites the appropriate proportion of the population expected to visit that site each year should be applied):

  population = number of people living within the circle drawn x percentage of population expected to visit the site (regional/national sites only)

- or, using population density data, calculate the affected population using the following formula:

  population[10] = 3.14 x distance (in km) squared (from Table 5.4) x population density x percentage of population expected to visit the site (regional/national sites only)

[10] population = π x (distance)^2 x population density (where π = 3.14).

Table A2.4 Standard data for estimating informal recreation visitor numbers

Site Type	Importance	Visit Rate		Total Visits per Annum	
		Per Adult per Year	Average Distance from Site	Total Visits per Annum	Likely Site Characteristics
Local ('Fair' Importance)	Upper	27.6	1 km	30,000	access: good facilities: good/moderate
	Mid	21.3	1 km	20,000	access: moderate facilities: moderate/fair
	Lower	17.1	1 km	10,000	access: fair facilities: fair/poor
Honeypot ('Fair' to 'Moderate' Importance)	Upper	17	3 km	250,000	urban area access: good facilities: good/moderate
	Mid	17	3 km	125,000	suburban area access: good/moderate facilities: moderate/fair
	Lower	17	3 km	60,000	rural area access: moderate facilities: fair/poor
Regional/ National Site ('Moderate' to 'High' Importance)	Upper	2	60 km	540,000	10% of population within 60 km visit site each year access: good facilities: good
	Mid	2	30 km	270,000	20% of population within 30 km visit site each year access: good/moderate facilities: good/moderate
	Lower	9	10 km	180,000	26% of population within 10 km visit site each year access: moderate/fair facilities: moderate/fair

Source: based on Green *et al.* (1992); and CRN (1996), in Environment Agency (2003)

Availability of alternative sites

A key issue that arises in estimating informal recreation benefits (and other recreation benefits) concerns the existence of alternative sites and the degree to which this will impact on visitor numbers to the site in question. When deciding whether a site is likely to be an alternative site, it should be considered whether the level of access, facilities and quality are likely to be similar to the site. This is particularly important for regional/national sites, where potential alternatives must also be of regional/national importance to be considered appropriate alternatives.

If there are alternative sites within the same distance as considered above, the total number of adult visits per annum should be divided by the number of alternative sites plus one (to account for the site in question).

$$\textit{Number of visits to site in question} = \frac{\textit{total number of visits (estimated above)}}{\textit{number of alternative sites plus one}}$$

Reality checks

The estimation of participation rates is normally associated with a high degree of uncertainty. The following checks are suggested to examine whether the calculated figures are of the right order of magnitude (especially when using default data).

The first check is to divide the estimate of annual visits by 365 to calculate the implied number of visitors per day to see whether this figure seems right in the context of the site, access to it and its characteristics. The default data in particular may lead to overestimates in rural areas or for poor quality sites.

$$\textit{Reality check 1: daily number of visits} = \frac{\textit{number of visits to your site}}{365}$$

Table A2.5 provides an indication of the number of visits made to different rivers, with details given on the type of river, level of access, facilities and importance provided. These can then be compared with the descriptions given in Table A2.5 and the site to determine whether the estimates are likely to be realistic.

Table A2.5 Number of trips per year to different rivers/canal

River/Canal	Description	Number of Visits per Year
River Nene	Long distance footpath (regional/national importance) Moderate facilities and good access Alternatives available (e.g. Cam, Ouse)	1,800/km
Caen Hill Locks near Devizes, Kennet and Avon Canal	Nationally important site with feature of locks Popular attraction with good access Count taken by infra-red pedestrian counter	94,000 (68,000 visitors plus 26,000 locals)
Maidenhead Ditch	Runs through Maidenhead town before joining the Thames at Bray Access good, but attracts mainly local residents (within 3 km), few facilities Number of alternative sites available (including the Thames)	41,000
Ravensbourne River	Queen's Mead recreation ground, Bromley, Kent Many visits to park rather than specifically to river; river of poor quality, access good, few facilities, mainly used for sporting activities	125,000
River Skerne	River running through Darlington prior to restoration Access fair to moderate with no facilities, very poor water quality, visited by local residents only (those living within no more than 1 km from the river)	7,800

Source: Environment Agency (2003)

Benefits transfer

Once the number of visitors has been calculated, it is necessary to find a best fit value in order to value the impacts on recreation. The choice of value will depend on the type of impacts arising from the different options. Different transfer values are provided in Table A2.6, these are based on WTP values. The transfer values should be multiplied by the number of visits, when the value is given as a 'per visit' value, or by the number of households, where the transfer value is given as a 'per household' value.

Table A2.6 Suggested transfer values for changes in quality and recreation (2001 prices)

Study	From	To	Transfer Value	Required Adjustments
Rivers				
Coker *et al* (1990)	Channel partly filled with water (also litter within river channel and along river banks)	Channel filled with water (litter removed from channel and river banks)	£1.35 per visit	Study relates to Maidenhead residents and visitors from the surrounding area. Adjustment for wealth may be deemed appropriate
Tapsell *et al* (1992)	Channelised river system	Creation of new meanders, bankside planting and some habitat	£2.91 to £3.61 per user (dependent on degree of habitat creation)	No adjustment suggested when assessing local schemes
Garner *et al.* (1995)	Straightened river channel with some adjoining park area	River restoration through channel modifications, habitat creation and landscaping	£8.75 per adult per visit	No adjustment suggested when assessing local schemes. Adjustment for wealth may be deemed appropriate.
Jacobs Gibb (2002)	Low flows every 4 or 5 years out of 20 years	Full restoration to low flows once every 20 years	<0.5 km: £0.34 per household per km per year 0.51-3 km: £0.25 per household per km per year 3-12 km: £0.07 per household per km per year 12-60 km: £0.03 per household per km per year	Adjustments are proposed for different site characteristics. These are still under development, but users may want to examine the implications. WTP values adjusted for high income of respondents
ERM and Willis (1992)	Low flow conditions	Environmentally acceptable flow regime in River Darent	£8.20 per visitor household per year	Apply unit of measurement depending on information available
Wetlands				
Woodward and Wui (2001)	Wetland providing little habitat and no value of single service provision of birdwatching	Wetland of value for birdwatching	£3,944 per hectare per annum	Is an international value and must be treated as being indicative only

Study	From	To	Transfer Value	Required Adjustments
O'Neill (2001)	No birdwatching	Provision of birdwatching at different inland wetland sites	£0.08, £1.72 and £2.85 per visit to Tudeley Woods, Weir Wood and Pulborough Brooks	Values vary across sites so site characteristics should be considered in choosing a value
Klein and Bateman (2001)	Current site quality and characteristics	Protection against future damage to the site and loss of birdwatching and habitat	£1.69 per visit or £51.42 per household per annum (assumes 13 visits per adult/annum and 2.3 adult/household)	Apply unit of measurement depending on information available. Adjustment for resident household visitors may be needed

Source: Environment Agency (2003)

A3 Angling

Overview

This Section looks at the valuation of angling impacts from implementation of flood management and coastal defence options. The rationale for considering these impacts separately is that anglers are normally deemed as a special type of recreational users (as for example, in the Multi-Coloured Manual) (Penning-Rowsell *et al*., 2003); other methodologies do also consider anglers as a separate user category.

When it comes to valuation, though, the Multi-Coloured Manual does not distinguish between anglers and more general/informal users, that is to say, there is not a different set of values for the valuation of angling impacts. The AMP4 methodology, on the contrary, gives different values for valuing angling impacts. This Section looks at the AMP4 methodology for inferring the number of anglers visiting rivers and valuing impacts on recreational fisheries in the flood management and coastal defence context.

Qualitative description

The first step is to determine whether an impact on angling is expected and, if so, to describe it in qualitative terms. The qualitative description of impacts should be included in the AST with this answering the following:

- is there access to the river? Will access to the site be improved under any of the options?
- is there a fishery in the river now? What is the current fishery type (no fishery, coarse fishery, trout fishery or salmon fishery)? Is the fishery 'natural', or 'stocked', is the river natural or modified? What are the characteristics of the fishery (upstream, middle reaches, pool and riffle, lowland, etc.)?
- will the option result in the creation of a new fishery, i.e. the creation of a game fishery where a river is currently only capable of supporting a coarse fishery or the creation of a fishery where no fishery currently exists? Could these result from the removal or introduction of structures, pools and riffles, side ponds, etc.?
- how long is it expected to take before the impact is noticeable in the river (in years)? This will be influenced by including bankside planting, introduction of gravel beds, etc.
- what length of river will see this change (in km)? and
- how many anglers are likely to benefit from the option?

The current constraints to the quality of the fishery or the creation of a new fishery should also be considered, e.g. are there other constraints such as the river type or any barriers to fish movements that would prevent creation of a new fishery?

The influence of river type is summarised in Table A3.1. This shows whether a river with a particular gradient (and, hence, flow speed) could be expected to support a coarse fishery only, coarse and game fishery or game fishery only and the probable maximum quality of fishery that may be obtained. The table should be taken as a guide to whether it is theoretically feasible to create a new fishery or to improve the quality of a current fishery.

Table A3.1 River gradient and maximum fishery types that can be supported

River Gradient (m/km)	Coarse	Game
0 to 1 (very slow)	Good	-
1 to 2 (slow)	Good-moderate	Moderate-poor (possible, but unlikely)
2 to 4 (moderate)	Moderate-poor	Moderate-poor
4 to 8 (rapid)	Poor (possible, but unlikely)	Good-moderate
>8 (very rapid)	-	Good-moderate

Source: Environment Agency (2003)

Quantitative assessment

One of the key variables in determining benefits from the option is the number of anglers that may be affected. Table A3.2 sets out the different types of information that can be obtained on participation rates. The 'best' information is given towards the top of the table; this is the most site specific. Default values are given where the other sources of information are not available or where time constraints mean such information cannot be obtained.

Table A3.2 Information sources for participation rates

Source(s)	Type of Information Required
Site visits or visitor surveys	Counts of anglers along the affected stretch at different times during the day and year to give the basis for an estimate of annual number of visits (but remember the close seasons)
Consultation with angling clubs/owner of the fishery	Number of trips made to affected river per year (or per week if per year is not available) (by members and, where available, through day tickets to non-members/general public). Numbers of members of angling clubs could also be used with their views on average number of times they fish
Environment Agency rod licence data	Number of rod licences in local area by postal code zone
Default data	Information provided in tables given below

Site visits or visitor surveys

The result of a count made during a site visit and/or visitor survey will give a direct estimate of the number of anglers at that particular time. It is then necessary to aggregate up this count so that an estimate of the annual number of anglers can be obtained. Close season must be taken into consideration. These run from 15 March to 15 June for coarse fishing. The close season for salmon and trout (game) fishing varies from three to six months according to the river in question, with close seasons being 31 October to 1 February for salmon and 30 September to 1 March for sea trout (unless otherwise stated in local byelaws).

Where direct information on the annual number of trips is unavailable, it is necessary to aggregate up from the site count to estimate annual number of visits. A review of studies and surveys has been undertaken as forming the basis for the division of trips into weekdays and weekend days. This is given in Table A3.3.

Table A3.3: Proportion of visits made on weekdays and weekend days

Day of Week	Percentage of Trips Made
Weekday (per day)	4.4%
Weekend (per day)	39%

Source: CRN (1996), in Environment Agency (2003)

$$\textit{Weekly trips} = \textit{daily estimate} \div \frac{\textit{percentage (from Table 5.9)}}{100}$$

$$\textit{Monthly trips} = \textit{weekly trips} \times 4$$

Using this information, a site count taken on a Saturday, which saw 25 anglers along 3 km of accessible banks would be converted to 64 weekly trips (from 25 divided by 0.39). This then needs to be multiplied to a monthly total. Multiplying it by four gives 256 trips per month. An estimate of the annual number of trips can then be made, by using the figures given in Table A3.4. The table also highlights the close season months by type of fishery. Continuing the example, the count was taken in July, which represents 18% of all trips; this gives estimated annual number of trips of 1,425.

$$\textit{Annual trips} = \textit{monthly trips} \div \frac{\textit{percentage (from Table 5.10)}}{100}$$

Table A3.4 Monthly variations in visit patterns as percentage visiting each month by activity

<table>
<tr><th>Month</th><th>Percent of Angling Trips</th><th>Coarse</th><th>Sea Trout</th><th>Salmon</th></tr>
<tr><td>January</td><td>6%</td><td rowspan="3">Open season</td><td rowspan="2">Close season: ends 1 March – no sea trout fishing</td><td>Close season: ends 1 February – no salmon fishing</td></tr>
<tr><td>February</td><td>3%</td><td rowspan="9">Open season</td></tr>
<tr><td>March</td><td>3%</td><td rowspan="6">Open season</td></tr>
<tr><td>April</td><td>8%</td><td rowspan="3">Close season: mid-March to mid-June – no coarse fishing</td></tr>
<tr><td>May</td><td>6%</td></tr>
<tr><td>June</td><td>14%</td></tr>
<tr><td>July</td><td>18%</td><td rowspan="6">Open season</td></tr>
<tr><td>August</td><td>10%</td></tr>
<tr><td>September</td><td>15%</td></tr>
<tr><td>October</td><td>8%</td><td rowspan="3">Close season: starts 1 October – no sea trout fishing</td></tr>
<tr><td>November</td><td>8%</td><td rowspan="2">Close season: starts 1 November – no salmon fishing</td></tr>
<tr><td>December</td><td>1%</td></tr>
</table>

Notes: Percent of visits per month taken from RPA (1997)
Close seasons for sea trout and salmon may vary according to local byelaws

Source: Environment Agency (2003)

Consultation with angling clubs/owner of the fishery

Angling club secretaries and/or the owner of the fishery are often a good source of information on the number of anglers that visit a particular stretch of river. In many cases, this will be limited to the number of visits to stretches of river owned (or leased) by their club, but it may cover members of the angling club and day tickets purchased by non-members to give a good estimate of participation. Where there are also lengths of river with open access, angling clubs may be able to give an indication of the number of trips made by club members but may not include trips made by the general public.

The NRA Angling Survey 1994 gives the following estimates of club membership by fishery type. This is shown in Table A3.5 and can be used to estimate the number of trips made by non-members to a fishery when you have obtained an estimate of member trips.

Table A3.5: Attendance at different fishery categories according to membership status

Fishery Type	% Members	% Non-Members
Coarse Fishery	51% to 56%	44% to 49%
Trout (Non-Migratory Salmonid) Fishery	55%	45%
Salmon (Migratory Salmonid) Fishery	62%	38%

Source: based on information given in NRA (1995): *National Angling Survey 1994*, and supporting information from the FWR Manual (1996); in Environment Agency (2003)

Environment Agency rod licence data

Obtaining the number of rod licences within the local area (by postal code zones) will give the basis for estimating the potential number of anglers that visit the affected river. To do this, it is necessary to determine what distance from the river is likely to include those anglers who would visit the river being assessed. This will be determined by the quality of the fishery and the existence of other fisheries in the area that are of a similar (or better) quality (alternative sites). The proportion of rod licence holders that will visit a coarse, trout and salmon fishery are given in Table 6.12, along with the most appropriate distances that they will travel to a particular site. These figures have been generated through a review of specific data on anglers and their visit characteristics.

Number of licence holders visiting the river = number of licence holders within given distance (from Table A3.6) x % of licence holders visiting the fishery type (from Table A3.9)

The total number of angling visits being made to the affected river can be estimated by using the average number of trips made by anglers to different fishery types (Table A3.7).

Table A3.6 Proportion of rod licence holders that may fish the affected river

Fishery Type	Few (<2) Alternative Sites	>2 Alternative Sites
Coarse Fishery	35% within 30 km	35% within 15 km
Trout (Non-Migratory Salmonid) Fishery	46% within 60 km	46% within 30 km
Salmon (Migratory Salmonid) Fishery	29% within 60 km	29% within 30 km

Notes: Given as a guide as to the distance that anglers may be willing to travel to visit a particular river.
For very high quality fisheries (e.g. nationally, regionally known), larger distances may be appropriate.

Source: Based on a number of sources including Spurgeon *et al* (2001), NRA (1995), in Environment Agency (2003).

Table A3.7 Number of trips made per year to different fisheries

Fishery Type	Number of Angling Trips per Year	
	Lower Bound	Upper Bound
Coarse Fishery	17	32
Game Fishery	3	11

Source: based on information given in Spurgeon *et al* (2001) and NRA (1995) for percent of trips made to the regular site and number of trips made to each fishery type, in Environment Agency (2003)

Number of angling trips = number of licence holders visiting the river x number of trips made per year

Default data

Where no site counts, visitor survey, angling club or rod licence data are readily available, it will be necessary to use default data to estimate the potential number of anglers. When selecting the most appropriate figures the following should be considered:

- level of access to the fishery: is it privately owned with restricted access? Is it privately owned with access through angling clubs? Is it a day ticket or open access fishery?
- how many alternative fisheries are there likely to be in the local area that are of similar (or better) quality?
- what is the current level of angling activity and the potential to attract new anglers or encourage existing anglers to make more trips to the river?

Table A3.8 provides a summary of the distances anglers may be willing to travel combined with the percentage of the population that may visit each fishery type (by Agency Region).

Table A3.8: Proportion of the total population that may visit a fishery type

Fishery Type	Distance	% of Population							
		Anglian	Northumbria & Yorkshire	North West	Severn Trent	Southern	South Western	Thames	Wales
Coarse fishery	30 km	6%	4%	4%	4%	5%	4%	3%	4%
Trout fishery	60 km	7%	5%	5%	5%	7%	5%	4%	6%
Salmon fishery	60 km	5%	3%	3%	3%	4%	3%	3%	3%

Notes: Given as a guide as to the distance that anglers may be willing to travel to visit a particular river.
For very high quality fisheries (e.g. nationally, regionally known), larger distances may be appropriate
Source: Environment Agency (2003)

There are two methods to infer the number of population affected:

- drawing a circle around the river with a radius equal to the most appropriate distance shown in Table 5.14 and either using GIS-data, census data or an OS map determine the population (number of adults) within the circle:

  population = number of people living within the circle drawn x percentage of population expected to visit the fishery type

- or, using the population density data, to calculate the affected population by using the following formula:

  population = 3.14 x distance (in km) squared x population density

Table A3.7 above, shows the average number of trips made to fisheries of different type and quality. Two values are given (an upper and lower bound) to highlight uncertainty within the estimates.

Number of angling trips = population x average number of trips (Table A3.7)

Alternative sites

The estimated number of angling trips made to each fishery type each year is calculated by multiplying the appropriate population by the number of trips made to each fishery type. However, this needs to be corrected for the number of alternative sites that may be available. The adjustment is made by estimating the number of alternative sites of better or similar angling opportunities and dividing the total number of angling trips made each year by the number of alternative sites plus one (to account for the site in question).

Number of trips to site in question = total number of angling trips (from above) / number of alternative sites plus one

Reality checks

The estimation of participation rates can often be associated with a high degree of uncertainty. The following checks are designed to give an indication of whether the obtained participation rate estimates are likely to be appropriate for the affected length of river in question. There are two approaches given here:

- comparison with maximum angler densities; and
- comparison with expected number of visitors to different types and qualities of fishery.

These comparisons are not designed to estimate participation rates, but rather to provide an indication of the expected number of visitors.

Comparison with maximum angler densities

For coarse fishing, there is generally one angler per 25m of bank[11], while for game fishing, there is (at most) one angler per 50 m of bank. To test whether the participation rate estimates are appropriate, it is assumed that 78% of angling trips are made at weekends, i.e. Saturday and Sunday, and this is the basis for determining if the participation rates are unreasonably high. For a coarse or salmon fishery, there are around 76 'weekend days' and for a sea trout fishery 62 'weekend days' within the open season. Thus in order to calculate the number of anglers per km bank the following is applied:

Coarse/salmon fishery: daily number of visits = number of angling trips x 0.78 ÷ 76
Sea trout fishery: daily number of visits = number of angling trips x 0.78 ÷ 62

Number of anglers per bank = length of accessible river bank ÷ daily number of visits

For example, if there are 3,200 angling trips made annually to a coarse fishery, the number of 'weekend days' trips is estimated at 2,500 (3,200 multiplied by 78%), which gives an average of 33 trips per weekend day. If the affected length of accessible riverbank is 5 km, the average density on a weekend day can be estimated at 1 angler per 150m. Therefore, the estimated annual number of trips does not appear to be unreasonably high.

[11] It could be expected, however, that this average density may be higher in urban areas owing to higher levels of demand.

Comparison with expected number of angling trips

Table A3.9 provides a number of sites where the number of angling visitors has been counted. These figures may provide a useful comparison against the estimates.

Table A3.9 Visitor numbers to selected angling sites

Location	Fishery Type and Description	Number of Anglers
Mawddach (Dolgellau)	Regionally important salmon river, access through angling club/day ticket and/or for visitors to accommodation with privately owned stretches	1,980/km bank per year
River Waveney	Locally important coarse fishery (with day tickets available for visitors/tourists)	2,100/km bank per year
Rutland Water	Stillwater trout fishing, regionally important lake stocked with trout	1,400/km bank per year
Grafham Water	Stillwater trout fishing, regionally important lake stocked with trout	1,100/km bank per year
12-acre lake in North West	Non-migratory trout in lake with access by day ticket	280/km bank per year

Source: Based on consultation undertaken by RPA when assessing impacts on angling for a number of river/lake schemes, plus published visitor numbers (where available), in Environment Agency (2003)

Benefits Transfer

The contingent valuation studies undertaken as part of the development of the *FWR Manual* (FWR, 1996) derived a range of values relating to the improvement of the quality of a fishery, where this includes moving from no fishery to a high-class fishery. These values are presented in Table A3.10 for coarse angling. These are the best estimates currently available for use in BT. They were derived specifically for use in a BT context. The surveys were undertaken in a number of different locations across England and Wales with the aim of generating mean estimates that would be broadly correct within any regional context, in terms of variations in river types and characteristics and in socio-economic characteristics.

Table A3.10 Benefit per angling trip for improvements in a coarse fishery (2001 prices)

Quality of Fishery to be Created	Willingness to Pay per Angling Day	Marginal Value of Improvement in Fishery Quality
'Poor' (assumed average fish biomass <600g/100m^2)	£4.30 per person per trip	No fishery to Poor = £4.30
'Moderate' (assumed average fish biomass 600-2000g/100m$^{2)}$	£4.53 per person per trip	Poor fishery to Moderate = £0.23

Quality of Fishery to be Created	Willingness to Pay per Angling Day	Marginal Value of Improvement in Fishery Quality
'Good' (assumed average fish biomass >2000g/100m^2)	£6.87 per person per trip	Moderate fishery to Good = £2.34

Source: Green and Willis (1996) in Environment Agency (2003)

The study undertaken by Green and Willis (1996) for the FWR Manual also determined willingness to pay (WTP) values for the creation of different quality trout fisheries, with the resulting values set out in Table A3.11.

Table A3.11 Benefit per angling trip improvements in a trout fishery (2001 prices)

Quality of Fishery to be Created	Willingness to Pay per Angling Day	Marginal Value of Improvement in Fishery Quality
'Poor' (assumed average fish density of fish >20 cm, <0.8 fish per 100m^2)	£9.81 per person per trip	Coarse to Poor Trout =£1.94
'Moderate' (assumed average fish density of fish >20 cm, 0.8 - 2 fish per 100m^2)	£11.43 per person per trip	Poor to Moderate = £1.62
'Good' (assumed average fish density of fish >20 cm, >2 fish per 100m^2)	£17.91 per person per trip	Moderate to Good = £6.48

Source: Green and Willis (1996); *FWR Manual*: *Assessing the Benefits of Surface Water Quality Improvements,* in Environment Agency (2003).

Only two surveys have been identified which have derived estimates of the value of a salmon angling day. The first was undertaken by Radford (1984) and found a value of roughly £17.30 per angler per day. The second study is that undertaken for the *FWR Manual*. A value of £28.20 per person per trip was found for the creation of a new, good quality site, where an average angler had a 1 in 10 chance of catching a salmon each day[12]. Both values could be carried forward as a lower and upper bound, as they will provide a range and an indication of the uncertainty surrounding the estimates.

[12] The figure of £28.20 is supported by research undertaken on salmon fisheries in Northern Ireland (Davis and O'Neill 1992). This study found WTP values of between £20 and £28.50 (depending on experience) for maintaining access to angling licences and permits in Northern Ireland

A4. Coastal Sites

A4.1 Recreation

Overview

This Section discusses the valuation of recreational benefits from coastal protection and draws on the Multi-Coloured Manual with regard to transfer values. This is because the values used in other methodologies are of more limited transferability, being linked with water quality changes. There is another advantage from using the values provided in the Multi-Coloured Manual, this being that they include more specialist users. For aggregation, the methodology proposed in the AMP4 methodology has been adjusted in order to integrate informal and more specialist recreational users.

Qualitative description of impacts

The first step in the assessment is to determine whether recreation activities take place along the beaches/shoreline that will be affected by the scheme. To do this, the following questions to be considered:

- how long is the relevant shoreline that will be affected and what is the extent of the access to the shoreline? Are there car parks, promenades, footpaths, etc. providing access?

- does recreation take place now along the shoreline? Are there any data on visitor numbers to the shoreline area? To what extent is the shoreline likely to be used for recreation purposes throughout the year? and

- would it be likely to develop new recreational opportunities or change existing recreational activities in the future if the option is implemented (e.g. increasing the length of the promenade)? In answering this the decision maker should think about whether there is a nearby population centre and whether there are already nicer areas nearby that draw more local residents.

The answers to the above questions should be summarised and incorporated into the AST. If benefits to recreational users are expected to arise, then the next step is to move on to the quantitative assessment.

Quantitative assessment for recreation

There are a number of different methods available for estimating the number of people that may visit a particular beach for recreation purposes. The 'best' method will depend upon (i) the amount of information that is readily available and (ii) the amount of time you have to obtain and/or calculate potential participation rates.

Table A4.1 sets out two different approaches for estimating the number of beach users. The first relates to actual counts that have been made on the beach by lifeguards, the local council (including car park counts) or a count taken on a site visit. Default values are given where the other sources of information are not available or where time constraints mean site specific information cannot be obtained.

Table A4.1: Information sources for participation rates

Source(s)	Type of Information Required
Site Visits or Visitor Surveys	Counts of number of beach/shoreline visitors on the beach over a specified period of time Car park data can also be used to give an indication of the potential number of beach/shoreline visitors
Default Data	Information provided in tables given below

Source: Environment Agency (2003)

Site visits or visitor counts

Counts of the number of visitors to a particular beach may be available from lifeguards (where present), local councils/authorities and/or other counts taken such as for Garber Data. These counts can take a number of forms. Depending on the type of data, the following adjustments will be necessary.

Adjustment for number of people travelling by car

The estimate of number of beach visitors should only include those over 16 (since these are the only visitors assumed to hold willingness to pay). Therefore, the number of adults travelling by car is based on the number of adults per household. This is estimated as 2.3 adults per household (the average number of adults per household as given by National Statistics 2002). Therefore, to convert number of cars to number of beach visitors the number of cars counted should be multiplied by 2.3.

Adjustment for day of the week that the count was taken

Where counts are given for a specific day, it is necessary to convert this into a weekly total. Table A4.2 sets out the proportion of beach users that use beaches on specific days. These figures are based on the Countryside Recreation Network's *Day Visits Survey 1994* (CRN, 1996) as reported in RPA (2003). Different values are provided for England and Wales, as a review of studies considering numbers of beach visitors has found significant differences

between the two countries. To adjust a daily count to a weekly count, the daily count should be divided by the appropriate percentage shown in Table 6.19. For example, if a count shows 134 beach visitors on a Friday in England, practitioner should divide this by 10% (0.10) to give 1,340 weekly visitors. Multiplying this weekly total by four will give an estimated monthly total.

Table A4.2 Adjustment for day of the week count was taken

Day	Adjustment	
	England	**Wales**
Weekday (per day)	8% - 10%	10%
Weekend (per day)*	16 % - 44%	15% - 33%

* range reflects variation according to bathing visits;
Source: based on CRN (1996), in Environment Agency (2003)

Adjustment for month in which count was taken

As with the daily counts, the number of trips made to a beach varies by month, with the peak months tending to be July and August in England and August and September in Wales. Table A4.3 provides an indication of the proportion of beach visits that are made each month. The practitioner should adjust the monthly totals by dividing by the percentage given for the month in which the count was taken. For example, if a monthly count of 275 beach visitors was taken in October in England, the practitioner should divide this by 6% (0.06) to give an annual estimate of beach visitors of 4,600. The user should compare this figure with the reality checks.

Table A4.3 Adjustment for month in which count was taken

Day	Adjustment Factors	
	England	Wales
January	6%	8%
February	3%	2%
March	3%	4%
April*	6% - 23%	8% - 10%
May*	11% - 19%	2% - 13%
June*	6% - 19%	9% - 12%
July*	9% - 22%	10% - 15%
August*	14% - 23%	14% - 21%
September*	7% - 11%	16% - 31%
October	6%	5%
November	5%	6%
December	6%	12%

* range reflects variation according to bathing visits (for large sandy coastal sites, visits will increase in summer time, towards the upper end of the range).

Source: based on CRN (1996), in Environment Agency (2003)

Default data

Where count data are not readily available, the number of recreational trips to the beach can be estimated using default data. To estimate the number of recreational trips, the following steps should be followed:

Step 1: determination of the appropriate distance from which visitors are likely to travel to the affected beach. Table A4.4 sets out some default distances that are based on the specific properties of different beach types. A review of the literature has shown significant differences between England and Wales, hence different assumptions are used for beaches in these countries.

Table A4.4 Distances from which a visitor may travel to visit a particular beach

Beach Type	Estimated Distance	
	England	Wales
Small beach, little access, valued for 'peace and quiet'	30 km	15 km
Small resort, good access, some beach facilities available	50 km	25 km
Large resort (long beach), facilities and entertainment available	130 km	65 km

Source: Environment Agency (2003)

Step 2: estimation of the adult population living within the distance identified from Table A4.4. To use population densities the practitioner will need to multiply the square of the distance from which a visitor may travel to the beach by 3.14 and by the population density to obtain the visitor population[13]. For example, the population density in Lincolnshire is 100 people/km^2. For a small resort, we would expect visitors to travel from up to 50km away. This gives a total potential visitor population of 785,000.

Step 3: not all of these potential visitors are likely to visit a beach. The estimated number of beach visitors is obtained by multiplying by 3% for beaches in England and 8% for beaches in Wales (based on CRN 1996, as reported in RPA 2003). For the small resort in Lincolnshire, the number of beach visitors can be estimated at 24,000.

Step 4: visitors may make more than one visit to the beach each year. Table A4.5 sets out the number of trips made by visitors to the beach/seaside each year. Using Table 6.26, the number of visits to the beach in Lincolnshire can be estimated at between 140,000 and 350,000 per year.

Table A4.5 Number of trips made to the beach/seaside each year

Beach Type	**Number of Trips per person per year**	
	England	**Wales**
Recreation trips	9.75 - 14.5	15.7 - 24

Source: CRN (1996), in Environment Agency (2003)

Step 6: where there are alternative sites of a similar type and quality within the distance that a visitor may travel, only a proportion of all trips are likely to be made to the affected site. Thus, the number of visits to the site will be obtained by dividing the total number of visitors by the number of alternative sites plus one

Number of households

Some of the BT values use willingness to pay per household per annum rather than per visit. Where there is a site count, the total count represents the number of household groups. The number of household visits is obtained by dividing the count by 2.3. The next step is to follow the approach set out above to adjust for the day and month in which the count was taken. Finally, the number of household visits needs dividing by the number of trips made per year (see Table A4.5).

[13] The formula to be applied is: π (3.14) x (distance a visitor may travel)^2 x population density.

Reality checks

Table A4.6 provides an indication of the number of recreational visitors estimated for different beach types (as reported in RPA, 2003). Note that not all these types of visitors are included, and thus figures may under or over-estimate the total number of visitors. The figures are offered for comparison purposes only, i.e. for checking whether the estimates are of the right order of magnitude, thus they do not aim to replace estimates for the number of visitors to the site.

Table A4.6 Numbers of users at different beach types

Beach Location	Number of Recreation trips per Year	Beach/Site Description
Pembrokeshire Coast Path[1]	1,500,000 (4,300/km of path)	Coastal path is main site for walking in area, running for 300km from Amroth to Poppit
Whitmore Bay, Wales[2]	210,000	Large sandy beach with easy access and good facilities
Llandudno North Shore[2]	34,000	Resort town with wide promenade. Good access and facilities
Llandanwg[2]	23,000	Less of a resort beach with mixed sand, shingle and rock. Attracts active visitors rather than sunbathers. Good access and some facilities
Pendennis Head, Cornwall[2]	26,000	On South West Coast Path, important visitor attraction, car park
St Anthony Head, Cornwall[2]	9,200	On South West Coast Path, car park
South West Coast Path[2]	1,100/km of path	Estimate taken from South West Coast Path Survey; important and well-used footpath around the coastline
Blackpool, central[2]	130,000	Large resort with wide beach and promenade
Mablethorpe, Lincolnshire[3]	166,000	Large resort on Lincolnshire coast, includes dog walking, walking, games by holiday makers, day trippers and local residents
Heysham, North West[2]	48,000	Sandy, popular beach
Sutton-on-Sea, Lincolnshire[3]	71,000	Spacious beach, with peace and quiet one of its main attractions
Haverigg, North West[2]	9,000	Sand dunes, high amenity
Huttoft, Lincolnshire[3]	11,000	Small resort, peace and quiet an important attraction, people can drive onto car terrace to look at sea
Allonby South, North West[2]	600 to 2,300	Sand and rock, slightly muddy, popular beach

[1] Includes water sport participants
[2] Informal recreation only
[3] Includes bathers
Source: based on Environment Agency (2003)

BT for coastal recreation benefits

In 1992, the Flood Hazard Research Centre developed and tested a variant of the CV method, based on the value of enjoyment per adult visit (VOE). This is one of the recommended approaches for use in coastal recreation benefit assessment in the Multi-Coloured Manual (Penning-Rowsell *et al*., 2003) and is also accepted by FCDPAG 3 at the pre-feasibility stage. In the VOE approach, respondents are asked to put a value on their enjoyment of a day's visit under varying options in £'s and pence, therefore measuring use value alone. Visitors are classified as follows:

- **local visitors:** those living within a 3 mile radius of a site, which is deemed to be possible walking distance;

- **day visitors:** anyone starting and finishing their trip from their permanent home, including some who may define themselves as locals but who live more than three miles away from the site; and

- **staying visitors:** anyone staying away from home for one or more nights. This includes visitors not staying at or near the site but making a day trip there while staying away from home.

The annual recreation benefits can then be determined as:

Annual benefits = £ value of the option (VOE gains and/or losses or WTP valuations) x number of visits per annum (VOE) or number of beneficiaries/visitors (WTP).

Table A4.7 shows average losses under the 'do-nothing' options. Table A4.8 shows average gains under the 'do-something' options, including a description of the change with the option.

Table A4.7: £ losses per adult visit with erosive changes at coastal sites – 'do-nothing'

Site	Change with erosion	% expecting less enjoyment	£ loss mean per adult visit – updated to 2001			
			Local	Day	Staying	All
Beach and promenade erosion						
Yellow Manual Standard data: 4 sites	Deterioration in beach and promenade	85%	2.36	3.53	8.28	5.36
Lee-on-Solent	Shingle beach erosion	NA	3.05	2.12	3.74	2.74
Herne Bay Visitors survey	Deterioration in beach, seawall and promenade collapsed in parts	-	2.72	2.55	10.61	5.25
Cliftonville	Cliff erosion, deterioration in beach, cliff top promenade closed in parts	83%	6.46	6.32	5.65	5.91
Corton (Residents staying visitors)	Cliff erosion, deterioration in beach and seawall very reduced access to, and along beach and seawall	81%	2.08	-	1.82	1.89
St Mildred's Bay	Severe damage to esplanade wall, esplanade unsafe and closed in parts	92%	6.92	7.84	8.25	7.71
Hastings	Beach deterioration	NA	NA	NA	NA	5.43
Breach scenarios						
Hengistbury Head	Breach, boat access only to Head, reduced cliff top area and paths	62%	4.44	3.26	3.55	2.80
Hurst Spit	Breach to shingle spit, access by boat only	98%	2.41	6.36	3.60	4.90

Source: Penning-Rowsell *et al* (2003)

Table A4.8: £ Gains per adult visit with coastal protection scheme options at coastal sites – 'do-something'

Site	Change with scheme options	£ gain mean per adult visit – updated to 2001			
		Local	Day	Staying	All
Beach and promenade erosion					
Yellow Manual Standard data: 4 sites	Nourished beach and promenade	1.55	2.69	1.95	2.22
Lee-on-Solent	(a) Shingle beach renourishment	1.29	1.23	1.26	1.26
	(b) Rock groynes	1.24	1.18	0.75	1.24
Herne Bay Visitors survey	(a) Reef or jetty with no boat facilities	2.88	2.46	5.53	3.82
	(b) Reef or jetty with boat facilities	2.74	1.87	1.73	1.98
	(c) Higher seawall, and promenade, rock groynes	1.74	2.46	2.81	2.45
Cliftonville	(a) Concrete lower promenade	1.75	1.59	4.19	3.36
	(b) Rock lower promenade	0.89	1.37	2.47	1.97
Corton	(a) Hold the line for a limited period Short term protection to cliff, limited access to beach and along seawall	1.99	-	1.84	1.88
	(b) Hold the line for a longer period >50 years. Full access along renewed seawall and onto all the beach from village	13.64	-	6.83	8.40
	(c) Managed retreat. Sea defences and seawall removed to leave a 'natural' seafront', direct access from village to beach	-0.20	-	1.81	1.30
St Mildred's Bay	Improved beach and promenade	2.39	1.73	1.98	2.10
Hastings	Beach improvement	NA	NA	NA	
Breach Scenario					
Hengistbury Head	(a) five rock groynes full cliff protection	-0.01	0.53	-0.22	0.04
	(b) three rock groynes partial protection	-2.16	-1.07	-2.72	-2.13
	(c) Beach nourishment Annual disruption	-1.96	-3.18	-4.69	-3.22
Hurst Spit	Slightly enlarged shingle spit	0.83	0.33	0.59	0.51

Source: Penning-Rowsell *et al.* (2003)

WTP values for coastal protection are given in Table A4.9. The problem with these, however, is that they do not allow for option comparison between 'do something' options, thus limiting their applicability to the appraisal of different flood and coastal defence standards of protection.

Table A4.9 Willingness to pay for coastal protection

Site	Survey date	Sample size and type	Payment vehicle	WTP format	% WTP	£ Mean WTP: Updated to 2001
Peacehaven cliff top	1988	214 Residents	Increased rates and taxes p.a.	WTP diagram	55% overall	
				50p starting point		2.92
				£1 starting point		4.52
Herne Bay	1990	189 Residents	Extra national and local taxes p.a.	WTP diagram	3% overall	
				40p starting point		7.48
				80p starting point		8.94
Herne Bay	1990	143 Visitors	Extra national and local taxes p.a.	WTP diagram	55% overall	
				40p starting point		4.81
				80p starting point		6.33
Hurst Spit	1991	550 Visitors	Additional taxes p.a.	WTP payment ladder	74% overall	
				25p starting point		12.14
				£32 starting point		53.52
St Mildred's Bay	1992	462 Visitors	Extra national and local taxesp.a.	WTP payment ladder and two starting points: 25p and £128	61% overall	39.70
Cliftonville	1993	528 Visitors	Small increase in national and local taxes p.a.	WTP payment ladder with two starting points: 50p and £64	62% overall	23.79
Caister (1)	1997	452	Extra taxes every year	Open question	NA	
		Visitors				34.84
		Local residents				28.47

Source: Penning-Rowsell *et al.* (2003)

A5. Sensitivity Analysis

Sensitivity analysis is an important part of the economic appraisal of impacts as a means of checking the robustness of the valuation of impacts. It is recognised as a paramount step in the different appraisal methodologies, including flood management and coastal defence appraisals, but also more general government guidance. The Green Book (HM Treasury 2003), for instance, notes that where there is significant uncertainty about values assigned to outputs and outcomes, or to their probabilities, sensitivity analysis can establish how vulnerable the conclusions of the appraisal are to alternative plausible assumptions (HM Treasury 2003).

Within the flood management and coastal defence context, FCDPAG 3 notes that, for major projects, it is particularly important to identify 'switching points' where a change in the assumptions would change the option choice (MAFF 1999).

The purpose of the sensitivity analysis should thus be to assess the impact that changing the values of parameters would have on the benefits of the option, that is, the impacts of changing assumptions on calculating the number of users affected, when applicable, and/or benefits transfer values. FCDPAG 3 also lists other possibilities for inclusion within the sensitivity analysis, and those more applicable to benefits transfer are:

- timing of benefits/dis-benefits, that is, when impacts are expected to arise and cease; and
- threshold of flooding (for instance, sensitiveness about the level and frequency of flooding affecting recreation and angling under different management options).

It is important, however, to undertake a sensitivity analysis in a reasonable manner. The Green Book stresses that although sensitivity analysis can be carried out on all parameters associated with uncertainty, it is essential that this is undertaken for those factors that have the most significant impacts on the NPV. Thus, we recommend sensitivity analysis only when there is a high degree of uncertainty to the benefits and any changes in parameters could prove important to the end results.

References

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